

engage

Engage Society for
Risk Awareness and Resilience



Deliverable 2.2 – Formal solutions to improve societal resilience

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Abstract: ENGAGE aims at linking the resilience capacities naturally inherent in civilians with the work of authorities and emergency organizations to prevent, prepare for, respond to, and recover from disasters. It brings together 14 partners from 8 countries aiming to show how individuals and local practices can interrelate effectively with planned preparedness and response, practitioners, and technology. In this deliverable we identified the already used formal solutions to improve the interaction of emergency organizations and authorities with the civil society. These solutions have been classified based on the solution type, in which phase of the disaster they should be implemented and the interaction purposes they address. In total we identified 168 solutions and 104

of them were targeted at improving information and knowledge sharing purpose; this was the most addressed interaction purpose.

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Executive summary

Background: Civil society plays a crucial role in dealing with disasters and it has to be part of the preparation, response, and recovery processes of the crisis. To fully utilize the potential of the civilians in dealing with crises, it is essential to improve the collaboration and interaction of authorities and emergency organizations with the civil society to efficiently respond and recover from crises. For that to happen, authorities and emergency organizations set and use a group of practices, guidelines, techniques, tools, methods, etc. that help them reach the society and involve it in crisis management. In this project, we use the term “solutions” to refer to this set of means that emergency responders and authorities can use and implement to reach out to the public and improve the interaction with them. These solutions can be either formal or informal based on whether they have been defined and developed beforehand to be used in a given situation or on the contrary, they have been created on the fly because a solution is inexistent or not suitable to handle the given situation (for further details about these concepts look at Table 1 in section 1.5). Furthermore, defining how this interaction with the civilians is carried out and what specific purposes are achieved through this collaboration is needed to move further in this aim.

Goal: This deliverable aims at identifying formal solutions that emergency organizations and authorities already use and implement to improve their interaction with the civil society. These formal solutions are described in detail and classified based on the solution type, on the crisis phase in which they are implemented, and on the interaction purposes they contribute to. In this first step, we collected the different solutions that are already used by the end-users with the aim of afterward (in WP3) make a selection of the most promising solutions based on the effectiveness of the solutions depending on the contextual factors of each region.

Methodology: We applied a variety of methods to identify solutions. These methods are basically classified into two big groups, the ones related to the analysis of scientific and grey literature and the ones based on collecting the information from the end-users. A systematic literature review, a revision of European projects and international reports, and the analysis of case studies were carried out to identify solutions defined in the scientific and grey literature. On the other side, a co-creation process with the end-users was done applying different methodologies to gather information from them. A survey with the partner end-users, an end-user workshop, a KI-CoP workshop, and semi-structured interviews with end-users were performed to identify solutions. As a result of the systematic literature review, 130 papers were analysed. From the revision of the European projects, initially, 66 projects were selected and priority was given to the recent ones (the last 5 years). In the case of international reports, web searches and references were used and priority was given to reports close in time. For the analysis of case studies, as it is explained in D1.1, L'Aquila earthquake in Italy, flash floods in Israel's Negev desert, the Japan Tsunami, the Swedish wildfires, the coronavirus pandemic, the Utoya terrorist attack in Norway, the Thalys train attack in Belgium and Fukushima Daiichi nuclear accident were studied. In order to collect the solutions from the end-users, a survey with partner end-users of the project was carried out in which they were asked to fill a form with each of the solutions they use in their professional tasks. Based on a specific scenario related to COVID-19, in the end-user workshop and the KI-CoP workshop, the end-users were asked to provide solutions they would have used to handle these situations. And finally, in the semi-structured interviews with external end-users, different solutions already used by the participants were collected.

Results: In total, 168 formal solutions were obtained from this variety of sources of information. 42 solutions were identified in the scientific and grey literature and 126 were collected from the end-users. In the case of scientific and grey literature review, 14 formal solutions were identified through the systematic literature review, 17 from the revision of European projects, and international reports, and 11 from the analysis of case studies. In the case of formal solutions collected from the end-users, 35 come from the partner end-user survey, 20 from the end-user workshop, 22 from the KI-CoP workshop, and 49 from the semi-structured interviews. These formal solutions were classified



into different types of solutions: 28 belong to the awareness and training campaigns group, 26 are apps, 20 guidelines are proposed, 16 belong to the collaborative methods and technologies group, 16 are plans to deal with different kind of disasters, 14 solutions represent different traditional media and social media channels, 12 solutions are classified into services to reach society, 11 are web platforms, 7 solutions belong to call centers type, 6 solutions cover the idea of community of practices, 5 solutions were identified within the alert system group and another 5 within the framework type, and finally 2 solutions were oriented towards providing incentives for improving the disaster management.

