



Designing E-Services for Improving Crisis Communication in Local Municipalities: Cooperation with Apartment Associations

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Abstract

In this study, we develop and formatively evaluate a conceptual e-service framework to support municipalities and apartment associations in crisis preparedness. Using an exploratory design-oriented case study informed by selected Action Design Research principles, we combine a World-Café-style session with older residents, expert consultations, and secondary-data analysis. The study develops the Coordination Framework for Municipal-Apartment Association Crisis Preparedness (C-MAACP Framework), which integrates municipal coordination, apartment-association participation, register-supported information management, privacy-aware access, preparedness-status visualization, and multi-channel communication. The concept was formatively evaluated with experts from the Estonian Rescue Services Agency and the Tallinn Municipal Police Department. The findings suggest that the framework can support municipal crisis preparedness by improving information coordination, clarifying stakeholder roles, and structuring cooperation between municipalities and apartment associations. The study contributes a transferable conceptual design framework while identifying implementation, adoption, legal, and privacy issues for future research.

Keywords Crisis management · E-services · Emergency evacuation · Municipal crisis preparedness · Apartment associations · Digital crisis communication

1 Introduction

The purpose of this research is to examine how crisis preparedness within local municipalities can be strengthened through digital cooperation with apartment associations, using the Kristiine district¹ as a case study.

Unfortunately, a survey conducted by the Tallinn Municipal Police Department (City of Tallinn, 2022) shows that Tallinn's apartment associations² are not adequately prepared for crises.

Successful crisis management (ISO22301- 2019; ISO22361- 2022; ISO22326- 2018; ISO22320- 2018; ISO22300- 2021, 2025) at the municipal level requires close collaboration between local governments and apartment associations. This collaboration encompasses identifying vulnerable populations, assessing their living conditions and potential needs across various crisis scenarios, establishing direct communication channels, and jointly developing

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¹ <https://www.tallinn.ee/en/kristiine>

² As the case study in this paper focuses on Estonia, we use the term “apartment association” from the official English translation of the relevant Estonian law (Riigikogu, 2014).

comprehensive preparedness and response plans. Currently, no dedicated information technology solution exists to support these activities. According to the Estonian Union of Co-operative Housing 96% of apartments have been privatized. All of these privatized apartments are managed through apartment associations and housing cooperatives³, making them key stakeholders in crisis situations.

The global population of older adults is increasing rapidly, with the number of people aged 60 or above growing by about 3% annually. Europe currently has the highest share, and by 2050 most regions of the world are expected to have at least one quarter of their population in this age group. The number of older persons is projected to reach 1.4 billion in 2030 and 2.1 billion in 2050 (United Nations and Social Affairs, 2017).

Accordingly, while the broader crisis-preparedness context concerns vulnerable populations more generally, the empirical resident perspective examined in this study focuses specifically on older adults.

Digital transformation plays a pivotal role in enabling socially responsible and sustainable public service. Pappas et al. (2023) emphasize that such initiatives must be designed with clear societal value and stakeholder inclusion in mind. Pappas et al. (2023) highlight that effective digital solutions require not only technological capability but also governance structures that support transparency, trust, and equitable participation. This perspective underscores the importance of developing digital tools that strengthen collaboration between municipalities and local communities, particularly in contexts where coordinated action is essential for public safety and crisis resilience.

The aim of this paper is to investigate crisis preparedness and management (ISO22301-2019, 2019; ISO22361-2022, 2022; ISO22326-2018, 2018; ISO22320-2018, 2018; ISO22300-2021, 2021; ISO22300-2025, 2025; Draheim & Pirinen, 2011) practices in urban areas. The COVID-19 pandemic revealed the urgency for municipalities to develop swift and adaptive crisis response mechanisms. In parallel, increased awareness of natural and industrial hazards has reinforced the role of systematic monitoring in efforts to minimize impacts through proactive prevention, mitigation, and preparedness strategies (ISO22326-2018, 2018). Therefore, it is essential to strengthen existing systems and enhance cooperation between local governments and apartment associations through the use of digital solutions always before the next large-scale emergency occurs. A local government has the legitimacy to manage public affairs, whereas a community is a social unit defined by shared networks, beliefs, values, norms, and cohesion among members, who

represent social capital and identify with the group (Kamberi, 2021).

Estonia's advanced e-governance infrastructure and well-developed digital services present significant opportunities to improve crisis preparedness (Lips et al., 2023; Saputro et al., 2020). These capabilities should be actively used to strengthen digital cooperation between local governments and apartment associations. Through the integration of national databases and the creation of e-services that support apartment associations, municipalities can improve coordinated and effective crisis response practices. In Estonia, the use of e-services is broadly supported and widely accepted by citizens (Tsap et al., 2020). However, the capacity and preparedness of apartment associations vary significantly, making it essential to identify effective solutions that foster stronger cooperation and enhance crisis management capabilities across different contexts. There are approximately 6,000 apartment associations in Tallinn, once more reflecting their significant role in local crisis preparedness⁴.

The voluntary status of apartment associations and their primary function as property owners have resulted in unclear crisis preparedness responsibilities. To foster effective engagement, these organizations need structured guidance and motivation to develop capacity, participate in planning processes, and undertake proactive actions that enhance their resilience and that of their communities.

Therefore, based on the problem statement, the main research question is:

- How to improve digital cooperation between local governments and apartment associations to prepare for crises?

To answer the main research question, two sub-research questions were formed as follows:

- What kind of digital infrastructure is required to guide crisis preparedness efforts and ensure a complete, up-to-date online overview of apartment associations in the district?
- How can information be effectively shared and communication maintained with older adults during emergency crises?

Answering the main research question requires identifying relevant databases that can enhance crisis response, improving information sharing among stakeholders, and reinforcing communication channels. Moreover, it is essential to incorporate the perspectives of those who may be affected

³ <https://ekyl.ee/en/organisation/housing-cooperatives-in-estonia/>

⁴ <https://www.tallinn.ee/en/kriisiennetus/news/ancillary-questionnaire-survey-regarding-crisis-preparedness-apartment-association-managers>

by crises, to address their needs, and take user experience into account. As part of the research, a World-Café-style discussion (Löhr et al., 2020) was organized with older residents from the local community; we met with experts, analyzed secondary data sources, and ultimately designed a new e-service. The proposed e-service was evaluated during a meeting with crisis management experts from the Estonian Rescue Services Agency⁵ and Tallinn Municipal Police Department⁶.

The research paper is structured as follows: Section 2 presents an analysis of the relevant literature. Section 3 gives an overview of the research background, i.e., the Estonian crisis management context. Section 4 details the research design and the research methodology used. Section 5 presents the results of the research. Section 6 presents the designed e-service. Section 7 describes the formative expert evaluation of the conceptual e-service framework. Section 8 discusses the findings in relation to IS, e-government, and crisis-management research. Section 9 summarizes the limitations and future research directions. The paper finishes with conclusions and final remarks in Section 10.

2 Literature Review

This chapter presents a literature review that examines existing research on enhancing crisis communication in local municipalities through e-services and digital solutions. The aim is to identify current approaches, technologies, and key findings that can inform the design of an e-service to support collaboration between local governments and apartment associations in crisis preparedness and response.

The literature review was conducted in two stages to capture both national and international perspectives on the research topic. The first stage, completed in 2023, focused on the Estonian Context and involved searches through the TalTech Library Portal⁷ and EBSCOhost⁸ using relevant keywords related to crisis management and local municipalities. The second stage, conducted in 2025, extended the scope to a global level through searches in SCOPUS⁹ and Google Scholar¹⁰, identifying recent international studies and research trends. Together, these stages provided a comprehensive and up-to-date overview of the field by combining national insights with a broader international perspective.

⁵ <https://www.rescue.ee/en/>

⁶ <https://www.tallinn.ee/en/tallinn-municipal-police-department>

⁷ <https://taltech.ee/en/all-databases>

⁸ <https://research.ebsco.com/>

⁹ <https://www.scopus.com/>

¹⁰ <https://scholar.google.com/>

2.1 Estonian Context

Recent experiences during the COVID-19 pandemic provide important lessons for crisis management. Although many digital solutions were introduced, several faced issues with adoption and usability. For example, the Estonian contact tracking app HOIA did not achieve the expected user engagement and trust, illustrating the importance of considering user experience and motivation in the design of digital crisis tools (Sousa & Kalju, 2022). Continued analysis of both successful and unsuccessful solutions is needed to inform the development of more resilient and user-centered e-services.

On the other hand, local municipalities were successful. Local governments have demonstrated resilience and operational capacity, as evidenced by their effective management of the COVID-19 pandemic. These capabilities stem from accumulated expertise and sustained investment in local public healthcare systems, as well as the availability of comprehensive databases and governance structures grounded in strong linkages with local communities (Vongsayan & Nethipo, 2021). Vongsayan and Nethipo (2021) are confident that the responsibility for successfully managing future crises will increasingly fall on local municipalities.

The development of new e-services should build on insights from recent crises, as ICTs play a vital role in disaster management throughout all stages of the disaster cycle (Kontogiannis et al., 2017). ICT encompasses the use of digital technologies for registration, online information sharing, communication, monitoring, service provision, crisis management, and related activities. Advances in artificial intelligence and machine learning further enable these processes to be automated, reducing the need for constant human intervention. “In Estonia, 99% of public services are available online 24 hours a day”¹¹. This creates a highly suitable environment for ICT-based research and experimentation with e-governance solutions, state databases, and the X-Road¹² data exchange system (Saputro et al., 2020), supported by strong civic engagement and digital participation. New e-services developed in this context could serve as a model for other countries. The need for such tools is therefore significant.

The concept of civil society is interpreted according to the definitions provided in ISO 22300:2021 (ISO22300-2021, 2021) and its current edition, ISO 22300:2025 (ISO22300-2025, 2025).

In Estonia, local governments play a central role in crisis management and in the development of respective action plans – making effective collaboration with residents and

¹¹ <https://e-estonia.com/solutions/e-governance/government-cloud/>

¹² <https://x-road.global/>

apartment associations crucial for strengthening community resilience. Although municipalities provide various forms of support such as training, financial assistance, and advisory services, these efforts remain fragmented. Since apartment associations hold a distinct position within civil society, their involvement in crisis management could be further developed and systematically supported.

Approximately 96% of apartments have been privatized in Estonia, and these units are managed through apartment associations and housing cooperatives¹³. Moreover, apartment associations are required to prepare for crises. To respond effectively, each association should develop a plan that describes how to act whenever essential services such as water, district heating or electricity are disrupted¹⁴. E-government initiatives have the potential to strengthen the relationship between citizens and public authorities by ensuring comprehensive access to public information. Such transparency fosters citizen satisfaction and promotes greater participation in governance processes (Burlacu et al., 2021).

Currently, there is no functioning e-service that supports cooperation between apartment associations and local municipalities. This calls for testing new digital solutions. Progress, however, depends on political commitment and the establishment of appropriate regulatory frameworks. Equally important is understanding residents' perspectives on what kinds of e-services are needed during crises.

2.2 International Context

Globally, municipalities continue to draw lessons from recent crises, highlighting the need for innovative techniques and guidelines that reduce vulnerability and strengthen resilience, adaptive capacity, and the sustainability of urban environments.

Information and Communication Technologies (ICTs) serve as critical tools in disaster management, exerting a broadly positive influence and being utilized across all phases of the disaster management cycle (Kontogiannis et al., 2017). To maintain essential infrastructure and services, emerging technological tools can also be utilized. Contemporary crisis management increasingly incorporates innovations such as drones, blockchain applications, cloud-based services and decentralized solutions (Javadpour et al., 2023; Li et al., 2024).

Bharosa et al. (2007) demonstrate how structured information management can enhance coordination among crisis responders by effectively integrating technological tools into operational workflows. Their findings from

large-scale field exercises in the Port of Rotterdam highlight that dedicated information managers significantly improve situational awareness and support more efficient decision-making during emergencies. Bharosa et al. (2009) further show that crisis response increasingly relies on shifting from system-centric setups toward network-centric operations that enable flexible information sharing across organizational boundaries. Their field studies reveal that such network-oriented approaches enhance the adaptability and responsiveness of crisis management networks, particularly when dealing with complex, multi-actor emergencies.

Bharosa and Janssen (2010) emphasize that effective crisis response depends not only on the availability of ICTs but also on an organization's ability to adapt its information management practices as conditions evolve. Their dynamic-capability perspective highlights how flexible processes and interoperable systems are essential for leveraging technological innovations during rapidly changing disaster scenarios.

Various studies emphasize the importance of direct and open communication, growing reliance on social media, shared understanding, trust in local leadership, and strong stakeholder engagement in crisis cooperation and information sharing (Eriksson, 2018; Austin & Jin, 2018).

Dubey et al. (2024) show that organizations can better exploit technological innovations during crises when they combine digital transformation efforts with strong inter-organizational alliances. Their multi-method study demonstrates that such collaborations enhance dynamic supply chain capabilities, enabling more resilient and adaptive responses under rapidly changing conditions.

The emergency management cycle comprises mitigation, preparedness, response, and recovery. Across all four phases, citizen participation is considered crucial, placing responsibility on local governments to promote meaningful involvement (Wu et al., 2016). ISO 22326:2018 outlines guidance for hazard monitoring in facilities with known risks, including planning, implementation, operation and control, and ongoing review and improvement (ISO22326-2018, 2018). Tallinn and Estonia are highly digitalized and have many popular e-services - successful solutions of a new e-service bear on the technological readiness of organizations. For example, in an examined Norwegian municipality (Gjesten et al., 2017), the integration of technological solutions into healthcare services remained largely aspirational rather than operational, primarily due to a low degree of organizational readiness.

On the other hand, the design of a new e-service must deal with the threat that the new service might not be accepted. The extensive body of literature on acceptance stands in stark contrast to the persistently low adoption rates of public e-services across most European countries (Distel, 2020).

¹³ <https://ekyl.ee/en/organisation/housing-cooperatives-in-estonia/>

¹⁴ <https://www.olevalmis.ee/en/news/crisis/apartment-associations-still-have-time-to-apply-for-crisis-support/>

Regarding the quality of different e-services, the picture is very different. For example, the quality of public e-services related to labor market support exhibits substantial variation across European countries (Liutkevičius & Ben Yahia, 2022).

2.2.1 Use of Social Media

Numerous case studies examine crisis communication in different contexts, including research on Hurricane Irma (Knox, 2023), Ukraine's decentralized crisis response during the Russo-Ukrainian war (Keudel & Huss, 2024), the use of social media during the Louisiana floods (Scott & Errett, 2018), social media use in communicating Zika-related health risks (Hagen et al., 2020) and broader overviews (Hagen et al., 2018), as well as the use of Twitter by local governments during the 2016 Italian earthquake (Splendiani & Capriello, 2022).

Several studies have examined the COVID-19 pandemic response at different levels of governance, however, for the purposes of this article, the local or municipal level is most relevant. The literature includes local governments' use of social media during the pandemic (Padeiro et al., 2021), social media communication by English local government organisations (Love et al., 2023), and national case studies such as Korea's response to COVID-19 (Lee-Geiller & Lee, 2022). Spanaki et al. (2024) highlighted how mindfulness and digital resilience shape both individual and organisational information management during crises, offering further insight into local governments' communicative capacity in pandemic contexts.

Initial findings from the literature review indicate that the use of social media in local crisis communication is an increasingly prominent topic. Examples include studies on social media in emergency management and Twitter as a tool for communicating risks to the public (Panagiotopoulos et al., 2016), surveys of local governments in Florida on social media and crisis communication (Neely & Collins, 2018), the role of social media as an opportunity for local communities (Zamora Medina & Losada Díaz, 2016), and social-media-based crisis communication (Noor et al., 2024).

Social media is becoming an important tool for public agencies and emergency managers during crises. While federal-level adoption has been well studied, there is comparatively little evidence on how local agencies use these platforms, or how adoption differs across organizational and demographic contexts (Neely & Collins, 2018).

One of the central challenges in emergency management is communicating risk effectively to the public. At times the aim is to raise awareness of emerging threats, while in other situations it is necessary to prevent unnecessary public

concern. Social media enables the rapid sharing of critical information and can help shape public responses during emergencies (Panagiotopoulos et al., 2016). As this field continues to evolve, further research and practical case studies are needed.

Moreover, social media platforms enable rapid communication and help overcome traditional barriers to information exchange, allowing active citizens, non-governmental organizations (NGOs), private sector actors and other stakeholders to participate. Findings show that NGOs display significantly higher levels of online engagement with citizens than local governments. In particular, NGOs maintain a more active presence on their Facebook pages than governmental institutions (del Mar Gálvez-Rodríguez et al., 2019).

Sadhukhan et al. (2018) demonstrate that social media mining can significantly enhance post-disaster management by enabling authorities to extract timely, actionable insights from user-generated content. Their work highlights how computational intelligence techniques help identify emerging needs, assess situational dynamics, and support more informed decision-making during crisis response. By leveraging real-time social media data, the authors show that disaster management plans can become more adaptive, data-driven, and responsive to affected communities.

Overall, research on the role of apartment associations in crises remains scarce, despite evidence that close resident engagement and open communication enhance preparedness. Meanwhile, studies on social media use in crisis communication are steadily growing.