Regarding the interaction purposes addressed by the solutions, most of the solutions aimed at improving knowledge and information sharing with the civil society (104 out of 168) followed by improving communication with the civilians (92 out of 168). 84 out of 168 solutions cover enhancing the society's risk awareness level; increasing preparedness and empowering the civilians in governance and leadership practices are the next purposes covered by the solutions. Starting from the bottom, only 44 out of 168 aim at facilitating resource allocation, 51 out of 168 target improving health and mental outlook, and 61 out of 168 can be used to capitalize on social networks and relationships.

Conclusions: This deliverable identifies the formal solutions that are used or can be used by authorities and emergency organizations to enhance their interaction with the civil society. We gathered solutions from different sources and they have been classified based on the solution type, the crisis phase in which they could be implemented, and the interaction purposes they address. The distribution of solutions across purposes gives us a good idea of which solutions serve which kind of benefit and which purposes are lacking solutions. This could help policymakers, authorities, and emergency responders to identify the solutions they can apply in each case based on their goals. This study presents the first step in this process and in the future a more detailed analysis about in which cases these solutions are effective and in which cases they are not should be carried out to select the most promising solutions for each situation. This will be done in WP3 and a more detailed analysis about the effectiveness of the solutions will be provided in D2.5.



1 INTRODUCTION

1.1 SCOPE OF THE DELIVERABLE

Civilians plays a crucial role in dealing with disasters and it has to be part of the preparation, response, and recovery processes of the crisis. To fully utilize the potential of the civil society in dealing with crises, it is essential to improve the collaboration and interaction among the authorities and emergency organizations with the society to efficiently respond and recover from crises. For that to happen, authorities and emergency organizations set and use a group of practices, guidelines, techniques, tools, methods, etc. that help them reach the civil society and involve it in crisis management. In this project, we use the term “solutions” to refer to this set of means that emergency responders and authorities can use and implement to reach out to the public and improve the interaction with them. We define solutions as anything such as guidelines, practices, processes, strategies, methods, tools, etc. we can apply to reach a desired outcome. This deliverable aims at identifying and describing the existing solutions to enhance this interaction of the authorities and emergency organizations with the civilians.

These solutions can be either formal or informal based on whether they have been defined and developed beforehand to be used in a given situation or on the contrary, they have been created on the fly because a solution is inexistent or not suitable to handle the given situation (for further details about these concepts look at Table 1 in section 1.5). In this deliverable, we will present the formal solutions identified through two main sources, solutions gathered from academic literature and solutions collected from the end-users.

Furthermore, to define how each solution contributes to this interaction of emergency organizations and authorities with the civil society, we define ten specific interaction purposes that these solutions contribute to when they are implemented in practice. These interaction purposes are closely related to the target aspects that help to improve societal resilience.

1.2 OBJECTIVES

The main objective of this deliverable is to identify and describe the formal solutions that currently are defined, adopted, and used to improve the interaction of emergency organizations and authorities with the civil society. Furthermore, we will present a preliminary analysis about when the solutions should be used and what benefits these solutions serve in enhancing the interaction between emergency organizations and authorities on one hand and civil society on the other hand. This deliverable complements the results obtained in D2.3 and D2.4. D2.3 covers the informal solutions that improve this kind of interaction, and D2.4 addresses how to carry out the communication between authorities and emergency organizations, and civilians.

The specific objectives of this deliverable are:

- Define what formal and informal solutions are.
- Identify and describe formal solutions that already exist to strengthen the interaction of emergency organizations and authorities with the civil society.
- Identify the benefits/purposes we aim at trying to enhance the interaction.
- Classify the formal solutions based on the solution type, on the crisis phase in which the solution is implemented, and on the interaction purpose they serve.
- Analyse for each interaction purpose what kind of solutions are used.



1.3 SIGNIFICANCE

The overall aim of the ENGAGE project is to amplify the inherent capacity of the civil society through better involving them in disaster management. In this vein, it is essential to improve the collaboration and interaction of emergency organizations and authorities with the civil society to foster their involvement and better use the capacities of the civil society in dealing with disasters.

1.3.1 CONTRIBUTION TO THE FIELD OF STUDY

In this deliverable, we studied the already existing solutions such as tools, applications, methods, guidelines, practices, and strategies that are used and implemented to improve the collaboration and interaction of emergency organizations and authorities with the civil society. We identified a set of formal and informal solutions to capitalize on the relationship of emergency organizations and authority with the civilians based on scientific and grey literature and information gathered from the end-users.

Furthermore, this deliverable defines for each solution the specific purposes that are achieved through this interaction between emergency organizations and authorities with the civil society. These purposes are related to the target and contextual aspects that should be improved in order to facilitate the interaction of emergency organizations and authorities with the civilians.

This deliverable lists the formal solutions identified and explains when -disaster phase- each solution should be used, what stakeholders each solution involves, and what specific interaction purpose each solution addresses. These formal solutions will afterward be particularized specifying in which contextual aspects they are more effective (WP3) and will be validated (WP4) in three validation exercises.

1.3.2 SPECIFIC CONTRIBUTION TO THE ENGAGE PROJECT

This deliverable proposes a set of formal solutions gathered from different sources, mainly from end-users and scientific and grey literature, in order to list the already existing formal solutions that emergency organizations and authorities can use or implement to reach the civil society. Whereas WP1 follows a bottom-up approach analysing the inherent societal factors that can foster the society's involvement in managing crises, the WP2 follows a top-down approach identifying what solutions from authorities and emergency organizations can facilitate the interaction with the society to improve societal resilience. This deliverable provides input in this second approach identifying the solutions that are already used and implemented in practice to improve the interaction of emergency organizations and authorities with the civil society.

This deliverable contributes directly to the second objective of the ENGAGE project "Identify existing formal and informal solutions for enhancing societal resilience transferable across contexts". Furthermore, it also serves as an input for the third objective of the project "Produce validated actionable knowledge on societal resilience by demonstrating the benefits and impact of the project solutions in different types of disasters [...] and geographic conditions".

Related to these objectives, the deliverable will contribute to the following results that the ENGAGE project expects to obtain: Catalogue of solutions for societal resilience (R5), Validated ENGAGE solutions and examples of applications (R6), ENGAGE knowledge platform (R1).

1.4 FIT WITHIN ENGAGE

D2.2 identifies the already existing formal solutions to improve the interaction of emergency organizations and authorities with the civil society, defining what stakeholders are involved, in which



phase of the crisis the solution should be implemented, and what interaction purposes each solution covers. It is related to other work packages and deliverables, mainly, WP1, WP2, WP3, and WP4. As input for this deliverable, we use the results obtained in the following deliverables:

D1.1: Preliminary model for assessing and methods for improving societal resilience: the contextual aspects described in D1.1 were used to define the interaction purposes we defined in D2.2 in order to determine the specific aim of each solution in improving the interaction.

D1.2: Local perceptions, risk awareness, needs, and expectations about societal resilience: The constructs and scales defined for the questionnaire were used in order to define the interaction purposes we defined in D2.2.

Furthermore, the results presented in this deliverable (D2.2) will be used in the following near-future tasks:

T3.1: Selection of promising solutions: the list of solutions presented in D2.2 will help for the selection of the most promising solutions that will compose the catalogue of societal resilience solutions that will be presented in D3.1.

T3.2: Exploration of innovative use of communication and social media technologies: the list of solutions presented in D2.2 will help to establish the future directions about how the characteristics and uses of the solutions related to improving communication should be.

T4.2: Initial validation of solutions: the solutions that will be validated in the three validation exercises that will be conducted in WP4 will be taken from the list of solutions provided in D2.2.

Furthermore, in order to collect information for this deliverable, we collaborated with the KI-CoP members (WP5). The first workshop with the KI-CoP conducted in March was used to identify already existing solutions implemented by the end-users in the field. The results obtained from this workshop are explained in section 3.3.2 of this deliverable.

1.5 DEFINITION OF THE MAIN TERMS

Table 1: Definition of the main terms

Term	Definition
Solutions	We define solutions as any kind of mean or instrument that emergency organizations and authorities can apply to reach the public and improve the interaction with them. This set of means or instruments can be guidelines, practices, processes, strategies, methods, technologies, tools, applications etc. that afford the aforementioned aim.
Formal solutions	A solution is formal when it is replicable, defined, and developed beforehand to be used in a given situation, having studied its suitability to be applied in these established situations and with specific goals. Normally, these solutions are part of the recommended policies by authorities and different entities to be used in a situation.
Informal solutions	A solution is informal when it is created on the fly because a formal solution is inexistent, or not suitable to handle the situation, or because it cannot be applied due to some specifics of the context. They can also be formal solutions applied in ways that are different from what was planned, they are used in a new way that was not foreseen. Informal solutions are defined and developed based on the intuition and experience of the end-users and implementers.