2.2.2 Barriers

There are many documented obstacles to improving crisis management and preparedness. Nekoei-Moghadam et al. (2016) indicate that significant challenges persist across various aspects of planning, including the lack of coherent programs, insufficient attention to healthcare needs, inadequate inter-agency and inter-organizational coordination, and limited training for volunteers and community members. Although responsibilities and decision-making processes are defined by law, the contribution of voluntary organizations remains essential. Disasters occur when events exceed the capacity of natural and social systems to cope with their impacts. Increasingly frequent and intense rainfall is already overwhelming both structural and nonstructural mitigation measures, raising concerns about future damage. While structural interventions are necessary, they require considerable time to implement.

Janssen and van der Voort highlight that crisis response efforts during COVID-19 were often hampered by rigid institutional structures, fragmented decision-making, and

insufficient agility in public-sector governance (Janssen & van der Voort, 2020).

Paulus et al. (2022) show that cognitive biases significantly impair crisis decision-making, leading different groups of decision-makers to systematically misjudge risks and response options. Their experimental findings indicate that such biases can exacerbate coordination problems and impede the effective implementation of crisis management measures.

Taken together, the literature highlights several interconnected challenges that inform the design of municipal crisis e-services. Effective crisis preparedness requires timely and reliable information exchange across organizational boundaries, interoperable digital infrastructure, communication channels that can reach heterogeneous resident groups, and sufficient organizational and user readiness for adopting digital services. Prior research also emphasizes the importance of citizen participation and cooperation among public authorities, community actors, and other local stakeholders. At the same time, the specific role of apartment associations as digitally connected intermediaries between municipalities and residents remains comparatively underexplored. These gaps provide the conceptual basis for the proposed e-service, which combines cross-organizational information exchange, register-supported interoperability, multi-channel communication, and municipality–apartment association coordination. The specific design requirements derived from the empirical findings are presented and linked to these broader literature-based design directions in the subsequent sections.

The main literature-derived challenges and their implications for the proposed e-service are summarized in Table 1.

3 The Estonian Crisis Management Research Context

At present, there is no functioning crisis preparedness or communication solution for apartment associations in Estonia, despite a clear need for one. Robust monitoring systems can provide continuous, timely and accurate data that is relevant and easy to interpret, thereby supporting informed decision-making in both public and private emergency management (ISO22326-2018, 2018). To propose an effective solution for crisis management, it is essential to understand

the existing legal framework, the relevant stakeholders and the available digital resources.

Because the regulatory and public-warning environment continued to evolve after the primary empirical data collection, this section includes contextual updates up to 2025 where they are relevant for interpreting the continued need for municipal crisis-preparedness e-services.

During the final revision stage, the Estonian crisis-management legal framework was further updated: the Crisis Situation and National Defence Act was adopted on 2 June 2026 and published in Riigi Teataja on 30 June 2026, with entry into force scheduled for 1 October 2026 (Riigikogu, 2026). Because this development occurred after the primary empirical data collection and after the 2025 contextual updates, it is treated here as a legal-context update rather than as part of the empirical evidence.

3.1 Legislation

Effective crisis management depends on a supportive legislative framework at both the government and municipal levels. Tables 2 and 3 provide a detailed overview of legislation and regulations for crisis situations issued by the Parliament of Estonia and Government of the Republic. Table 4 provides an overview of legislation and regulations for crisis situations issued by the Tallinn City Government and City Council.

Crisis management within Tallinn City is governed by a structured framework of regulatory instruments, some of which are designated exclusively for internal administrative application.

According to the Emergency Act, an emergency is defined as an event, a chain of events, or an interruption of a vital service that endangers the life or health of many people, causes major property or environmental damage, or severely disrupts the continuity of vital services. Addressing such situations requires the prompt and coordinated actions of multiple authorities, the use of an exceptional command structure, and the involvement of more personnel and resources than usual (Riigikogu, 2017a).

In Estonia, e-services are used daily, and many of them are essential. The Act defines a vital service as one that has a critical impact on the functioning of society, where its interruption poses an immediate threat to life, health, or the operation of another vital or public service. A vital service

Table 1 Literature-Derived challenges and e-service design implications

Theme	Identified challenge	E-service implication
Information management	Fragmented information flows	Shared crisis information and coordination
E-government and interoperability	Cross-system data integration	Register integration via X-Road
Crisis communication	Unequal channel reach	Multi-channel communication
Technology readiness and adoption	Readiness, trust, and adoption barriers	Staged implementation and user support
Citizen participation	Limited integration of local intermediaries	Municipality-apartment association cooperation

Table 2 Overview of legislation and regulations relevant to crisis situations issued by the parliament of Estonia

Regulation	Description
Local Government Organization Act (Riigikogu, 1993)	Grants local governments the right, authority, and duty to independently organize and manage local issues based on the legitimate needs and interests of their residents. This right is exercised by democratically formed bodies of power within a rural municipality or city, as provided for in the Constitution of Estonia. Local governments operate pursuant to law and in consideration of the specific development of their municipality or city.
Emergency Act (Riigikogu, 2017a)	Establishes the legal framework for crisis management, including emergency response, continuity of vital services, and cooperation between authorities. Defines key terms and outlines procedures for declaring and resolving emergencies, involving Defence forces, ensuring electronic security, and organizing mass evacuations. A recent amendment to the Emergency Act (adopted on 24 September 2025) regulates siren installation and testing and broadens EE-ALARM integration across media and mobile applications, starting from July 1, 2026 new buildings must also include a shelter (Riigikogu, 2025).
Crisis Situation and National Defence Act (Riigikogu, 2026)	Adopted on 2 June 2026 and scheduled to enter into force on 1 October 2026, this act consolidates the legal framework for crisis situations and national defence. It strengthens crisis-role clarity by specifying the responsibilities of state authorities, local governments, providers of vital services, and other critical actors. For local governments, the act confirms responsibilities related to essential services, evacuation-location preparation, evacuation support, key local services, and informing residents.
Apartment Ownership and Apartment Associations Act (Riigikogu, 2014)	Regulates the formation and operation of non-profit apartment associations for managing shared property and representing owners. While not a crisis law, it supports e-service implementation by leveraging apartment associations as a local communication and coordination structure during emergencies.
Rescue Act (Riigikogu, 2010)	Regulates rescue operations, including prevention and response to emergencies. Defines the structure and responsibilities of the Estonian Rescue Services Agency, including its role in mass evacuations and crisis response. Supports integration with e-services for communication and coordination.
Chemicals Act (Riigikogu, 2015a)	Regulates the handling and use of chemicals and sets requirements for managing chemical risks. Relevant for hazardous material incidents, supporting evacuation planning and public risk communication through e-services.
Building Code (Riigikogu, 2015b)	Sets requirements for the design, construction, and use of buildings. Ensures structural safety during crises, supporting evacuation planning and public safety communication via e-services.
National Defence Act (Riigikogu, 2015c)	Provides the legal basis for national defense, including military involvement in civil emergencies. Relevant for large-scale crises where coordination with defense authorities and information sharing via e-services may be required.
Motor Vehicle Act (Riigikogu, 2017b)	Regulates motor vehicle use. Important for organizing transportation during mass evacuations and deploying emergency services. E-services can help coordinate transport resources efficiently

Table 3 Overview of regulations relevant to crisis situations issued by the Government of the Republic

Regulation	Description
(Vabariigi Valitsus, 2021a).	Detailed regulations that specify the procedures for crisis management, cooperation, public information, and large-scale evacuation. These regulations provide the details for how the principles in the main acts are implemented. For instance, they include requirements for conducting risk analyses and preparing continuity plans for essential services, as well as guidelines for their development and implementation
(Vabariigi Valitsus, 2017b)	Procedures for emergency management, inter-agency cooperation, public communication, information sharing, and large-scale evacuation
(Vabariigi Valitsus, 2017a)	Procedure for calculating and compensating for compulsory expropriation and use of property during a state of emergency.
(Vabariigi Valitsus, 2015)	Procedure for involving the Defence Forces and Defence League Police in rescue operations and emergency tasks.
(Vabariigi Valitsus, 2011)	Procedure for cooperation between state and local authorities and participants in a rescue event.
(Vabariigi Valitsus, 2021c)	List of potential emergencies, requirements and procedures for preparing resolution plans, responsible authorities for planning and managing emergencies, and guidelines for organizing risk communication.
(Vabariigi Valitsus, 2021b)	Requirements and procedures for conducting and organizing crisis management exercises.

includes not only the service itself but also the infrastructure, equipment, staff and reserves required for its functioning (Riigikogu, 2017a).

Within this context, any interruption in Internet connectivity or digital service provision would exert a substantial impact on Tallinn's residents, whose daily activities are increasingly mediated by these technological infrastructures.

In the context of scenarios necessitating emergency evacuation, it is essential to recognize that, pursuant to the Estonian Emergency Act, mass evacuation is defined as the temporary relocation of individuals from a hazardous area to a secure location during an emergency situation (Riigikogu, 2017a). When apartment associations demonstrate preparedness for evacuation and maintain sufficient reserves and operational capacities, municipal authorities are able to

Table 4 Overview of legislation and regulations for crisis situations issued by the Tallinn City Government and City Council

Regulation	Description
Descriptions and Operational Requirements of Vital Services organized by the City of Tallinn (Tallinna Linnavolikogu, 2019)	Specifies requirements for organizing vital services in Tallinn, including electricity, water, heating, and communications. Supports local implementation of the Emergency Act and guides e-services in ensuring service continuity and security.
The formation of the Tallinn Crisis Committee and the committee's statute (Tallinna Linnavalitsus, 2018)	Defines the structure and procedures of the Tallinn Crisis Committee, responsible for coordinating crisis response at the city level. Supports e-service integration to enhance communication with city departments and the public.
Restricting the traffic of vehicles with dangerous goods in the city of Tallinn (Tallinna Linnavalitsus, 2006)	Outlines rules for transporting dangerous goods within city limits. Supports crisis planning for hazardous materials and enables e-services to manage traffic and inform the public during emergencies.
Traffic routes of N2 and N3 category motor vehicles in the city of Tallinn (Tallinna Linnavalitsus, 2009)	Specifies traffic routes for heavy-duty vehicles (N2 and N3) within the city. Important for crisis logistics, enabling emergency transport and public communication via e-services.
Orders of the Tallinn City Government	Orders issued by the city government address a range of matters, including crisis management. These directives reflect the city's executive body's immediate instructions and serve as a vital source of real-time or situational information.

Table 5 Overview of stakeholders in crisis management

Register name	Description
Local Government (e.g. Tallinn City, Kristiine District Administration)	Independent organization and management of local issues; coordination of crisis management within its administrative territory.
Tallinn Crisis Committee	A permanent committee of the Tallinn City Government. Its primary purpose is to coordinate crisis management activities within the administrative territory of Tallinn and assist emergency-solving authorities.
The Estonian Rescue Services Agency	The leading state authority in crisis management. Responsible for overall state-level crisis coordination, ensuring the availability of basic necessities across the country.
Apartment Associations	Non-profit associations established by apartment owners for the shared management of common areas of buildings and representation of their members' shared interests.

allocate resources more effectively, prioritizing assistance for the most vulnerable populations.

Almost all apartment buildings are managed by apartment associations. According to the Apartment Ownership Act, an apartment association is a non-profit entity established by apartment owners to manage the shared property of the building and plot of land and to represent the collective interests of its members (Riigikogu, 2014). The Act further defines an apartment association as a private legal person whose members consist of all owners of apartment ownerships within a single immovable property divided into apartment ownerships (Riigikogu, 2014).

Crisis management in Tallinn operates within a multi-layered regulatory framework that defines organizational structures and operational procedures. Some provisions apply only to internal administration, while others are publicly available. Key instruments include the Orders of the Tallinn City Government, which establish the composition and functions of the Tallinn Crisis Committee, set directives issued by the city's executive authority, and regulate matters such as traffic restrictions, the transport of hazardous materials and designated traffic routes. Together, these orders form essential procedural and operational guidelines for effective crisis management.

3.2 Stakeholders in Crisis Management

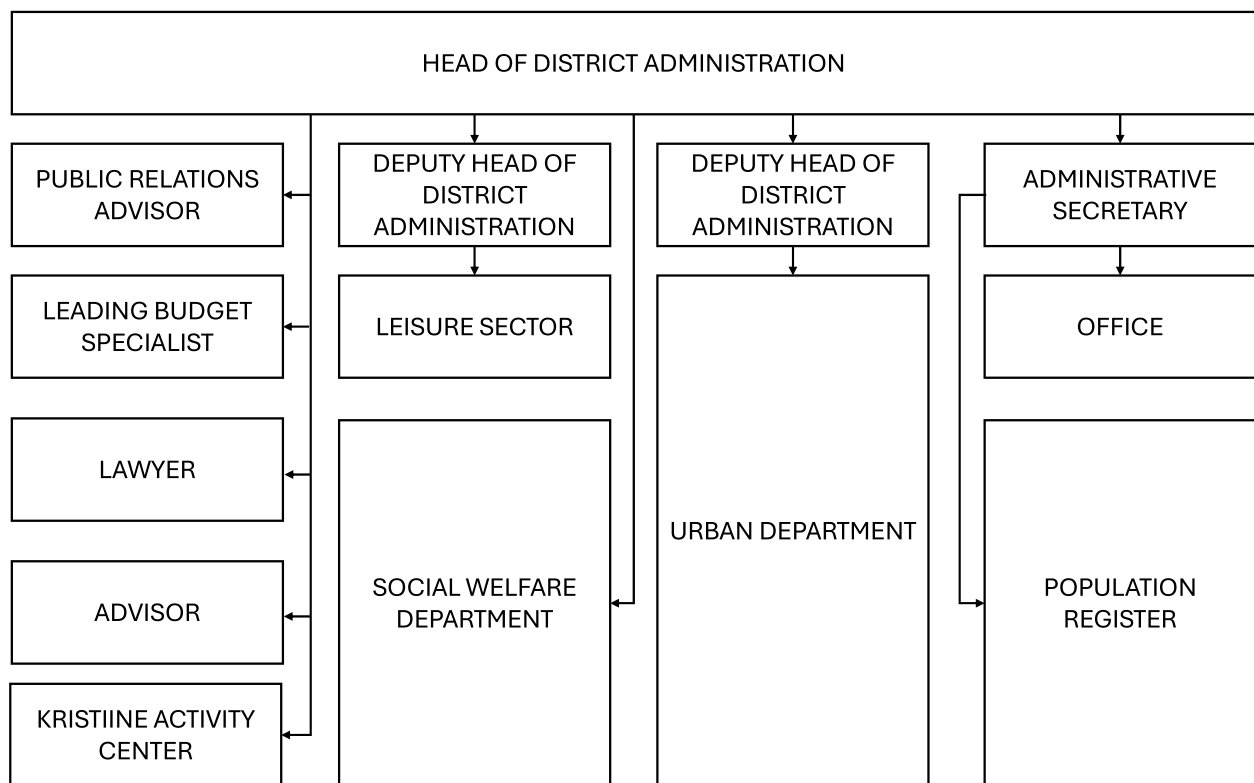
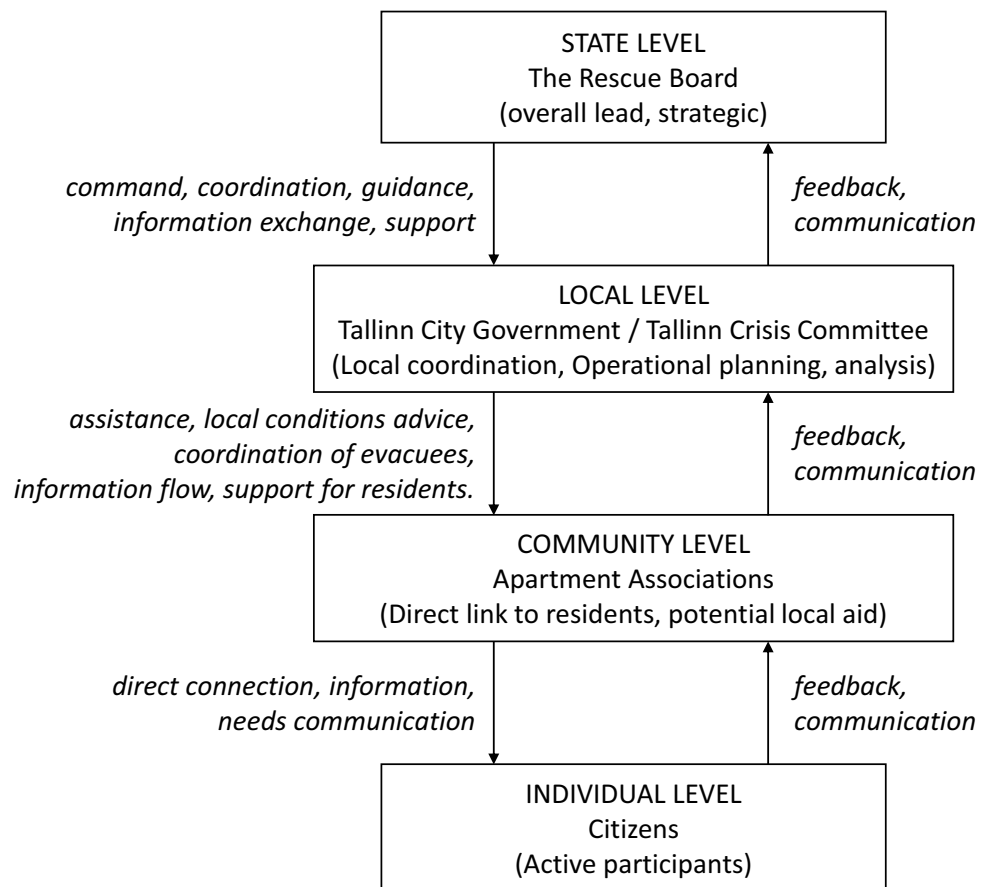
This section outlines the roles and responsibilities of local governments, apartment associations and the Estonian Rescue Services Agency in crisis management. Stakeholders are identified during the development and refinement stages of the monitoring process, and their composition may change as the process advances (ISO22326-2018, 2018). To support this discussion, Table 5 presents an overview of the key stakeholders and their main characteristics.