Interaction purposes	<p>Interaction purposes are the different aims that the emergency organization and authorities pursue when improving their interaction with the civilians. We define the following 10 interaction purposes when enhancing the interaction:</p> <ul style="list-style-type: none"> • improve the communication with the society, • enhance society' risk awareness, • facilitate the resources allocation from/to society, • improve the information and knowledge sharing with the society, • enhance the preparedness of the society to deal with crises, • capitalize upon social networks and relationships among the society, • improve the society's health and mental outlook, • increase the level of trust of the society towards authorities and emergency organizations, • improve the involvement of the society in dealing with crises, • empower society in governance and leadership activities.
Authorities	Officials at national, regional, or local level governments who are responsible for managing emergencies and disasters.
Emergency organizations	Any entity with the ability and responsibility to be on the front line in the event of an emergency or a disaster. They also provide help for the public maintaining their safety and wellbeing in current situations.
Civilians / civil society	Ordinary people, part of the overall population, without a specific responsibility in case of emergencies or disasters.
End-users	End-users refer the authorities and emergency organizations responsible for designing, developing and implementing the formal solutions presented identified in this deliverable
KI-CoP	Knowledge and Innovation Community of Practice. An open association including practitioners, NGOs, Virtual Operations Support Teams, scientists, researchers and citizens' representatives supporting ENGAGE as users and co-owners of its solutions.

2 SCIENTIFIC BACKGROUND

2.1 CONCEPT OF SOCIETAL RESILIENCE

A huge body of research addressed the concepts of societal resilience and community resilience (in this research we will use both terms societal resilience and community resilience interchangeably); its definition, components, assessment methods, conceptualization, and relationship to other related concepts such as vulnerability (Wilson and Wilson 2019; Jacinto, Reis, and Ferrão 2020; Ran et al. 2020; Cutter, Ash, and Emrich 2016; Cutter, Burton, and Emrich 2010). In this sense, there are many definitions of societal resilience (Patel et al. 2017), the one we adopt in this deliverable is “the capability of a community to face a threat, survive and bounce back or, perhaps more accurately, bounce forward into normality newly defined by the disaster-related losses and changes. Community resilience is, in effect, a reflection of people's shared and unique capacities to manage and adaptively respond to the extraordinary demands on resources and the losses associated with disasters” (Cox and Perry 2011).

One way to view societal resilience is that it is an intrinsic ability of a community that is highly shaped by its pre-existing conditions (Cutter et al. 2008; Burton 2015). A group of these pre-existing conditions is the community stakeholders themselves, their conditions, actions, and interactions. Individuals, authorities, emergency services, and civil society organizations represent the main stakeholders of a society when handling a disaster. The interaction between those different parties influences the resilience level of a society (Kruse et al. 2017; Norris et al. 2008). Not only that but also some researchers argue that these interactions especially on a local level hold as a buffer against disasters (Kruse et al. 2017).

Here, we define the interaction as any interplay within one group of stakeholders, or between two or more community stakeholders, that influences their resilience in a way. This interplay can range from a simple exchange of conversation or knowledge to a more serious action such as sharing and exchanging financial resources or engaging in international agreements.

Given that societal resilience is an inherent feature of a society (D1.1), we pay special attention to the interactions and relationships between different members of a society. In this direction, it is important to investigate two main societal resilience frameworks that capture these kinds of interactions: (Kruse et al. 2017) and (Norris et al. 2008).

2.2 SOCIETAL RESILIENCE FRAMEWORKS

Kruse et al. (2017) proposed a societal resilience framework (Figure 1), in which they consider resilience as a relational evolving property resulting from the interaction between individuals and environmental, and technological systems. It is propagated and built through social interactions. They argue that these interactions especially on a local level hold as a buffer against disasters. Actions, resources and capacities, and learning are the three intersecting domains in the framework. These domains are further rooted in two layers of extra-community processes and structures: first, disaster risk governance, which refers to rules, strategies, and roles of various actors on multiple governance levels. The second layer is affected by wider social, economic, political, and environmental background influences, as well as gradual or incremental socioeconomic changes over time and disturbance. As demonstrated, the interactions and relations between different societal components are at the core of this framework.