Figure 1 illustrates the roles and actions of the different stakeholders involved in the process.

3.2.1 Local Government

According to the Local Government Organisation Act, local government is defined as the right, authority and duty of democratically formed municipal bodies to independently organise and manage local matters in accordance with the law, based on the legitimate needs and interests of residents and the specific development context of the rural municipality or city (Riigikogu, 1993).

Our study focuses on the Kristiine district in Tallinn and provides an overview of Tallinn's crisis management framework. The structure of the Kristiine District Administration is presented in Fig. 2. In Tallinn, Crisis coordination

Fig. 1 Roles and actions of stakeholders in the process**Fig. 2** Structure of Kristiine District Administration (42,2 positions)

is carried out by the Tallinn Crisis Committee, a permanent body within the city government. Its primary mandate is to coordinate crisis management activities across the city's administrative territory and, when necessary, to support competent authorities and emergency managers in resolving emergencies. In the event of a crisis, the Committee convenes and activates established crisis plans.

The main responsibilities of the local government's crisis management team, represented by the Tallinn Crisis Committee, include:

- ensuring readiness to address crises or emergencies,
- managing emergencies arising from disruptions to vital services,
- making strategic decisions, analyzing and resolving the causes of crises,
- coordinating inter-agency cooperation, and
- organizing information exchange among relevant authorities and stakeholders.

The Committee is also responsible for mobilizing and deploying all necessary resources to effectively mitigate and resolve crises (Tallinna Linnavalitsus, 2018).

In Estonia, the requirement that certain municipal tasks must continue during crises is embedded in national and municipal legislation on civil protection and emergency management. The Emergency Act (Riigikogu, 2017a) and the newly adopted Crisis Situation and National Defence Act (Riigikogu, 2026) confirm that local governments retain key crisis-related responsibilities, including the continuity of essential services, preparation of evacuation locations, support for evacuation, provision of important local services, and communication with local residents. This obligation embodies the principle of task permanence, requiring municipalities to sustain core infrastructure and support evacuation, temporary accommodation, and public communication.

Tallinn operationalizes these mandates through its Crisis Commission Statute (Tallinna Linnavalitsus, 2018), which institutionalizes preparedness, resource coordination and resilience planning, thereby aligning local governance with the state's decentralized crisis management framework.

Support functions of local governments include ensuring the continuity of essential services during crises. This involves designating evacuation sites, facilitating large-scale evacuations, coordinating with other municipalities to receive evacuees and providing basic necessities at evacuation locations (Tallinna Linnavalitsus, 2018; Riigikogu, 2017a).

Local governments also advise rescue agencies by offering context-specific information on local conditions, a role

closely linked to the activities of apartment associations, which are key actors in urban governance.

3.2.2 The Estonian Rescue Services Agency

The Estonian Rescue Service Agency consists of departments responsible for developing, planning and managing activities, regional rescue services and the Explosive Ordnance Disposal Centre, all of which carry out the agency's core functions. The Northern, Southern, Eastern and Western rescue services manage day-to-day operations, including rescue work, fire safety supervision, emergency prevention and crisis management¹⁵.

The roles of the Estonian Rescue Service Agency include providing consultation, facilitating cooperation and information exchange between state authorities and local governments, managing regional crisis committees, preparing and implementing shelter arrangements, and preparing and conducting large-scale evacuations.

3.2.3 Apartment Associations

According to the Apartment Ownership Act, an apartment association is a non-profit entity established by apartment owners to jointly manage the shared parts of the building and the plot of land, and to represent the collective interests of its members (Riigikogu, 2014). According to the Estonian Business Register, there were 6,575 apartment associations in Tallinn as of 31 October 2025¹⁶. Although apartment associations could contribute meaningfully to crisis management, their role in this regard is currently unclear. This raises the key question of how to encourage property owners to invest in better crisis preparedness.

The Kristiine District Administration cooperates daily with the Tallinn Municipal Police Department, which assists in planning various activities. The most recent data and insights on apartment associations in Tallinn come from this department, which holds responsibility for the city's crisis management. In 2022, the department conducted a survey focused on apartment associations, carried out between September and November.

A survey published on 14 December 2022 on the official Tallinn website assessed the crisis preparedness of apartment associations in the capital. Of 694 respondents, 423 completed the questionnaire in full. The highest participation came from Põhja-Tallinn (28.1%), followed by Lasnamäe (22.2%) and Nõmme (13.2%). Respondents identified electricity and water supply disruptions as the most likely crises.

¹⁵ <https://www.rescue.ee/en/estonian-rescue-services-agency-who-are-we>

¹⁶ Query from the Estonian e-Business Register on 31 October 2025, available at: <https://ariregister.rik.ee/est>

However, 80% of associations had not mapped alternative solutions or backup systems, and 65% were unaware of the reliability of district heating during emergencies. More than 90% had not considered alternative heating options, and 76% had not planned for water or sewage outages.

Despite these shortcomings, 90.5% of buildings ensure systematic access to technical infrastructure rooms, and 80% maintain resident contact information for emergency communication.

Approximately 67% of association leaders know which residents require special assistance during prolonged outages, yet 44% reported a lack of clarity on how to obtain information about service disruptions (City of Tallinn, 2022).

3.3 Existing Crisis Management Resources

While no comparable e-service is currently available, insights can be derived from existing solutions and tools. First, various public information sources provide guidance on how to prepare for and respond to crises. In Estonia, for example, the “Ole valmis!” (“Be Prepared!”) mobile application offers general information about various threats and recommended actions. The application has been downloaded more than 12,000 times, with 95% of downloads originating from Estonia; additional users come from countries such as Finland, Norway, Russia, Germany, Belgium, the United States and others¹⁷. There is also an official website available in Estonian, Russian and English (www.olevalmis.ee), which, together with the mobile application, provides guidelines from the Rescue Board on how to act in the event of an emergency or crisis.

Second, various mechanisms exist for informing citizens about threats and providing instructions, although some are still under development. According to national regulations, when instructed, all media channels and mobile operators are required to transmit emergency warnings and guidelines to the public. In Estonia, the national broadcaster’s channels (err.ee, Vikerraadio, Raadio 4, ETV and ETV+) will spread official crisis information, and additional media channels may do so as well¹⁸. Hazard alerts are issued via the EE-ALARM system, supported by national broadcasting channels, other media outlets and sirens placed in major urban areas¹⁹.

On 14 May 2025, Estonia conducted the first nationwide test of the EE-ALARM public warning system. The full system was activated: SMS alerts, mobile app notifications,

ERR TV text crawlers, err.ee and ERR Uudised updates, and sirens in 22 towns²⁰. Unfortunately, large-scale SMS alerts were slow, and app notifications in “Ole valmis!” and “Eesti app” showed delays. The siren network underperformed: only 62% activated on time, 10% were delayed, and 28% failed to activate, with all sirens reaching just 72% of the intended volume. Most problems appear to be software-related, and a full technical analysis of both hardware and software is ongoing²¹. On 30 October 2025, a brief functional test of the siren network was conducted, with all posts activating successfully within one second²². Work on the development and testing of public alerting systems continues.

3.3.1 Overview and Description of Data Registers

Given the research focus and Estonia’s digital infrastructure, multiple state e-registers can support the development of new e-services, all of which communicate via the X-Road system (Saputro et al., 2020). This section examines which e-registers are suitable for developing new e-services and specifies the data most useful for the study. Table 6 presents an overview of existing registers and the key attributes that can support improvements in crisis management activities.

STAR (Social Services and Benefits Data Register) is a national register of social services and benefits used daily by local government social workers. It serves as a digital platform for managing client cases and administering services. The system retrieves necessary client information from multiple national databases, including the Population Register, Social Protection Information System (SKAIS), Unemployment Insurance Fund systems, Health Insurance Fund registers, the Tax and Customs Board, the Employment Register, the Education Information System (EHIS), the Traffic Register and the Real Estate Register²³.

According to the Social Insurance Board, STAR is an electronic platform that enables social service providers and municipalities to exchange information and coordinate activities. It allows practitioners to quickly access and verify clients’ data, support consistent decision-making and improve transparency. STAR functions as a unified digital dossier containing information on individuals receiving assistance and their related services. Using the X-Road data

¹⁷ <https://lounaestlane.ee/naiskodukaitse-mobiilirakendus-topis-esimeste-hulgas/>

¹⁸ The Estonian Rescue Services Agency. What to do in crisis situation: be prepared! (updated version), available at: <https://kriis.ee/>

¹⁹ <https://kriis.ee/en/threat-alert>

²⁰ <https://mil.ee/en/news/public-warning-system-ee-alarm-to-be-launched-nationwide-on-may-14-during-exercise-siil/>

²¹ <https://www.olevalmis.ee/en/news/civil-protection/how-did-the-first-launch-of-the-public-warning-system-go>

²² <https://www.rescue.ee/en/news/technical-test-of-emergency-sirens-was-successful-3161>

²³ Information retrieved from the Republic of Estonia, Social Insurance Board webpage, accessed November 7, 2025: <https://sotsiaalkindlustusamet.ee/spetsialistile-ja-koostoopartnerile/star>

Table 6 Overview of Estonian e-registers, descriptions, and key data fields

Register name	Description	Key Data Fields
STAR Register (Social Services and Benefits Data Register) (sotsiaalteenuste ja -toetuste andmeregister)	An electronic environment for social work professionals to manage client cases, assign benefits and services, and document social work activities.	Name, birth data, sex, personal ID, citizenship, addresses, contact details, residence info, ID document, health insurance status, social protection info, benefits/services details, comments.
E-Business Register (Äriregister)	Provides real-time data on all legal entities registered in Estonia, including official information and contacts for businesses and apartment associations.	Legal entity name/apartment association, register code, status, address, communication tools, personal ID, role, person's name, date of birth, registered businesses at location, contacts.
E-Land Register (Kinnistusraamat)	Contains detailed cadastral and property-related data, including ownership, boundaries, and encumbrances.	Property number, registry department, property name/type, cadaster code, purpose, location, size, restricted rights, owner, servitudes, mortgages, usage rights, pre-emptive rights, preliminary notations.
E-Population Register (Rahvastikuregister)	The central national register for personal data of Estonian residents, including personal identification codes, official addresses.	Name, birth data, sex, personal ID, citizenship, domicile and additional addresses, contact details, residence info, ID document.

exchange system, it interfaces with multiple external databases, reducing the administrative burden on citizens²⁴.

Key operational and data management aspects relevant to crisis response include the use of STAR by the Kristiine District Welfare Department to retrieve essential client data such as names, addresses and contact details for communication by email, SMS or phone. Data access depends on electricity, therefore, municipalities rely on backup generators to maintain continuity during outages. Rapid identification and prioritization of individuals remain challenging. The Estonian e-Business Register provides official information on apartment associations, including board members and contact details, and is accessible free of charge with authentication²⁵. Although comprehensive, registry data may be outdated, even though the system links to other databases and supports bulk data queries upon agreement.

4 Research Design and Methodology

Our study aims at answering the following main research question (RQ1) and two sub-questions (SQ1, SQ2):

- RQ1. How to improve digital cooperation between local governments and apartment associations to prepare for crises?
 - SQ1. What kind of digital infrastructure is required to guide crisis preparedness efforts and ensure a complete, up-to-date online overview of apartment associations in the district?

- SQ2. How can information be effectively shared and communication maintained with older adults during emergency crises?

This study is positioned as an exploratory design-oriented case study informed by selected principles of Action Design Research (ADR) (Sein et al., 2011). We do not claim to have completed a full ADR cycle involving Building, Intervention, and Evaluation in an organizational setting, nor do we claim to have deployed or iteratively evaluated a working artifact. Rather, ADR is used as a sensitizing methodological framework for problem formulation, stakeholder engagement, reflection on empirical insights, and the development of a conceptual e-service artifact. The study should therefore be understood as a problem-driven requirements-elicitation and concept-development effort that prepares the ground for future prototype development and full ADR-based evaluation.

To make the relationship between the study process and the ADR framework explicit, Table 7 maps the activities reported in the manuscript to the four ADR stages described by Sein et al. (2011). This mapping does not imply that a complete ADR cycle was conducted; rather, it shows which elements of the present exploratory design-oriented study correspond to, or prepare the ground for, the respective ADR stages.

To improve construct precision, we use the following terms consistently. The term *e-service concept* refers to the conceptual artifact proposed in this study, not to a deployed or operational system. The term *formative expert evaluation* refers to expert feedback on the perceived relevance, feasibility, risks, and further development needs of the conceptual artifact; it is distinguished from summative evaluation, which would require a working prototype, use in an organizational setting, and assessment of actual outcomes. The term *monitoring* is used in the crisis-management sense of maintaining a structured overview of preparedness-relevant

²⁴ Information retrieved from The Health and Welfare Information Systems Centre webpage, accessed November 16, 2025: <https://www.tehik.ee/en/social-services-and-benefits-registry>

²⁵ Information retrieved from e-Business Register webpage, accessed November 16, 2025: <https://ariregister.rik.ee/eng>

Table 7 Relationship between ADR stages and the activities conducted in this study

ADR stage	Corresponding activity in this study	Status
Problem Formulation	Research problem definition, research questions, contextual analysis, resident workshop, and expert consultations used for requirements elicitation.	Substantively addressed.
Building, Intervention, and Evaluation	Conceptual artifact development in Section 6 and formative expert feedback in Section 7. No working prototype was deployed and no organizational intervention or iterative BIE cycle was conducted.	Partially represented at the conceptual and formative level.
Reflection and Learning	Reflection on empirical findings, expert feedback, design constraints, theoretical implications, and limitations in the formative evaluation, Discussion, and Limitations sections.	Addressed within the exploratory study scope.
Formalization of Learning	Requirements and transferable design principles abstracted from the case, together with the discussion of their broader applicability and boundary conditions.	Partially addressed through conceptual design knowledge.

information, risks, resources, and communication needs, rather than continuous surveillance of individuals. The term *civil society* follows ISO 22300:2021 and refers to individuals, groups, networks, associations, and organizations outside the state and market that may contribute to preparedness and crisis response.

The empirical material was analysed through a structured requirements-oriented qualitative analysis. First, the anonymous World Café responses were reviewed to identify recurring needs, barriers, communication preferences, and crisis-preparedness challenges among older residents. Second, notes from expert consultations were analysed to identify institutional, technical, legal, and operational constraints relevant to municipal crisis management. Third, these resident- and expert-derived insights were grouped into thematic categories and translated into design requirements. Finally, the design requirements were mapped to specific functions of the proposed e-service. This procedure was used to strengthen traceability between empirical observations, design requirements, and the resulting conceptual artifact.

For the World Café material, the unit of analysis was an anonymous written response to a question or a set of closely related answers in the question-answer dataset. The analysis combined descriptive aggregation and qualitative categorization. Descriptive aggregation was used where responses were structured or countable, for example regarding preferred communication channels, Internet use, evacuation experience, or awareness of shelters. Qualitative categorization was used for open-ended responses and discussion outputs. The categorization followed a requirements-oriented logic: responses were first grouped into recurring empirical issues, then abstracted into analytical themes, and finally translated into design requirements relevant to the proposed e-service. The main categories were: communication channels and information access; evacuation and shelter-related uncertainty; residence and contact-data accuracy; trust and institutional responsibility; local knowledge and willingness to help; and support needs during crisis situations.

Analytical rigor was supported through several transparency measures. The unit of analysis, categorization logic,

and main categories are reported explicitly; the anonymized World Café dataset is publicly available; illustrative anonymized response excerpts are provided in the findings section; and the link between empirical evidence, analytical themes, design requirements, and e-service features is summarized in a traceability table. Because the study was exploratory and the analysis was conducted for requirements elicitation rather than for theory-building qualitative coding, no inter-coder reliability statistics were calculated. This limitation is acknowledged, and future research should apply a more formal qualitative coding procedure with multiple coders and participant or expert validation where feasible.

The problem formulation stage in ADR consists of six tasks: identifying and conceptualizing the research opportunity, formulating initial research questions, framing the problem within a broader class of challenges, determining relevant theoretical foundations and prior technological developments, securing sustained organizational commitment, and defining roles and responsibilities (Sein et al., 2011).

During this research, several key activities were undertaken. First, an initial analysis was conducted to define the research problem and formulate questions related to crisis management, municipal responsibilities and cooperation with apartment associations, drawing upon the Kristiine District as a case study. An adapted World-Café-style (Löhr et al., 2020) participatory workshop with older adults was organized to examine crisis-related communication preferences, evacuation concerns, use of digital services, trust in information sources, local support networks, and technology-related constraints.

The resident data were collected through an adapted World-Café-style participatory workshop with older adults. The workshop was held on 16 January 2023 from 13:00 to 15:00 at the Kristiine Activity Center, Sõpruse pst 5, Tallinn. Participation was voluntary. The invitation was publicly announced in the local district newspaper, and there was no prior registration or participant selection. The workshop was conducted in Estonian and was facilitated by the first author. At the beginning of the meeting, the facilitator explained that the discussion was part of research on

crisis management, communication, and the design of future e-services. Participants received printed paper question sheets and pens, and the facilitator guided the discussion through the question sheet. Although three physical tables were available in the room, the discussion was conducted as a plenary, facilitator-led session rather than as separate table-based rounds with participant rotation. For this reason, we describe the procedure as an adapted World-Café-style workshop rather than as a full formal World Café protocol.

The question sheet covered five thematic sections: introductory background information, evacuation, crisis management, apartment associations, and e-governance and technical readiness. The prepared workshop question sheet included 39 items; during data preparation, the anonymous written responses were entered into Excel and organized into 36 analysed question items. The Excel dataset, rather than the original paper sheets, constitutes the empirical basis for the descriptive aggregation and requirements-oriented qualitative categorization reported in this manuscript. Participants could leave individual questions unanswered or provide written comments. In total, 30 anonymous responses were obtained. No audio recordings, photographs, transcripts, participant registration lists, or directly identifying participant data were collected. No separate ethics-committee or formal institutional review board approval was obtained for this study. The anonymized question-answer dataset is publicly available as a research dataset (Riibe, 2023).

Open-ended written responses were not treated as representative quotations from interviews, but as anonymized response excerpts that illustrate recurring issues identified through the requirements-oriented categorization. Short examples are reported in Section 5.1 to show how the qualitative material informed interpretation and design reasoning.

Expert input was collected in three meetings. First, two open expert consultations were held with crisis-management experts from the Tallinn Municipal Police Department. The first consultation took place on 23 February 2023 with the expert responsible for the crisis-management field in Tallinn and the deputy head of the office/head of department. The second consultation took place on 2 March 2023 with a leading specialist from the Tallinn Municipal Police Department. These two meetings were used to obtain feedback on the research questions, understand municipal crisis-management responsibilities, and examine cooperation between local governments and apartment associations. Second, after the e-service concept had been developed, a formative expert feedback meeting was held on 13 April 2023 with experts from the Estonian Rescue Board and the Tallinn Municipal Police Department.

The three meetings were open expert consultations and formative feedback discussions rather than formal interviews. Calendar invitations and, where applicable,

Microsoft Teams invitations document the scheduling of the meetings. The meetings were not audio-recorded, video-recorded, or transcribed. Experts preferred not to be identified by name in the manuscript; therefore, the reporting refers to their institutional roles rather than personal names. During the meetings, the first author presented the research questions, emerging findings, and, in the final meeting, the proposed e-service concept. Experts then provided open feedback, comments, concerns, and suggestions. The first author documented the feedback as free-text notes during or immediately after the meetings.

The expert notes were analysed as practice-oriented consultation material. The notes from the first two meetings were used primarily to identify institutional needs, operational constraints, data-related problems, and design implications for the e-service concept. The notes from the third meeting were used as formative feedback on the perceived relevance, feasibility, risks, and further development needs of the proposed concept. Across the three meetings, the notes were reviewed to identify recurring institutional, technical, legal, and operational issues. These issues were grouped into categories such as municipal overview of apartment associations, accuracy of resident and contact data, evacuation and shelter-related information needs, inter-organizational coordination, data protection and access rights, technical integration with state registers, motivation of apartment associations, resilience during Internet or electricity outages, and future prototype testing. Because the expert material consisted of author-documented notes rather than recorded interviews or validated transcripts, it is reported as expert consultation and formative feedback rather than as a formal interview study or summative artifact evaluation.

The study uses the term cooperation rather than full co-creation to describe the relationship with apartment associations. Older residents contributed needs and communication preferences through the adapted World-Café-style workshop, and crisis-management experts contributed institutional and operational requirements. However, apartment association boards did not participate as formal co-design partners in the development of the conceptual artifact. Their direct involvement is therefore identified as an important next step for prototype development and evaluation.

The primary empirical material was collected in early 2023, while parts of the legal, infrastructural, and secondary-data context were updated during the revision process to reflect developments up to 2025. We therefore distinguish between empirical findings and contextual updating. The 2023 World Café responses and expert consultations are used to identify resident needs, institutional constraints, data-quality problems, and design requirements. The 2025 updates are used to situate these findings within the current Estonian crisis-management and e-government

environment, not to claim that the 2023 participants evaluated the later legal or technical developments.

Together with the proposed e-service concept, the study produced requirements and transferable design principles that can guide future prototype development, implementation, and evaluation in similar municipal crisis-preparedness contexts.

We label the resulting conceptual artifact the Coordination Framework for Municipal-Apartment Association Crisis Preparedness (C-MAACP Framework) to provide a concise reference for the integrated set of empirically grounded requirements, design principles, stakeholder roles, privacy constraints, and communication mechanisms developed in this study (Table 8).

OpenAI ChatGPT (GPT-5.5 and GPT-5.6 Sol) was used during the preparation and revision of the manuscript as a language-editing and supplementary manuscript-review aid. Its use included translation support, refinement of English phrasing, consistency checking, and review of manuscript text for clarity. All suggested revisions, interpretations, and final wording were reviewed and verified by the authors, who retain full responsibility for the content of the manuscript.

5 Research Results

This section reports the empirical findings from the anonymous World Café responses and expert consultations. To improve analytical transparency, the findings are organised around recurring empirical themes that informed the proposed e-service concept. In addition to descriptive response patterns, Table 9 presents illustrative anonymized written response outputs from the World Café dataset, while

Table 11 summarises the traceability from empirical evidence to analytical themes, design requirements, and corresponding e-service features.

5.1 Meeting Results

The adapted World-Café-style (Löhr et al., 2020) participatory workshop with older adults, described in Section 4, was held on 16 January 2023 at the Kristiine Activity Center. The session was voluntary, conducted in Estonian, and used the printed paper-based question structure described in the methodology section.

Responses were returned anonymously, recorded in Excel, and analysed using descriptive aggregation and requirements-oriented qualitative categorization (Riibe, 2023). Countable responses were summarized descriptively, while open-ended answers were grouped into recurring categories related to communication, evacuation, shelter awareness, trust, data accuracy, local support networks, and crisis-related assistance needs.

The percentages reported below provide descriptive context, while the analytical categories explain how the World Café material informed the design requirements summarized later in Table 11. Because participants could leave individual questions unanswered, percentages are calculated from the valid responses to each item and the corresponding counts and denominators are reported below. For multiple-response questions, the denominator represents the number of participants who selected at least one response option.

Because the World Café material consisted of anonymous written responses rather than recorded interviews, the manuscript reports anonymized response excerpts and aggregated patterns rather than interview quotations.

Table 8 Requirements-Oriented categorization of World Café material

Analytical category	Type of empirical material	Use in design analysis
Communication channels and information access	Responses concerning television, radio, SMS, phone calls, printed notices, Internet use, e-mail, and social media.	Used to derive the requirement for multi-channel crisis communication rather than a web-only e-service.
Evacuation and shelter-related uncertainty	Responses concerning evacuation experience, shelter awareness, transport concerns, safe routes, and uncertainty about whom to contact.	Used to derive requirements for crisis-plan information, evacuation guidance, and trusted instructions.
Residence and contact-data accuracy	Responses indicating mismatches between actual residence and registered address, together with expert concerns about incomplete contact data.	Used to derive requirements for improved resident and contact-data updating through apartment associations and registers.
Trust and institutional responsibility	Responses concerning trust in Tallinn City, state institutions, neighbours, apartment association boards, and social media.	Used to derive requirements for official municipal communication and apartment-association-mediated local information sharing.
Local knowledge and willingness to help	Responses concerning knowledge of neighbours needing help, willingness to volunteer, and willingness to share crisis information.	Used to derive requirements for association-level coordination and local support-network activation.
Crisis-related support needs	Responses concerning psychological support, transportation, reliable information, supplies, and contact with social workers.	Used to derive requirements for support prioritization and municipal overview of vulnerable residents and buildings.

Table 9 Illustrative anonymized written responses from the World Café dataset

Analytical theme	Example written response output	Interpretation for design
Evacuation logistics	“need extra transportation”; “need transportation”; “need city public transportation”	These responses indicate that evacuation support cannot be limited to information provision; the e-service should also support municipal awareness of transport-related assistance needs.
Need for timely and detailed information	“need detailed information about evacuation”; “to get information on right time”; “how long we have to leave home, which are safe trajectories”	These responses support the requirement for trusted, timely, and actionable crisis communication, including evacuation timing, routes, and instructions.
Safe destination and shelter-related uncertainty	“need safe place to stay”; “do not know where to go”	These responses show that residents need clear information on safe destinations, shelter options, and designated evacuation locations.
Psychological and social support	“need support person”; “fear, stress, uncertainty”; “anxiety, panic”	These responses indicate that crisis communication should also consider reassurance, social support, and links to local support networks, not only technical alerts.
Resource and service concerns	“not enough food, huge traffic jams”; “not enough water, not enough food”; “interruption of services”	These responses support the need for preparedness information, local resource awareness, and coordination between municipal services and community-level actors.
Collective awareness and cooperation	“when people are aware of situation, then they are able to work together”; “people’s support, communication is important”	These responses support the design choice to involve apartment associations as local intermediaries for information sharing and resident-level coordination.

Table 9 shows that the design rationale was not based only on percentages, but also on recurring qualitative concerns related to transportation, timing, safe destinations, trustworthy information, psychological support, and collective local coordination.

Thirty participants took part: 26 of 30 (87%) were women and 4 of 30 (13%) were men, 27 of 30 (90%) were over 70 years old, 23 of 30 (77%) lived in apartments, and 18 of 30 (60%) lived alone.

Because the workshop participants formed a small, self-selected convenience sample, these percentages should be interpreted only as exploratory descriptive indicators of the participating group. They are not statistically generalizable to all older residents of Kristiine, Tallinn, or Estonia. The percentages are therefore used to contextualize the qualitative requirements analysis, not to support strong population-level claims.

Most participants had no prior evacuation experience, with only 5 of 30 (17%) reporting that they had previously been forced to evacuate. Regarding the possibility of a large-scale evacuation, 8 of 30 (27%) reported thinking about it often and 9 of 30 (30%) had considered it once or twice.

Although 21 of 30 participants (70%) had a place to go in the event of evacuation, only 12 of 29 respondents to the shelter question (41%) reported access to a shelter. Awareness of current crisis solutions was limited: 19 of 30 (63%) did not know the locations of public shelters, 13 of 30 (43%) did not know which phone number to call in case of danger, and 10 of 29 (34%) expected authorities to contact them directly. The most frequently reported daily e-services were e-health services (16/30), e-banking (12/30), and Tallinn services (6/30). In addition, 9 of 29 respondents (31%) indicated that they would not leave their homes immediately in

an evacuation, highlighting the need for targeted communication and guidance.

The meeting also revealed issues related to registries and data accuracy: 3 of 30 participants (10%) did not live at the address listed in the Population Register. Internet use was uneven: 17 of 30 (57%) did not use it daily, 12 of 29 respondents (41%) had no email account, and 19 of 30 (63%) did not use their eesti.ee email account. Phone use varied, with 15 of 30 (50%) reporting smartphone use, 15 of 30 (50%) button-phone use, and 10 of 30 (33%) landline use. Fifteen of 30 (50%) used social media. Among the 29 participants who reported their current information sources, television and radio were each selected by 24 (83%), the city newspaper by 17 (59%), and Internet-based news portals by 12 (41%). When asked how they would prefer to receive information during a crisis, 21 of 30 (70%) selected radio, 20 of 30 (67%) television, 20 of 30 (67%) SMS, 18 of 30 (60%) phone calls, and 12 of 30 (40%) official websites.

Older adults were generally informed about events in their neighbourhood, even though 21 of 30 (70%) did not communicate with neighbours daily. Among the 26 participants who reported how information was shared within their apartment association, person-to-person conversations were selected by 14 (54%), phone calls by 13 (50%), and printed notices by 13 (50%). Many participants were also willing to contribute during crises: 13 of 30 (43%) were ready for volunteer work and 27 of 30 (90%) were willing to share crisis information with neighbours. Fifteen of 30 (50%) knew individuals in their local area who would need assistance evacuating, and 24 of 30 (80%) reported keeping an emergency food reserve at home.

Despite these strengths, respondents expressed concerns about transportation, safe evacuation routes, reliable information, and psychological support. They also raised

concerns about traffic congestion, shortages of essential supplies, and losing contact with social workers. Trust emerged as an important issue. Among the 29 participants who selected at least one trusted source, Tallinn City was selected most frequently (19/29, 66%), followed by state institutions (12/29, 41%), neighbours and acquaintances (10/29, 34%), apartment association boards (7/29, 24%), and social media (6/29, 21%).

Overall, the workshop findings indicate that, in this case, older residents may face specific crisis-communication and evacuation-related challenges, including limited awareness of some existing digital tools, uneven use of Internet-based services, uncertainty about shelters and evacuation procedures, and a preference for trusted multi-channel information. At the same time, the participants also demonstrated important local knowledge and willingness to support others, for example by sharing crisis information with neighbours. These findings suggest that a hybrid communication approach, involving both official municipal channels and apartment associations as local intermediaries, may strengthen preparedness for this resident group. However, this should be interpreted as an exploratory, case-specific finding rather than as evidence of the measured effectiveness of the proposed e-service.

This interpretation is consistent with prior crisis-communication and emergency-management research emphasizing that effective crisis response depends on trusted information flows, stakeholder coordination, shared situational awareness, and communication channels that match the capabilities and preferences of affected groups (Bharosa & Janssen, 2010; Eriksson, 2018; Neely & Collins, 2018; Panagiotopoulos et al., 2016).

5.2 Expert Meetings Results

To gather institutional and operational input for the design of the proposed e-service concept, two open expert consultations were held with crisis-management experts from the Tallinn Municipal Police Department. The first consultation took place on 23 February 2023 with the expert responsible for the crisis-management field in Tallinn and the deputy head of the office/head of department. The second consultation took place on 2 March 2023 with a leading specialist from the Tallinn Municipal Police Department. Each meeting lasted approximately 60 minutes and followed an open consultation format guided by the research questions and the emerging e-service idea. These meetings were not formal interviews, and no audio recordings, video recordings, or transcripts were produced. Instead, the first author documented the experts' comments and suggestions as free-text notes, which were later analysed to identify institutional

needs, operational constraints, data-related problems, and design implications.

In the first meeting, experts emphasized that, during a crisis, the state delegates numerous tasks to local municipalities, making preparedness essential. Digital infrastructure should support evacuation both within and between districts, which requires close cooperation with apartment associations and residents. A major challenge is the lack of reliable resident contact information, as apartment associations often do not have complete records. A new e-service could help maintain updated resident lists and reduce dependence on limited municipal staff during emergencies. Effective communication – especially regarding evacuation points – is critical and must comply with EU data protection requirements. Although apartment associations keep ownership registers, motivating them to collect and share resident information remains difficult, and the national Population Register does not provide complete residential data. Experts also noted that the state is considering investments in shelters and evacuation facilities, and an e-service could support prioritization by showing which buildings and residents require assistance.

The second meeting focused on technical issues. Experts highlighted the absence of a trustworthy, up-to-date database on apartment associations, as existing registers (including the e-Business Register) often contain outdated contact information. They stressed the need to analyze which state databases could feed into the proposed e-service. An additional idea was to link the e-service to property safety: information about building risks and preparedness could influence housing prices and inform residents when purchasing apartments. Coordination with the Estonian Rescue Service Agency is necessary because it also works with apartment associations. Another challenge is that municipalities and associations often do not know who the tenants are, which a new e-service could help address. Well-prepared associations with reserves and action plans could serve as models for others.

Since apartment associations face crises collectively, cooperation among all stakeholders is essential, and a new e-service could support crisis response by improving information coordination, preparedness planning, and communication routines.

The Table 11 also shows how context-specific empirical findings were abstracted into design requirements that connect to broader IS concerns, including crisis information management, e-government interoperability, data quality, trust, and socio-technical coordination.

5.3 Summary of Findings by Research Question

To make the connection between the empirical findings and the research questions explicit, Table 10 summarizes how the World Café responses, expert consultations, and secondary-data analysis answer the main research question and the two sub-questions. The table does not present the proposed e-service as a tested solution; rather, it shows how the empirical findings informed the requirements and design rationale for the conceptual e-service.

Building on the research-question summary above, Table 11 further shows how the main empirical themes were translated into design requirements and corresponding e-service features.

6 An E-Service Concept

The e-service concept was developed by translating the empirical findings and literature-based insights into design requirements. The analytical logic is summarized in Table 11. In particular, residents' communication preferences informed the requirement for multi-channel communication; identified gaps in residence and contact-data accuracy informed the requirement for register-supported data updating; trust-related findings informed the requirement for

official municipal communication and apartment-association-mediated local information sharing; and expert concerns about data protection informed the requirement for role-based access, data minimization, and privacy-by-design. The concept should therefore be understood as an empirically grounded design proposal rather than as a fully implemented or summatively evaluated system.