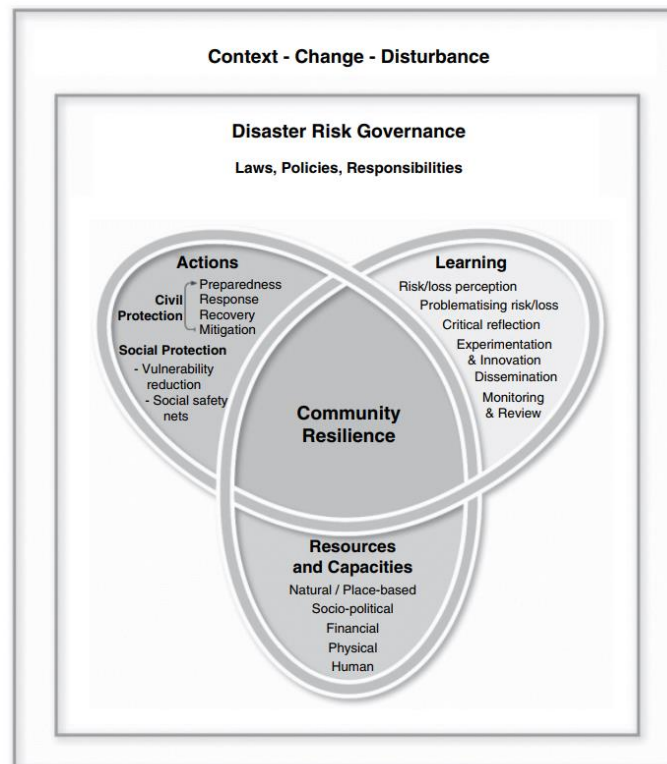


Figure 1 The emBRACE resilience framework for community resilience (Kruse et al. 2017)

The other framework that is worth mentioning is the one developed by Norris et al. (2008). In their research, they define resilience as “a process linking a set of adaptive capacities (resources with dynamic attributes) to a positive trajectory of functioning and adaptation after a disturbance”. While societal resilience is defined as “a process linking **a network** of adaptive capacities to adaptation after a disturbance or adversity.” The only difference between both definitions is the word “network” which emphasizes the idea that interactions and relations are at the heart of societal resilience.

Adaptive capacities could be defined as resources that possess dynamic attributes, namely, robustness, redundancy, and rapidity. Robustness is described as resource strength coupled with a low probability of resource degradation. While redundancy is the availability of substitutes for a resource in case of damage, rapidity presents the speed at which a resource can be accessed and used. The four adaptive capacities that construct the framework are economic development, information and communication, community competence, and social capital (Figure 2). We are not going to cover all the factors related to these adaptive capacities here, we will only highlight the ones that capture the interaction between authorities and emergency services on one hand and individuals on the other (based on our definition of interaction). These aspects are:

- Economic development: equity of resource distribution,
- Social capital: formal ties (citizen participation, leadership, and roles), organizational linkage and cooperation,
- Community competence: political partnerships,
- Information and communication: systems and infrastructure for informing the public, responsible media, and trusted sources of information.