The e-service is designed in accordance with the principles outlined in ISO-22320-2018, i.e., the organization should take the initiative to assess risks and align the response to increase response effectiveness, anticipate how incidents can change and use resources effectively, make decisions concerning various measures early enough for decisions to be effective when they are actually needed, manage the incident early, initiate a joint response instead of waiting for someone else to do so, find out what shared information is required, and inform and instruct involved parties, e.g., in order to build up new resources (ISO22320-2018, 2018). The activities in the e-service are designed according to the Incident Management Process. The e-databases incorporated into the new e-service are detailed in Table 6 and Fig. 3. The C-MAACP Framework should be understood as a conceptual e-service framework rather than as an implemented software system; its technical implementation, organizational deployment, and outcome-based evaluation remain future research tasks.

Table 10 Research questions and corresponding findings

Research question	Corresponding findings	Implication for the proposed e-service concept
RQ1: How to improve digital cooperation between local governments and apartment associations to prepare for crises?	The findings indicate that digital cooperation can be improved by creating a structured information environment in which municipalities, apartment associations, and rescue-service stakeholders can share preparedness-relevant information. Expert consultations showed that municipalities lack a reliable operational overview of apartment associations, contact persons, building resources, preparedness levels, and residents who may require support. World Café responses further showed that older residents rely on trusted and local communication channels, suggesting that apartment associations can act as intermediaries between municipal authorities and residents.	The e-service concept should function as a municipal coordination platform that combines apartment-association profiles, contact-data management, crisis-plan documentation, official communication, preparedness-status indicators, and staged access for relevant crisis-management actors.
SQ1: What kind of digital infrastructure is required to guide crisis preparedness efforts and ensure a complete, up-to-date online overview of apartment associations in the district?	The findings indicate a need for register-supported, role-based, and continuously updated digital infrastructure. Expert consultations emphasized problems with outdated apartment-association contact data, incomplete residence information, and fragmented data across state and municipal systems. Secondary-data analysis identified relevant Estonian registers and the X-Road data-exchange infrastructure as possible components for such a system.	The e-service concept should integrate relevant state-register data through secure interfaces, support local updating of apartment-association and resident-contact information, provide role-based access rights, and offer a red/yellow/green preparedness overview for municipal prioritization.
SQ2: How can information be effectively shared and communication maintained with older adults during emergency crises?	The World Café findings indicate that older residents do not rely uniformly on Internet-based services. Many preferred or used radio, television, SMS, phone calls, printed notices, and person-to-person communication. The findings also showed uncertainty about shelters, evacuation procedures, whom to contact, and what information would be provided during a crisis. Trust was higher in official municipal and state institutions than in social media.	The e-service concept should support a hybrid communication model: official municipal information should be coordinated through the system, while apartment associations and local contact networks help distribute information through multiple channels, including non-web-based communication. The design should therefore not be limited to a citizen-facing web portal, but should support trusted, multi-channel crisis communication.

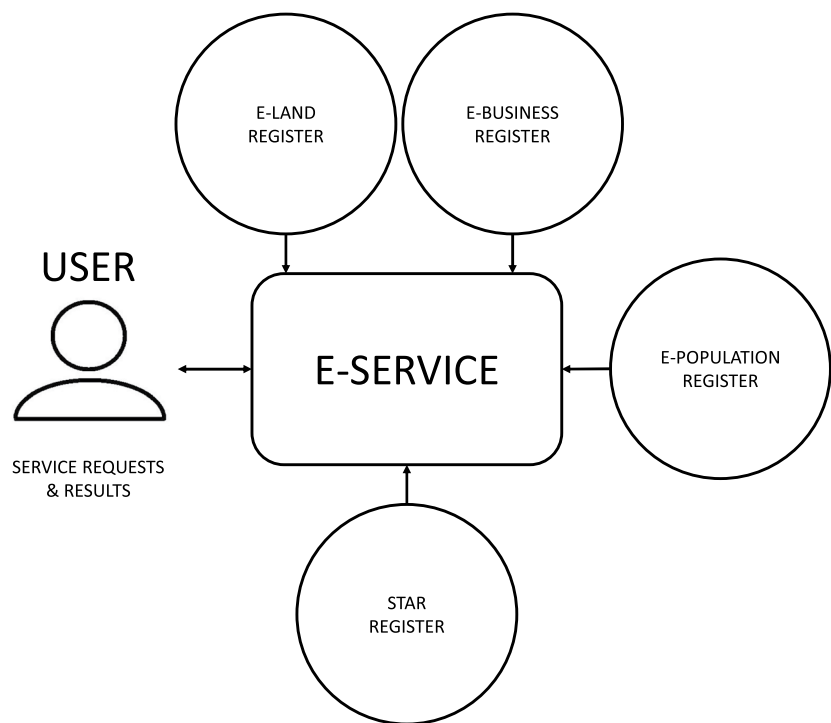
Table 11 Traceability from empirical evidence to design requirements and e-service features

Analytical theme	Empirical evidence	Design requirement	E-service feature
Multi-channel crisis communication	World Café responses showed that older residents relied strongly on television, radio, SMS, phone calls, printed notices, and person-to-person communication, while many did not use e-mail or Internet-based services daily.	The service should support multi-channel communication and should not rely exclusively on web-based interaction.	Communication module supporting municipal notices, SMS- and phone-oriented contact lists, official messages, and coordination through apartment associations.
Uncertainty about evacuation and shelters	Participants reported limited awareness of public shelter locations, uncertainty about whom to call in danger, and concerns about transport, safe routes, reliable information, and psychological support during evacuation.	The service should provide clear crisis plans, evacuation-related information, and trusted communication channels before and during emergencies.	Crisis-plan module, preparedness information, official communication archive, and association-level guidance.
Inaccurate residence and contact data	World Café responses showed that some participants did not live at the address listed in the Population Register. Expert consultations similarly emphasized that municipalities and apartment associations often lack accurate and up-to-date resident contact information.	The service should improve the accuracy of residence and contact information through cooperation between local governments, apartment associations, and relevant national registers.	Resident and contact-data update functionality connected to apartment associations and relevant state registers.
Need for municipal overview of apartment associations	Experts noted that no reliable and complete operational overview currently exists of apartment associations, their responsible contact persons, resources, building conditions, and preparedness levels.	The service should provide municipalities with a structured overview of apartment associations and their crisis-readiness status.	Apartment association profile, resource description, document archive, contact records, and red/yellow/green preparedness status overview.
Privacy and access-control constraints	Experts identified data protection as a central obstacle, particularly regarding what data may be collected, shared, and made visible to different actors.	The service should apply role-based access, data minimization, differentiated visibility, and privacy-by-design principles.	Differentiated access rights for municipalities, apartment associations, and rescue authorities; use of aggregated or limited indicators where appropriate.
Need for inter-organizational crisis coordination	Expert feedback indicated that the Estonian Rescue Services Agency could benefit from consolidated building, resident, sheltering, and preparedness information that is currently scattered across registers or collected through separate practices.	The service should support structured inter-organizational information sharing for crisis preparedness and response.	Future integration stage for rescue-service access to relevant building, sheltering, and preparedness data.
Need for future practical testing	Expert feedback suggested that the concept should be tested with apartment associations and relevant national stakeholders once a prototype is available.	The present study should be interpreted as concept development and formative evaluation rather than summative validation.	Future prototype development, deployment with apartment associations, and evaluation using explicit criteria for usefulness, feasibility, privacy, usability, and organizational adoption.

Effective crisis management relies on timely communication, accurate data, and structured preparedness. The following summarizes the concept for the proposed e-service.

- The e-service accelerates information exchange during emergencies by enabling rapid notifications, maintaining up-to-date contact lists, and improving the registration of official correspondence. This feature is grounded in the World Café findings showing that older residents rely on multiple communication channels, including radio, television, SMS, phone calls, printed notices, and person-to-person communication. Therefore, the proposed system is not conceptualized as a web-only service, but as a coordination platform that helps municipalities and apartment associations maintain reliable contact information and activate multiple communication channels during crises. In evacuation situations, this
- would support the distribution of transportation-point information and critical instructions.
- The e-service supports systematic assessment of apartment associations' crisis readiness, helping local governments prioritize interventions before and during emergencies. This feature is grounded in the empirical finding that residence and contact data may be incomplete or inaccurate, and in expert feedback that municipalities lack a reliable operational overview of apartment associations, contact persons, building resources, and preparedness levels. The service therefore stores standardized crisis plans, resident directories, contact details, and capability descriptions. Because the Estonian e-Population Register does not always reliably reflect actual residence, closer cooperation between municipalities and apartment associations is required. A visual status system, such as red–yellow–green indicators,

Fig. 3 e-Databases incorporated into the new e-service



provides an immediate overview of preparedness, with red marking high-risk buildings. The e-service and its application operate via X-Road, requesting necessary data through secure interfaces.

- Beyond crisis situations, the e-service improves everyday governance by guiding resource allocation to where support is most needed. The Estonian Rescue Services Agency would also benefit from consolidated data currently scattered across different registers or not collected at all. In the longer term, the service could assist prospective property buyers by offering information about local crisis preparedness and potential risks.
- Trust-related findings were operationalized in the system architecture through differentiated institutional roles and controlled communication channels. Because World Café participants reported higher trust in Tallinn City and formal institutions than in social media, the concept places the municipality in the role of system moderator and official communicator, while apartment associations function as local intermediaries for resident-level coordination. This division of roles is reflected in the separate user views for local government and apartment associations, the official correspondence archive, and the controlled access model. The design therefore links trust not only to communication content, but also to governance structure, access rights, and accountability within the e-service.

E-service development is organized into three sequential stages. The first stage focuses on answering the research

question and addressing the core problem. Across these stages, the anticipated user groups include local government administrators and designated representatives of apartment associations during Stage 1, followed by the Estonian Rescue Services Agency in Stage 2, and additional stakeholders in Stage 3.

The owner of the e-service is the Republic of Estonia, operating under the Ministry of the Interior. The designated legal entity is responsible for receiving, integrating, generating, analyzing, transferring, and outputting data (ISO22326-2018, 2018).

The e-service interface is designed according to role-based access and privacy-by-design principles. In GDPR terms, the proposed two-tier access model is intended to reflect the principles of purpose limitation and data minimization at the design level. Register-derived data should be processed only for predefined crisis-preparedness and emergency-management purposes, while each user group should receive only the data elements and level of granularity necessary for its assigned tasks. Accordingly, apartment associations should receive task-relevant or sufficiently aggregated preparedness information, whereas identifiable or vulnerability-related data should remain restricted to authorized municipal or rescue-service roles where a clear legal basis and operational need have been established.

Local municipalities may require access to identifiable data when this is legally justified for crisis-preparedness and emergency-management tasks. Apartment associations, however, should not receive individual-level sensitive data or small-cell vulnerability indicators. Their view should be

limited to the minimum information necessary for building-level preparedness, such as tasks, preparedness actions, communication responsibilities, and aggregated indicators only where the risk of re-identification has been assessed and mitigated.

Accordingly, the proposed concept treats privacy and data protection as design constraints rather than as implementation details. Before any deployment, the system would require a GDPR-grounded legal and organizational assessment, including clarification of the legal basis for processing, purpose limitation, data minimization, proportionality, retention periods, controller and processor roles, access rights, logging, and the need for a Data Protection Impact Assessment. Particular attention is required for building-level aggregates, because even aggregated indicators may become re-identifiable in small apartment buildings. Therefore, the concept should apply threshold rules, suppression of small-cell outputs, differentiated access rights, and audit trails before any vulnerability-related information is made visible outside authorized municipal or rescue-service roles.

The e-service provides local governments with a rapid and comprehensive overview of residents and apartment associations. Figure 3 provides an illustrative representation of the data flow between the e-service and the integrated databases. The e-service and its application are integrated with X-Road, through which all data requests are processed. Using this overview, buildings can be categorized into green, yellow, or red groups based on their preparedness level.

The valuation is assigned by the local government for each apartment association, after which a model action plan can be further developed together with the association during future implementation.

The long-term objective of this framework is continuous improvement, whereby buildings initially assessed as red advance to yellow and, ultimately, to green.

All data sharing is conducted in accordance with applicable legal requirements. Data must be structured in a manner that enables automated systems to identify the most recent and contextually relevant indicators. To ensure ongoing enhancement of the monitoring framework and to strengthen overall preparedness, analytical processes should incorporate incident statistics and predictive modeling techniques (ISO22326-2018, 2018).

In a crisis situation, this classification system enables local governments to prioritize their actions and allocate resources more effectively. A green rating indicates that the apartment association is sufficiently prepared to cope with the crisis and, if necessary, can evacuate residents independently. A yellow rating signifies that an action plan exists but requires further development—whether in terms of resources, investments, or capabilities. A red rating denotes

that the building is insufficiently prepared for crises and will require external support to manage the situation.

The operational framework of the proposed e-service begins with apartment associations accessing the system either through a dedicated application or via the local government's portal (e.g., the Tallinn city website). The officially registered contact person, as listed in the e-Business Register, receives access to relevant state databases. Authorized users then enter building-specific information, describe available resources, and upload documents such as shelter conditions, reserves, tools, and vehicles. A dedicated communication channel supports interaction between apartment associations and local governments, and all communication is archived for traceability. The system aggregates data from several national registers, including STAR, the e-Population Register, e-Business Register, and e-Land Register, through the X-Road data exchange layer.

Apartment associations should receive only legally permissible, minimized, and sufficiently aggregated preparedness information, while identifiable or sensitive data should remain accessible only to authorized municipal or rescue-service roles where a clear legal basis and operational need exist.

After mutual access approval, the e-service enables coordinated planning and incident management across operational, logistical, and administrative activities in accordance with established guidance (ISO22320-2018, 2018).

The general schematic view of the apartment association and the local government's users is presented in Fig. 4. This illustration presents the user-specific interface and functional options within the e-service for apartment associations and local government.

The e-service system creates an archive that includes building technical documentation and specifications, property ownership records, resident lists, official correspondence such as letters and notices, questions and responses, supplementary documents, resource descriptions, action plan documentation, agreed emergency procedures, operational procedures, and system logs with associated archival records. The scope and composition of this archive depend on and vary according to the specific requirements of crisis management and preparedness.

To complement the narrative description, Table 12 summarizes the principal use cases of the conceptual e-service. These use cases specify the main actor interactions and intended system functions; they describe the conceptual artifact and should not be interpreted as implemented or tested system behaviour.

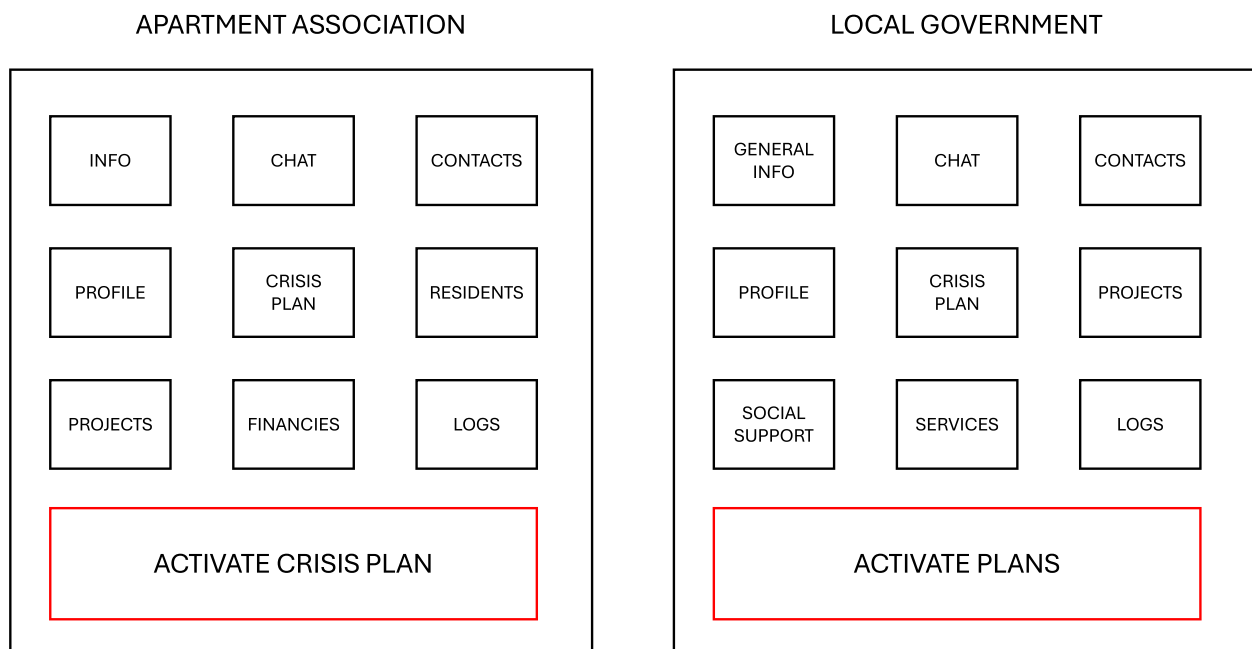


Fig. 4 Illustration of user views: Apartment association and local government

Table 12 Principal use cases of the proposed e-service concept

Use case	Actor(s)	Main function
UC1: Maintain preparedness profile	Apartment association; municipality	Maintain building resources, capabilities, contacts, and preparedness information.
UC2: Develop crisis plan	Apartment association; municipality	Prepare, review, update, and coordinate building-level crisis and preparedness plans.
UC3: Maintain preparedness-relevant data	Apartment association; municipality	Combine register-supported information with locally maintained resident, contact, and building data under role-based access controls.
UC4: Exchange crisis information	Municipality; apartment association; residents	Support coordinated crisis instructions, notifications, inquiries, and multi-channel communication.
UC5: Assess preparedness status	Municipality	Assign and maintain red-yellow-green preparedness classifications based on building-level preparedness information.
UC6: Prioritize crisis support	Municipality; Estonian Rescue Services Agency	Use preparedness, building, and assistance-related information to support situational awareness and prioritization of crisis-response resources.

6.1 Design Rationale and Empirical Grounding

The design rationale combines three sources: the World Café findings, expert consultation insights, and literature on crisis information management, e-government interoperability, digital public-service adoption, technology readiness, stakeholder coordination, and incident management. This positioning allows the case-specific empirical findings to be interpreted as part of a broader socio-technical IS problem: how municipalities can connect digital data infrastructures, local community intermediaries, and trusted communication channels to improve crisis preparedness.

The design is also informed by the literature reviewed in Section 2. Prior work on crisis information management emphasizes timely information exchange, shared situational awareness, and coordination across organizational boundaries. Research on digital public services and technology

readiness further indicates that e-service adoption depends not only on technical functionality, but also on usability, trust, institutional capacity, and stakeholder readiness. These insights informed the decision to design the e-service as a coordination and preparedness platform that combines register-based data exchange, municipal oversight, apartment-association participation, and multi-channel crisis communication.

Acceptance and adoption are therefore treated as explicit design considerations rather than only as future implementation concerns. The proposed staged rollout begins with municipal and apartment-association users, combines digital functionality with municipal guidance and support, and allows organizational roles, usability, and participation mechanisms to be refined before access is extended to additional stakeholder groups.

Table 13 Design principles abstracted from the case

Design principle	Mechanism	Rationale
DP1: Multi-channel crisis communication	Municipal crisis e-services should support coordinated communication through digital, telephone-based, media-based, printed, and local intermediary channels.	Older residents in this case did not rely uniformly on Internet-based services; prior crisis-communication research also emphasizes trusted and actionable information flows.
DP2: Register-supported local data stewardship	The system should combine national register data with local updating mechanisms through apartment associations and municipal administrators.	Technical interoperability alone does not ensure operationally accurate residence, contact, or preparedness data. Local data stewardship is needed to improve data quality.
DP3: Privacy-by-design and role-based access	The system should restrict personal and vulnerability-related data according to legal basis, purpose, institutional role, operational need, aggregation thresholds, and auditability.	Crisis preparedness may require sensitive data, but expert feedback and GDPR principles show that data minimization, proportionality, and re-identification risk must shape the system architecture from the outset.
DP4: Preparedness-status visualization	The system should translate heterogeneous preparedness information into a simple status overview for municipal prioritization.	Municipal actors need a rapid operational overview of apartment associations, building readiness, and support needs before and during crises.
DP5: Intermediary-based socio-technical coordination	The system should position local government as official coordinator and apartment associations as local intermediaries between authorities and residents.	The findings indicate that crisis preparedness requires not only digital infrastructure, but also trusted organizational roles and community-level coordination.
DP6: Adoption-aware staged implementation	The service should be introduced progressively, beginning with municipality-apartment association cooperation and expanding to additional stakeholder groups as organizational roles, user support, and participation practices are refined.	Public e-service adoption depends not only on technical availability, but also on usability, trust, institutional capacity, stakeholder readiness, and motivation to participate.

Table 14 Competency comparison: Local Government Administrators and responsible user of the apartment association

Local government administrator	Responsible user of the apartment association
Accessing and integrating database information on apartment associations and residents	Reviewing and approving crisis and development plans
Developing crisis plans and assessing progress	Providing capability and status information
Advising apartment associations and issuing official notices	Updating resource descriptions
Maintaining correspondence and assigning a municipal contact person	Managing correspondence and submitting inquiries
Initiating formal procedures and resolving operational issues	Requesting assistance and funding
Verifying legal compliance of documentation	Using anonymized resident profiles for planning
Preparing action plans and beneficiary lists	Maintaining current resident and ownership data
Making municipal investment decisions	Initiating project funding requests
Assigning preparedness ratings (red/yellow/green)	
Prioritizing crisis-related tasks	

To make the design contribution more explicit, Table 13 abstracts the case-specific e-service concept into transferable design principles. These principles are not presented as statistically generalizable findings, but as analytically generalized design knowledge that may inform similar municipal crisis-preparedness contexts where digital infrastructures, local intermediaries, and vulnerable resident groups must be coordinated.

6.2 User's Competences

Distinct development stages involve different user groups, each with specific competencies.

Local government administrators are responsible for data access, legal compliance, and crisis preparedness. Their key competencies include synthesizing information from multiple state databases, developing and implementing crisis management plans with apartment associations, providing

advisory support, maintaining systematic communication, initiating official procedures, resolving operational issues, and verifying documentation. Administrators analyze integrated data to prepare action plans, make investment decisions, and assign standardized preparedness ratings (green, yellow, red) to apartment associations. Task prioritization during crises forms an essential part of this role. The administrator position is a functional role that may be performed by multiple municipal staff.

The Table 14 presents a structured comparison of the core competencies required for local government administrators and apartment association responsible users, highlighting their respective roles in crisis management, regulatory compliance, communication, and resource coordination within the housing governance framework.

Responsible users of apartment associations ensure accurate communication with the local government and support organizational preparedness.

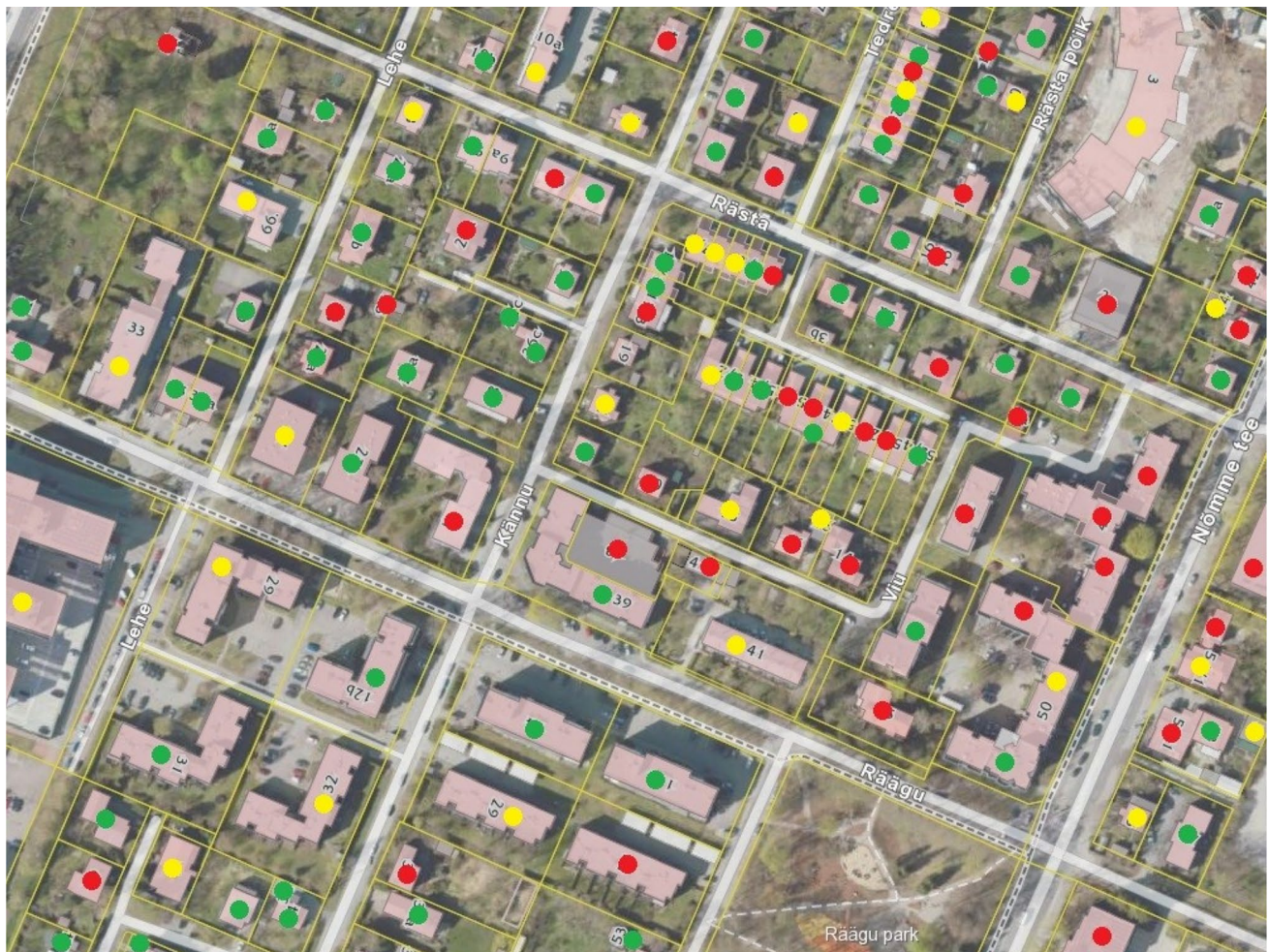


Fig. 5 Illustrative overview map of Kristiine district showing hypothetical apartment association preparedness statuses. The red, yellow, and green indicators are used only to demonstrate the proposed visu-

alization logic and do not represent an empirical building-level readiness assessment. Source: Maa-amet, MaaInfo (accessed 18 November 2025)

Their competencies include reviewing and approving crisis and development plans, providing information on the association's capabilities, updating resource descriptions, managing correspondence, requesting financial support, and maintaining up-to-date resident and ownership lists. They may also use anonymized resident data to guide planning and investment decisions.

In the second development stage, the Estonian Rescue Services Agency will gain access to the system to support operational decision-making. During incidents, responders will be able to retrieve data on residents, vulnerable individuals, and building specifications to improve situational awareness and integrate this information into operative cards. Apartment associations follow the ISO 22301:2019 PDCA cycle to support continuous improvement (ISO22301-2019, 2019).

The e-service development process comprises three stages:

- Connecting local governments and apartment associations;
- Adding the Estonian Rescue Services Agency for emergency data use;
- Providing anonymized profile data to the public to support informed decisions.

The first stage addresses the research question by enhancing digital collaboration for crisis preparedness. The second stage integrates rescue service data to strengthen inter-organizational coordination. The third stage introduces public access to preparedness ratings of apartment associations, supported by a map-based spatial overview for local governments to guide planning and resource allocation.

A visual status system employing color-coded indicators (e.g., red–yellow–green) enables rapid assessment of preparedness levels, with red denoting high-risk buildings. Figure 5 illustrates the proposed visualization logic using hypothetical red, yellow, and green preparedness statuses.

The indicators are illustrative only and do not represent apartment associations whose preparedness was empirically assessed in this study.

In summary, the e-service delineates clear roles to strengthen crisis preparedness. Local governments manage strategic oversight, data access, guidance, official correspondence, crisis plan approval, progress evaluation, status assignment, and financial support decisions. Apartment associations focus on communication, resource management, operational reporting, coordination with municipal contacts, and development and approval of crisis and development plans, ensuring their resources and capabilities are regularly updated.

6.3 Cloud Architecture Model

The proposed e-service is a cloud-based platform that strengthens crisis preparedness and coordination between apartment associations and municipal authorities. Accessible via mobile devices and web browsers, it provides tools for document management, secure messaging, media uploads, and service log access. Users can prepare crisis and development plans, maintain contact lists, and view anonymized resident profiles, while local governments serve as system moderators with designated administrators responsible for functionality and security. The system architecture includes an application layer, data storage, a cloud runtime environment, infrastructure management, and security controls. All databases are connected through Estonia's X-Road interface to ensure secure and interoperable data exchange. The platform is scalable and supports future integration of additional services.

7 Formative Expert Evaluation

Because the proposed e-service was developed as a conceptual artifact and was not implemented as a working prototype, the final expert meeting is reported as a formative expert evaluation rather than as validation in a summative sense. The purpose of the meeting was to assess the perceived relevance, feasibility, risks, and further development needs of the concept. The meeting was held on 13 April 2023 via Microsoft Teams with experts from the Estonian Rescue Board and the Tallinn Municipal Police Department and lasted approximately 60 minutes. The first author presented the research questions, the main empirical findings, and the proposed e-service concept, after which participants provided open feedback on the perceived need for the concept, possible implementation constraints, data-protection concerns, technical feasibility, and further development requirements. The meeting was not audio-recorded,

video-recorded, or transcribed, and no standardized scoring instrument was used. The first author documented the discussion in free-text notes during and immediately after the meeting. Participants included an adviser from the prevention work department of the Estonian Rescue Board, a crisis-preparedness adviser for local governments from the Emergency Preparedness Department of the Estonian Rescue Board, a shelter adviser from the Emergency Preparedness Department of the Estonian Rescue Board, and a specialist from the Tallinn Municipal Police Department.

Accordingly, the term evaluation in this section refers to formative assessment of a concept, not to summative validation of an implemented e-service.

The feedback was interpreted using formative criteria appropriate for an early-stage conceptual e-service: perceived practical relevance, feasibility of implementation, data availability and quality, privacy and access-control risks, inter-organizational coordination value, motivation of apartment associations, resilience during Internet or electricity outages, and need for future prototype testing. These criteria were used to structure the interpretation of the expert feedback and to distinguish supportive comments from unresolved implementation challenges.

Participants agreed it would be a new e-service and that does not exist today, but the main obstacle could be the data protection issues. It is debatable to what extent it is allowed to send data, collect it and share it with different counterparts, including regular residents in the third stage of development.

A full legal analysis remains necessary before implementation; however, the proposed concept already incorporates preliminary privacy-by-design constraints. As described in Section 6, the role-based two-tier access model addresses purpose limitation and data minimization through purpose-bound processing, differentiated visibility, and minimum-necessary data access.

When the prototype of the new e-service is ready, it would be good to involve the Estonian Union of Co-operative Housing Association to test it and redesign it according to their feedback. This should be shared across Estonia.

A huge question is how much the new e-service creation and development cost would be. In the public sector, projects are valued according to the investment's cost and the project's impact. Therefore, it is crucial to evaluate and map the costs of the project, and what could be the financial resources for this investment. The new e-service could also be a good tool for the Estonian Rescue Services Agency because now, sheltering conditions valuation is done according to the home visit. If we can activate apartment associations themselves, then it would save a lot of work time. Sheltering info is based on Rescue Agency home visits. Local government is "eyes and ears".

Still, the question is, how to motivate apartment associations to participate in the new e-service and make them more active. Support system could motivate them. Moreover, most apartment associations do not have the correct list of contacts for their house. Apartment associations should know their residents.

Usually, on paper, the interface to the databases seems easy, but, it is not. Many other projects do not have the correct interface to the different databases, so they cannot be developed.

The Estonian Rescue Services Agency struggles to identify people needing extra help during emergencies, as population registers lack accurate residence data and details on vulnerable groups. Frequent apartment rentals and limited contact with housing associations add to the challenge. Establishing this connection within the new e-service would enhance the systematic nature of crisis management.

Finally, there must be a plan for crisis management, when there is no Internet or no electricity. Question is, how to send information to residents during long-term power outages. The authors agreed with the recommendations provided by experts from the Estonian Rescue Services Agency and the Tallinn Municipal Police Department. According to the authors opinion, feedback generally supports the creation of the new e-service, but it gives some extra questions for further research directions.

Overall, the formative expert feedback indicated perceived practical relevance of the proposed concept, while also identifying substantial unresolved implementation challenges. The feedback should therefore not be interpreted as validation of effectiveness. Rather, it provides expert-informed refinement points for future prototype development, legal analysis, technical feasibility assessment, and empirical evaluation with apartment associations and municipal users.

Because the concept was not implemented or deployed, these findings should not be interpreted as evidence of measured effectiveness. They indicate perceived relevance and feasibility concerns that can guide future prototype development and evaluation.

8 Discussion

The findings show that municipal crisis preparedness is not only a technical problem of connecting databases, but a socio-technical coordination problem involving data quality, institutional responsibility, trusted communication, and local intermediaries. The World Café findings indicated that older residents rely on multiple communication channels and may not be reached through digital portals alone. The expert consultations showed that municipalities lack

a reliable operational overview of apartment associations, resident contact information, preparedness levels, and support needs. Together, these findings support the design of an e-service as a coordination platform rather than as a stand-alone citizen-facing application.

The study contributes to IS and e-government research by showing how national digital infrastructures can be connected to local crisis-preparedness practices through apartment associations. From a crisis information-management perspective, the findings support prior research arguing that crisis response requires shared situational awareness, trusted information flows, adaptable information-management practices, and coordination across organizational boundaries (Bharosa & Janssen, 2010). This study extends that discussion by identifying apartment associations as potential local intermediaries between municipal authorities and residents in digitally mature but operationally fragmented settings.

From an e-government and interoperability perspective, the case illustrates both the potential and the limits of register-based digital public services. Estonia's X-Road infrastructure and national registers provide a strong basis for inter-organizational data exchange, but the findings show that technically available data are not automatically operationally usable for crisis preparedness. Residence and contact data may be incomplete, outdated, or insufficiently aligned with actual living arrangements. This suggests that e-government interoperability must be complemented by local data stewardship, role-based governance, and community-level updating mechanisms involving apartment associations (Lips et al., 2023; Saputro et al., 2020; Tsap et al., 2020).

From a digital public-service adoption and technology-readiness perspective, the findings show that crisis-related e-services must be designed for heterogeneous user capabilities and trust relationships. The older residents in this case did not rely uniformly on Internet-based channels, and many preferred communication through radio, television, SMS, phone calls, or trusted local intermediaries. This finding is consistent with research showing that public e-service adoption depends not only on technical availability, but also on usability, trust, institutional capacity, and user readiness (Distel, 2020; Eriksson, 2018; Gjesten et al., 2017; Neely & Collins, 2018; Panagiotopoulos et al., 2016). Accordingly, the proposed e-service is conceptualized not as a citizen-facing web portal alone, but as a coordination platform that combines municipal authority, apartment-association mediation, multi-channel communication, and register-supported information management.

The practical implication is that municipalities should not treat crisis e-services only as information portals. They also need mechanisms for maintaining up-to-date contact

data, clarifying responsibilities, documenting preparedness activities, coordinating with local intermediaries, and communicating through channels that match residents' capabilities. For apartment associations, the concept highlights a possible role in supporting preparedness planning and local information sharing, while also showing that such participation requires clear responsibilities, motivation, guidance, and privacy safeguards.

The findings also show that privacy and data protection are central design issues. Register-based crisis preparedness may increase municipal situational awareness, but it also creates risks related to sensitive data, role-based access, and re-identification in small buildings. Therefore, privacy-by-design is not a secondary implementation detail but a core requirement for any future prototype. This insight strengthens the IS contribution by showing how crisis e-services must balance interoperability, operational usefulness, and data protection.

The contribution is context-bound but not limited to Estonia. The Estonian X-Road infrastructure and national registers provide unusually strong conditions for register-supported e-services. However, the broader design problem is relevant to other municipalities that need to coordinate digital infrastructures, local organizations, vulnerable residents, and trusted communication during crises. In less digitally mature contexts, the same principles may require different technical implementations, more manual data-updating procedures, or stronger reliance on community intermediaries.

The boundary conditions of the proposed design should therefore be made explicit. The concept assumes the existence of reliable institutional actors at the municipal level, legally defined local intermediaries such as apartment associations, access to authoritative public-sector data sources, and the possibility of secure data exchange between organizations. The Estonian case provides particularly favourable conditions because of X-Road, national registers, and high digital-service maturity. In contexts where such infrastructure is weaker, the same design principles may still transfer, but the implementation would need to rely more heavily on municipal data collection, manual verification of resident and contact information, non-digital communication channels, and community-based coordination. Thus, the IS contribution lies not in the specific Estonian technical configuration, but in the transferable socio-technical design logic for connecting public-sector data, local intermediaries, privacy-aware governance, and multi-channel crisis communication.

9 Limitations and Future Research Directions

This research has several limitations. One of the main challenges was the limited availability of crisis management experts from public institutions, due to their high workload. This made it difficult to secure a sufficient number of stakeholder interviews and expert consultations, which could have enriched the evaluation and validation of the proposed e-service.

Experts in crisis management from the Estonian Rescue Services Agency preferred to remain anonymous in the academic work; however, they contributed their insights during the meetings.

Certain details of crisis response plans are restricted for internal use by governmental organizations and cannot be disclosed publicly. Some of this information pertains to national security and is therefore not available for discussion in this research. As a result, the study is limited to publicly accessible data and expert insights that do not compromise sensitive or classified information.

The expert input also has methodological limitations. The two expert consultations and the later formative feedback meeting were documented through author notes rather than audio recordings, video recordings, or transcripts. The notes were not participant-validated. Consequently, the expert feedback should be interpreted as formative and practice-oriented input for concept refinement, not as a summative empirical evaluation or formal validation of a working artifact. Future research should apply a structured evaluation design with predefined criteria, documented instruments, systematic coding of expert and user feedback, and testing of a functional prototype in collaboration with municipalities, apartment associations, and rescue-service stakeholders.

A related limitation concerns qualitative trustworthiness. Although the revised manuscript improves transparency by reporting the unit of analysis, categorization logic, illustrative excerpts, and traceability from empirical evidence to design requirements, the analysis was not conducted as a full thematic analysis with multiple coders, intercoder agreement, or participant validation. Future studies should strengthen qualitative rigor through a predefined coding protocol, multiple analysts, documented coding decisions, and validation of interpretations with relevant stakeholder groups.

Another limitation concerns temporal coherence. The primary empirical material was collected in early 2023, whereas the legal and infrastructural context was updated during the revision process to include relevant developments up to 2025. These updates indicate that the need for reliable data, coordinated communication,

apartment-association involvement, and privacy-aware information sharing remains relevant. However, the study does not empirically evaluate how the 2025 legal changes affect the proposed e-service in practice. Future research should therefore reassess the requirements with apartment associations, municipal users, rescue-service stakeholders, and legal experts under the updated regulatory framework.

Another methodological limitation is that the resident workshop followed an adapted World-Café-style format rather than a full formal World Café protocol with rotating table rounds. The procedure was appropriate for eliciting anonymous written input from older residents, but future studies could use a more formally structured participatory design workshop with separate facilitated tables, documented rounds, and comparative analysis across groups.

The resident sample also limits the generalizability of the descriptive findings. The 30 workshop participants were self-selected, and the group was skewed toward women and residents over 70 years old. The reported percentages are therefore used only as exploratory descriptive information about this participant group. They should not be interpreted as representative estimates of the wider older-adult population. In particular, the concentration of women and participants over 70 means that the observed communication preferences, trust patterns, and use of digital services may reflect this demographic subgroup and should not be assumed to characterize older adults more broadly.

Future research should include larger and more diverse samples of residents, apartment association board members, and other vulnerable groups.

Another limitation of the research is that 23% of respondents were residents of private houses. While the proposed e-service primarily targets apartment associations, future implementation must also address the needs of individuals living in private homes—particularly older adult residents who live alone and lack the support structures provided by apartment associations. After the full mapping of district areas, it will be the responsibility of local governments to identify and engage with these households. Residents living with others in private homes are generally less vulnerable, but this distinction can be recorded within the e-service system. The platform could also include indicators of crisis preparedness levels for each household, enabling more targeted support and planning.

A further limitation concerns the formative expert evaluation. The final expert meeting provided valuable practice-oriented feedback, but it did not use a standardized evaluation instrument, did not include a deployed prototype, and did not measure actual use, adoption, or crisis-management outcomes. Future research should therefore develop a working prototype and evaluate it with apartment associations, municipal users, and rescue-service stakeholders

using explicit criteria such as usefulness, feasibility, usability, privacy protection, organizational adoption, and operational resilience.

Consequently, future research should develop a working prototype and evaluate it in collaboration with apartment associations, municipal users, and rescue-service stakeholders. Such evaluation should include explicit criteria for usefulness, feasibility, data quality, privacy protection, usability, and organizational adoption.

A further limitation concerns the degree of co-creation. The present study involved older residents and crisis-management experts in problem formulation, requirements elicitation, and formative feedback, but apartment association boards were not formal co-design participants. Therefore, the proposed concept should be understood as a cooperation-oriented conceptual design rather than as a fully co-created artifact. Future research should involve apartment association board members, responsible users, municipal administrators, and residents in participatory prototype development and iterative evaluation.

Further development will require additional research, continued investigation, and policy-level decisions to enable implementation and testing.

In this study, we focused on older adults as our primary target group; however, the conclusions drawn are broadly applicable to all vulnerable populations. Future research should explore the concerns and challenges faced by other vulnerable groups and compare these with those of older adults. Our current emphasis on older adults stems from their numerical predominance, making them the largest and most significant subgroup within this context.

A central limitation is that the present study does not provide a full legal analysis of the proposed data processing model. Because the concept may involve sensitive or vulnerability-related information, future development must include legal review, privacy engineering, and a Data Protection Impact Assessment before implementation. This is especially important for small buildings, where even aggregated indicators may create re-identification risks.

Because the e-service was not implemented or tested in operational use, the study cannot assess its actual effectiveness, adoption, or impact on crisis outcomes. The claims made in this paper are therefore limited to the empirical grounding, design rationale, perceived expert relevance, and future potential of the proposed concept.

The proposed e-service opens several avenues for further investigation:

- **Resilient connectivity:** explore solutions for maintaining e-service functionality during crises, including decentralized technologies, alternative infrastructure, and emergency communication systems. For example, in

Japan, the social networking service LINE is employed as a communication channel with local residents during disaster situations (Suzuki et al., 2019).

- Integration with private Systems: investigate interoperability with existing private apartment association platforms (e.g., Korto²⁶) to enhance data sharing and service efficiency.
- AI frameworks and machine learning applications: investigate the potential of advanced AI frameworks and machine learning methodologies to enable intelligent tools—such as conversational agents, automated alert systems, and evacuation planning algorithms—that enhance crisis response efficiency and significantly reduce human cognitive and operational workload.
- Community and NGO collaboration: assess the role of non-profit organizations (e.g., Estonian Neighborhood Watch²⁷) in supporting e-service deployment and crisis management at the local level.

10 Conclusion

This research aims to explore strategies for strengthening digital collaboration between local governments and apartment associations to enhance crisis preparedness. More specifically, the research centers on a case study of the Kristiine district - one of the eight administrative districts of Tallinn, the capital of Estonia.

Methodologically, the study is positioned as an exploratory design-oriented case study informed by selected ADR principles. The empirical work supported problem formulation, requirements elicitation, and the development of the Coordination Framework for Municipal–Apartment Association Crisis Preparedness (C-MAACP Framework). Prototype implementation and iterative evaluation remain important directions for future research.

To identify solutions and address the research questions, the authors conducted a meeting in World-Café-style (Löhr et al., 2020) format with older adult residents, engaged with subject-matter experts, analyzed various secondary data sources, and proposed a new e-service concept. The authors evaluated the proposed e-service during a meeting with a crisis management experts from the Estonian Rescue Services Agency and Tallinn Municipal Police Department.

The study answers the main research question by showing that digital cooperation can be strengthened through a socio-technical e-service concept that combines municipal oversight, apartment-association participation,

register-supported data exchange, role-based access, and multi-channel crisis communication.

Regarding the first sub-question, the findings indicate the need for secure, interoperable, and continuously updated digital infrastructure that connects relevant public-sector registers with local apartment-association information. Regarding the second sub-question, the findings indicate that communication with older adults should combine official digital channels with SMS, phone, broadcast media, printed notices, and apartment-association-mediated local communication.

The primary challenge addressed in this research is obtaining a comprehensive overview of all apartment associations within the district and understanding their specific needs. This includes mapping vulnerable individuals, categorizing their living conditions and potential needs during crises, establishing direct communication channels, and collaboratively developing crisis response plans and strategies.

As a result of the research, the authors proposed a new e-service concept designed for local municipalities and apartment associations to enhance crisis preparedness and facilitate effective communication during emergencies. The proposed e-service will be an online platform designed to support local governments in crisis preparedness. Prior to the onset of a crisis, it would enable municipalities to generate a comprehensive overview of all apartment associations within their jurisdiction, identify vulnerable individuals residing in these buildings, and gather critical information such as their location, health status, and potential evacuation plans. This data would facilitate targeted support and efficient coordination during emergencies. For apartment associations, the e-service would provide a centralized tool for managing household-related information and activities. In collaboration with local municipalities, it would support building-level crisis preparedness and development. The apartment building is positioned as a key operational unit of local crisis preparedness and coordination, encompassing its structure, exits, shelters, technical systems, residents, vulnerabilities, contact persons, crisis resources, and action plans. The system is designed to integrate with existing national e-government databases to offer a comprehensive overview of apartment associations in the area. Furthermore, the e-service will be connected to Estonia's X-Road platform, ensuring secure and efficient data exchange between stakeholders. During crisis management, the e-service would support prioritization of response efforts and enable direct communication with all residents in the affected area. The proposed e-service would be owned by the Republic of Estonia and fall under the jurisdiction of the Ministry of the Interior. As suggested by the authors, the e-service could be developed in three distinct phases, each offering increasing functionality and integration. Additionally, the concept

²⁶ <https://korto.ee/public>

²⁷ <https://naabrivalve.ee/>

opens up multiple avenues for future research, including technical implementation, user adoption, and policy implications.

The research findings suggest that existing Estonian e-government services and databases could be leveraged to develop the Coordination Framework for Municipal-Apartment Association Crisis Preparedness (C-MAACP Framework), a conceptual e-service framework supporting crisis preparedness and communication between apartment associations and local municipalities. Further prototype development, legal analysis, and empirical evaluation are required before claims can be made about operational effectiveness or life-saving impact.

Author Contributions Jaanus Riibe is the main author of the paper. He designed the research question and methodology, collected and analyzed the data, compiled the results and related work and wrote the paper. Jamal Mohamed Hassan contributed a revision of the paper. Silvia Lips contributed to the design of the research question and methodology, collection and analysis of data, compilation of results and related work and writing of the paper. Rahul Sharma contributed a revision of the paper. Dirk Draheim contributed in the writing and revision of the paper.

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Availability of Data and Material The anonymized World Café question-answer dataset analysed during the current study is publicly available as a research dataset (Riibe, 2023), DOI: 10.13140/RG.2.2.30498.29128. The collected responses did not contain information that would allow individual participants to be identified. Expert consultation notes are not shared publicly because they consist of author-documented meeting notes and may contain institutionally sensitive contextual information.

Declarations

Competing Interests The authors declare that they have no competing interests.

Ethics Approval and Consent to Participate No separate ethics-committee approval was obtained for this study. The empirical material consisted of anonymous written responses collected during a voluntary, discussion-based World-Café-style workshop and author-documented expert consultation notes. No directly identifiable personal data, participant registration lists, audio recordings, video recordings, photographs, or transcripts were collected. Participants were informed about the purpose of the workshop before participation, and the reporting of the findings does not include information that would allow individual participants to be identified.

Consent for Publication All authors consent to the publication of this manuscript.

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References

- Austin, L. L., & Jin, Y. (Eds.). (2018). *Social Media and Crisis Communication* (1st ed.). UK: Routledge, New York / Abingdon.
- Bharosa, N., & Janssen, M. (2010). Extracting principles for information management adaptability during crisis response: A dynamic capability view. In *2010 43rd Hawaii International Conference on System Sciences* (pp. 1–10). IEEE. <https://doi.org/10.1109/HICSS.2010.454>
- Bharosa, N., Appelman, J., & De Bruin, P. (2007). Integrating technology in crisis response using an information manager: First lessons learned from field exercises in the port of rotterdam. *Intelligent Human Computer Systems for Crisis Response and Management* (pp. 63–70). Brussels: VUBPress.
- Bharosa, N., van Zanten, B., Janssen, M., et al. (2009). Transforming crisis management: Field studies on the efforts to migrate from system-centric to network-centric operations. In M.A. Wimmer, H.J. Scholl, M. Janssen, et al. (Eds.) *Electronic Government (EGOV 2009), Lecture Notes in Computer Science*, vol. 5693, pp. 65–75. Springer. https://doi.org/10.1007/978-3-642-03516-6_6
- Burlacu, S., Patarlageanu, S. R., Diaconu, A., et al. (2021). E-government in the era of globalization and the health crisis caused by the COVID-19 pandemic, between standards and innovation. *SHS Web of Conferences*, 92, 08004. <https://doi.org/10.1051/shsconf/20219208004>
- City of Tallinn (2022). Kõsimustik tõi välja korteriühistute kriisideks valmisoleku kitsaskohad. <https://www.tallinn.ee/et/uudis/kusimustik-toi-valja-korteriuhistute-kriisideks-valmisoleku-kitsaskohad>
- Distel, B. (2020). Assessing citizens' non-adoption of public e-services in Germany. *Information Policy*, 25(3), 339–360. <https://doi.org/10.3233/IP-190214>
- Draheim, D., & Pirinen, R. (2011). Towards exploiting social software for business continuity management. In *22nd International Workshop on Database and Expert Systems Applications (DEXA)* (pp. 279–283). IEEE. <https://doi.org/10.1109/DEXA.2011.81>
- Dubey, R., Bryde, D. J., Blome, C., et al. (2024). Alliances and digital transformation are crucial for benefiting from dynamic supply chain capabilities during times of crisis: A multi-method study. *International Journal of Production Economics*, 269, 109166. <https://doi.org/10.1016/j.ijpe.2024.109166>
- Eriksson, M. (2018). Lessons for crisis communication on social media: A systematic review of what research tells the practice. *International Journal of Strategic Communication*, 12(5), 526–551. <https://doi.org/10.1080/1553118X.2018.1510405>
- Gjestsen, M. T., Wiig, S., & Testad, I. (2017). What are the key contextual factors when preparing for successful implementation of assistive living technology in primary elderly care? A case study from Norway. *BMJ Open*, 7(9), e015455. <https://doi.org/10.1136/bmjopen-2016-015455>
- Hagen, L., Scharf, R., & Neely, S. (2018). Government social media communications during Zika health crisis. In *Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age* (pp. 1–10).

- Association for Computing Machinery. <https://doi.org/10.1145/3209281.3209364>
- Hagen, L., Neely, S., Scharf, R., et al. (2020). Social media use for crisis and emergency risk communications during the Zika health crisis. *Digital Government: Research and Practice*, 1(2), 1–21. <https://doi.org/10.1145/3372021>
- ISO22300-2021 (2021). ISO 22300:2021 – Security and Resilience – Vocabulary. <https://www.iso.org/standard/77008.html>. published February 2021
- ISO22300-2025 (2025) ISO 22300:2025 – Security and resilience – Vocabulary. <https://www.iso.org/standard/85749.html>
- ISO22301-2019 (2019) ISO 22301:2019 – Security and Resilience – Business Continuity Management systems – Requirements. <https://www.iso.org/standard/75106.html>
- ISO22320-2018 (2018) ISO 22320:2018 – Security and Resilience – Emergency Management – Guidelines for Incident Management. <https://www.iso.org/standard/67851.html>
- ISO22326-2018 (2018) ISO 22326:2018 – Security and Resilience – Emergency Management – Guidelines for Monitoring Facilities with Identified Hazards. <https://www.iso.org/standard/67159.html>
- ISO22361-2022 (2022) ISO 22361:2022 – Security and Resilience – Crisis Management – Guidelines. <https://www.iso.org/standard/50267.html>
- Janssen, M., & van der Voort, H. (2020). Agile and adaptive governance in crisis response: Lessons from the COVID-19 pandemic. *International Journal of Information Management*, 55, 102180. <https://doi.org/10.1016/j.ijinfomgt.2020.102180>
- Javadpour, A., AliPour, F. S., Sangaiah, A. K., et al. (2023). An IoE blockchain-based network knowledge management model for resilient disaster frameworks. *Journal of Innovation & Knowledge*, 8(3), 100400. <https://doi.org/10.1016/j.jik.2023.100400>
- Kamberi, F. (2021). Cooperation between community and local governance - A comparative study of municipalities of pristina region. *Balkan Social Science Review*, 18, 263–283. <https://doi.org/10.46763/BSSR2118263k>
- Keudel, O., & Huss, O. (2024). Polycentric governance in practice: the case of Ukraine's decentralised crisis response during the Russo-Ukrainian war. *Journal of Public Finance and Public Choice*, 39(1), 10–35. <https://doi.org/10.1332/25156918Y2023D000000002>
- Knox, C. C. (2023). Local emergency management's use of social media during disasters: a case study of Hurricane Irma. *Disasters*, 47(2), 247–266. <https://doi.org/10.1111/disa.12544>
- Kontogiannis, V., Manousos, D., Karatzanis, I., et al. (2017). Innovative technologies to support appropriate accommodation in emergency shelters. In *2017 4th International Conference on Information and Communication Technologies for Disaster Management (ICT-DM)*, pp. 1–6. IEEE. <https://doi.org/10.1109/ICT-DM.2017.8275688>, <https://ieeexplore.ieee.org/abstract/document/8275688>
- Lee-Geiller, S., & Lee, T. (2022). How does digital governance contribute to effective crisis management? a case study of Korea's response to COVID-19. *Public Performance & Management Review*, 45(4), 860–893. <https://doi.org/10.1080/15309576.2022.2054434>
- Li, C., Zhang, Z., Liu, L., et al. (2024). A novel deep multi-instance convolutional neural network for disaster classification from high-resolution remote sensing images. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 17, 2098–2114. <https://doi.org/10.1109/JSTARS.2023.3340413>
- Lips, S., Tsap, V., Bharosa, N., et al. (2023). Management of national eID infrastructure as a state-critical asset and public-private partnership: Learning from the case of Estonia. *Information Systems Frontiers*, 25(6), 2439–2456. <https://doi.org/10.1007/s10796-022-10363-5>
- Liutkevičius, M., & Ben Yahia, S. (2022). Research roadmap for designing a virtual competence assistant for the European labour market. *Procedia Computer Science*, 207, 2404–2413. <https://doi.org/10.1016/j.procs.2022.09.299>
- Löhr, K., Weinhardt, M., & Sieber, S. (2020). The “World Café” as a participatory method for collecting qualitative data. *International Journal of Qualitative Methods*, 19, 1–15. <https://doi.org/10.1177/1609406920916976>
- Love, R., Darics, E., & Palmieri, R. (2023). Engaging the public: English local government organisations' social media communications during the COVID-19 pandemic. *Applied Corpus Linguistics*, 3(3), 100060. <https://doi.org/10.1016/j.acorp.2023.100060>
- del Mar Gálvez-Rodríguez, M., Haro-de Rosario, A., & del Carmen, C.-P.M. (2019). The Syrian refugee crisis: How local governments and ngos manage their image via social media. *Disasters*, 43(3), 509–533. <https://doi.org/10.1111/disa.12351>
- Neely, S. R., & Collins, M. (2018). Social media and crisis communications: A survey of local governments in Florida. *Journal of Homeland Security and Emergency Management*, 15(1), 20160067. <https://doi.org/10.1515/jhsem-2016-0067>
- Nekoei-Moghadam, M., Amiresmaili, M., & Araddei, Z. (2016). Investigation of obstacles against effective crisis management in earthquake. *Journal of Acute Disease*, 5(2), 91–95. <https://doi.org/10.1016/j.joad.2015.10.001>
- Noor, N., Okhai, R., Jamal, T. B., et al. (2024). Social-media-based crisis communication: Assessing the engagement of local agencies in Twitter during Hurricane Irma. *International Journal of Information Management Data Insights*, 4(2), 100236. <https://doi.org/10.1016/j.jjimei.2024.100236>
- Padeiro, M., Bueno-Larraz, B., & Freitas, Â. (2021). Local governments' use of social media during the COVID-19 pandemic: The case of Portugal. *Government Information Quarterly*, 38(4), 101620. <https://doi.org/10.1016/j.giq.2021.101620>
- Panagiotopoulos, P., Barnett, J., Ziaee Bigdeli, A., et al. (2016). Social media in emergency management: Twitter as a tool for communicating risks to the public. *Technological Forecasting and Social Change*, 111, 86–96. <https://doi.org/10.1016/j.techfore.2016.06.010>
- Pappas, I. O., Mikalef, P., Dwivedi, Y. K., et al. (2023). Responsible digital transformation for a sustainable society. *Information Systems Frontiers*, 25(3), 945–953. <https://doi.org/10.1007/s10796-023-10406-5>
- Paulus, D., de Vries, G., Janssen, M., et al. (2022). The influence of cognitive bias on crisis decision-making: Experimental evidence on the comparison of bias effects between crisis decision-maker groups. *International Journal of Disaster Risk Reduction*, 82, 103379. <https://doi.org/10.1016/j.ijdrr.2022.103379>
- Riibe, J. (2023). Question-answer dataset from a meeting held on 16 January 2023. ResearchGate. <https://doi.org/10.13140/RG.2.2.30498.29128>, [Data set]
- Riigikogu (1993). Local Government Organisation Act. <https://www.riigiteataja.ee/en/akt/512092025003>, passed 02.06.1993, RT 1993, 37, 558; entry into force 01.09.2025.
- Riigikogu (2010). Rescue Act. <https://www.riigiteataja.ee/en/eli/527122023004/consolide>, passed 05.05.2010, RT I 2010, 24, 115; entry into force 01.09.2010.
- Riigikogu (2014). Apartment Ownership and Apartment Associations Act. <https://www.riigiteataja.ee/en/akt/519122023001>, passed 19.02.2014, RT I, 13.03.2014, 3; entry into force 01.01.2018.
- Riigikogu (2015a). Chemicals Act. <https://www.riigiteataja.ee/en/eli/512062023001/consolide/current>, passed 29.10.2015, RT I, 10.11.2015, 2; entry into force 01.12.2015.
- Riigikogu (2015b). Ehitusseadustik. <https://www.riigiteataja.ee/akt/108072025039?leiaKehtiv>, passed 11.02.2015, RT I, 05.03.2015, 1; entry into force 01.07.2015.

- Riigikogu (2015c). Riigikaitse seadus. <https://www.riigiteataja.ee/akt/113032019147?leiaKehtiv>, passed 11.02.2015, RT I, 12.03.2015, 1; entry into force 01.01.2016.
- Riigikogu (2017a). Emergency Act. <https://www.riigiteataja.ee/en/eli/ee/508012024009/consolide/current>, passed 08.02.2017, RT I, 03.03.2017, 1; entry into force 01.07.2017.
- Riigikogu (2017b). Road Transport Act. <https://www.riigiteataja.ee/en/eli/516012024003/consolide>, passed 19.12.2017, RT I, 11.01.2018, 1; entry into force 01.06.2018.
- Riigikogu (2025). Hädaolukorra seaduse ja teiste seaduste muutmise seadus. <https://www.riigiteataja.ee/akt/102102025002>, passed 24.09.2025, RT I, 02.10.2025, 2; entry into force 12.10.2025.
- Riigikogu (2026). Kriisilukorra ja riigikaitse seadus. <https://www.riigiteataja.ee/akt/130062026001>, passed 02.06.2026, RT I, 30.06.2026, 1; entry into force 01.10.2026.
- Sadhukhan, S., Banerjee, S., Das, P., et al. (2018). Producing better disaster management plan in post-disaster situation using social media mining. In *Computational Intelligence for Multimedia Big Data on the Cloud with Engineering Applications. Intelligent Data-Centric Systems*, Elsevier, Amsterdam, chap 9, pp. 171–183. <https://doi.org/10.1016/B978-0-12-813314-9.00009-8>
- Saputro, R., Pappel, I., Vainsalu, H., et al. (2020). Prerequisites for the adoption of the X-Road interoperability and data exchange framework: A comparative study. In *2020 7th International Conference on eDemocracy & eGovernment (ICEDEG)*, pp. 216–222. IEEE. <https://doi.org/10.1109/ICEDEG48599.2020.9096704>
- Scott, K. K., & Errett, N. A. (2018). Content, accessibility, and dissemination of disaster information via social media during the 2016 Louisiana floods. *Journal of Public Health Management and Practice*, 24(4), 370–379. <https://doi.org/10.1097/PHH.0000000000000708>
- Sein, M. K., Henfridsson, O., Purao, S., et al. (2011). Action design research. *MIS Quarterly*, 35(1), 37–56. <https://doi.org/10.2307/23043488>
- Sousa, S., & Kalju, T. (2022). Modeling trust in COVID-19 contact-tracing apps using the human-computer trust scale: Online survey study. *JMIR Human Factors*, 9(2), e33951. <https://doi.org/10.2196/33951>
- Spanaki, K., Zamani, E. D., Jayawickrama, U., et al. (2024). Information management in times of crisis: the role of mindfulness and digital resilience for individuals and organisations. *Information Systems Frontiers*, 26(2), 369–374. <https://doi.org/10.1007/s10796-023-10419-0>
- Splendiani, S., & Capriello, A. (2022). Crisis communication, social media and natural disasters—the use of Twitter by local governments during the 2016 Italian earthquake. *Corporate Communications: An International Journal*, 27(3), 509–526. <https://doi.org/10.1108/CCIJ-03-2021-0036>
- Suzuki, T., Watanabe, T., & Okuyama, S. (2019). Facilitating community risk communication for wide-area evacuation during large-scale floods. *International Journal of Environmental Research and Public Health*, 16(14), 2466. <https://doi.org/10.3390/ijerph16142466>
- Tallinna Linnavalitsus (2006). Tallinna linnas ohtlike veostega sõidukite liikluse piiramine. https://oigusaktid.tallinn.ee/?id=3001&aktid=102749&fd=1&leht=1&q_sort=elex_akt.akt_vkp, tallinn City Government Regulation No. 125 of 21 December 2005, entry into force: 1 January 2006
- Tallinna Linnavalitsus (2009). N2 ja n3 kategooria mootorsõidukite liiklusmarsruudid tallinna linnas. https://oigusaktid.tallinn.ee/?id=3001&aktid=113850&fd=1&leht=1&q_sort=elex_akt.akt_vkp, Tallinn City Government Order No. 475 of 25 March 2009
- Tallinna Linnavalitsus (2018). Tallinna kriisikomisjoni moodustamine ja komisjoni põhimäärus. <https://www.riigiteataja.ee/akt/429052019072>, passed 31.01.2018 nr 10, RT IV, 07.02.2018, 20; entry into force 10.02.2018.
- Tallinna Linnavalikogu (2019). Tallinna linna korraldatavate elutähtsa teenuste kirjeldused ja toimepidevuse nõuded. <https://www.riigiteataja.ee/akt/431012019048>, passed 24.01.2019 nr 1; RT IV, 31.01.2019, 48; entry into force 03.02.2019.
- Tsap, V., Lips, S., & Draheim, D. (2020). eID public acceptance in Estonia: Towards understanding the citizen. In *Proceedings of the 21st Annual International Conference on Digital Government Research. Association for Computing Machinery*, New York, NY, USA, dg.o '20, pp. 340–341. <https://doi.org/10.1145/3396956.3397009>
- United Nations DoE, Social Affairs PD (2017). World population prospects: The 2017 revision, volume I: Comprehensive tables. https://population.un.org/wpp/assets/Files/WPP2017_Volume-I_Comprehensive-Tables.pdf. Accessed 06 Dec 2025.
- Vabariigi Valitsus (2011). Päästesündmusel osalevate riigi- ja kohaliku omavalitsuse asutuste ning isikute koostöö kord. <https://www.riigiteataja.ee/akt/114012011005?leiaKehtiv>, passed 06.01.2011 nr 5, RT I, 14.01.2011, 5; entry into force 17.01.2011.
- Vabariigi Valitsus (2015). Kaitseväge ja kaitsejõud politsei ülesannete täitmise, päästesündmuse lahendamise ning eriolukorra tööde tegemise kaasamise kord. <https://www.riigiteataja.ee/akt/128062017050?leiaKehtiv>, passed 18.12.2015 nr 144, RT I, 29.12.2015, 10; entry into force 01.01.2016.
- Vabariigi Valitsus (2017a). Eriolukorra ajal asja sundvõõrandamise ja sundkasutuse eest hüvitise arvutamise ja maksamise kord. <https://www.riigiteataja.ee/akt/128062017036>, passed 22.06.2017 nr 109, RT I, 28.06.2017, 36.
- Vabariigi Valitsus (2017b). Hädaolukorra lahendamise juhtimise, lahendamisel osalevate asutuste ja isikute koostöö, avalikkuse teavitamise ja asutustevahelise teabevahetuse ning ulatuslikuks evakatsiooniks valmistumise ja selle läbiviimise nõuded ja kord. <https://www.riigiteataja.ee/akt/128062017039?leiaKehtiv>, passed 22.06.2017 nr 112, RT I, 28.06.2017, 39; entry into force 01.07.2017.
- Vabariigi Valitsus (2021a). Elutähtsa teenuse toimepidevuse riskianalüüsi ja plaani nõuded, nende koostamise ning plaani kasutuselevõtmise nõuded ja kord. <https://www.riigiteataja.ee/akt/131072021002?leiaKehtiv>, passed 29.07.2021 nr 75, RT I, 31.07.2021, 2; entry into force 03.08.2021.
- Vabariigi Valitsus (2021b). Kriisireguleerimisõppuse läbiviimisele ning õppuse korraldamisele esitatavad nõuded. <https://www.riigiteataja.ee/akt/131072021003>, passed 29.07.2021 nr 76.
- Vabariigi Valitsus (2021c). Loetelu hädaolukorda põhjustada võivatest sündmustest, mille kohta koostatakse nende lahendamise plaan, plaani koostamise nõuded ja kord ning selle koostamist juhtivad asutused, hädaolukorra lahendamist juhtivad täidesaatva riigivõimu asutused, hädaolukordade loetelu, mille puhul korraldatakse riskikommunikatsiooni, ning selle korraldamise eest vastutavad asutused. <https://www.riigiteataja.ee/akt/131072021005?leiaKehtiv>, passed 29.07.2021 nr 78, RT I, 31.07.2021, 5; entry into force 03.08.2021.
- Vongsayan, H., & Nethipo, V. (2021). The roles of Thailand's city municipalities in the COVID-19 crisis. *Contemporary Southeast Asia*, 43(1), 15–23. <https://www.jstor.org/stable/27035519>
- Wu, W. N., Chang, K., & Tso, Y. E. (2016). If only we knew what we know: Factors for mobilizing citizen participation in community-based emergency preparedness. *Chinese Public Administration Review*, 7(1), 77–109. <https://doi.org/10.22140/cpar.v7i1.119>
- Zamora Medina, R., & Losada Díaz, J. C. (2016). Social media use in crisis communication management: an opportunity for local communities? In M. Z. Sobacı (Ed.) *Social Media and Local Governments: Theory and Practice*. Springer, Cham, pp. 321–335. https://doi.org/10.1007/978-3-319-17722-9_17

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