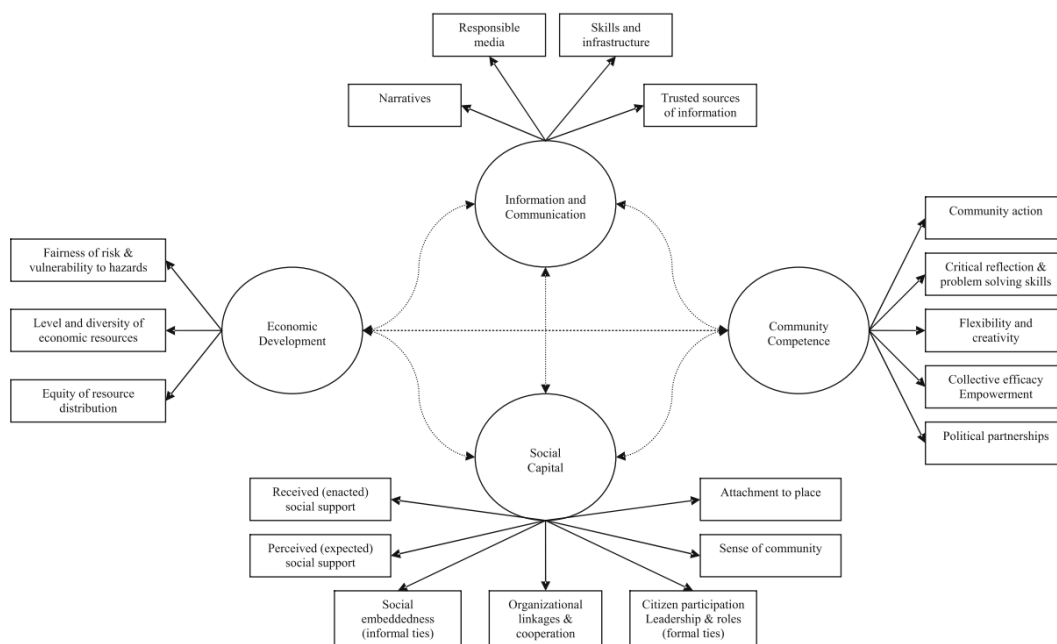


Figure 2 Societal resilience as a set of networked adaptive capacities (Norris et al. 2008)

2.3 COMMUNITY RESILIENCE THEMES

Several publications divide the factors that influence societal resilience into five main themes: social, economic, environmental/natural, physical infrastructure, and institutional (Shaw, Atta-Ur-Rahman, and Shaw 2015; Yoon, Kang, and Brody 2016; Sharifi 2016; Cutter, Ash, and Emrich 2016). Demographic characteristics, community wellness, and community capital, which includes a sense of belonging and social networks are all covered in the social theme. The society's well-being is expressed in the economic theme, which includes metrics such as per capita income, workforce, and income gap. Natural aspects of resilience, such as freshwater, natural disaster susceptibility, and biodiversity, are considered in the environmental domain. The built infrastructure of the system, such as housing and transportation, is referred to as the physical domain. Finally, the institutional theme discusses the government's and authorities' roles in disaster response, including disaster plans, legislation, and training programs.

Patel et al. (2017) conducted a literature review to identify the main elements of societal resilience. They found nine main elements: local knowledge, community networks and relationships, communication, health, governance, resources, economic investment, preparedness, and mental outlook. All the elements and their sub-elements could be found in Table 2. We can claim that these elements are different from the societal resilience themes identified earlier. But these elements represent a different point of view for the categorization of societal resilience factors.

Table 2: The elements of societal resilience (adapted from (Patel et al. 2017))

Community resilience element	Sub-elements		
Local knowledge (Understanding existing vulnerabilities)	<i>Factual knowledge</i> (disaster education, ex. first aid knowledge)	<i>Training and education</i> (local knowledge capacity)	<i>Collective efficacy and empowerment</i> (community's belief about overcoming hardships)
Community networks and relationships	<i>Connectedness</i> (social networks)	<i>Cohesion</i> (the type of social ties)	
Communication	<i>Effective communication</i> "the creation of common meanings and	<i>Risk communication</i> (providing accurate information about threats)	<i>Crisis communication</i> (up-to-date information to community members about

	understandings and the provision of opportunities for members to articulate needs, views, and attitudes”		the ongoing disaster impact and relief efforts)
Health (Tackling health systems liabilities helps in developing resilience before a catastrophe and reduce long-term problems after one)	<i>Health services</i> (facilities and capacity building to handle mass casualties)	<i>Physical and mental health</i> (post-traumatic stresses and depression)	
Governance and leadership	<i>Infrastructure and services</i>	<i>Public involvement</i>	<i>Support</i>
Resources (not only having the resources is important but also their utilization and allocation)			
Economic investment	<i>Post-disaster distribution of financial resources</i>	<i>Post-disaster economic programming and ensuring cost-effectiveness of interventions</i>	<i>Post-disaster economic development of infrastructure</i>
Preparedness			
Mental outlook (Attitudes and feelings toward uncertainty and the search for meaning)	<i>Hope</i>	<i>Adaptability</i> (capacity and willingness to adjust while knowing that things will be different)	

2.4 INTERACTIONS PURPOSES

Building on our previous discussion and the idea that communities can be viewed as a cyclic system with a feedback loop between its inputs (resources) and outputs (disaster mitigation phases; preparedness, response, and recovery) (Dhakai 2018), we believe that societal resilience can be represented as shown in Figure 3. Where the inputs of the system are the main themes of factors affecting societal resilience (Sharifi 2016); natural/environmental, social, economic, institutional, and physical/infrastructure and the outputs are disaster preparedness, response, and recovery. To get from the inputs to the outputs, there are some processing and interaction between several adaptive capacities, these capacities and the processing part in the figure are adapted from (Norris et al. 2008). Moreover, there is a feedback cycle between outputs and inputs so we can capture the interaction that happens between both the outputs and inputs of the system.

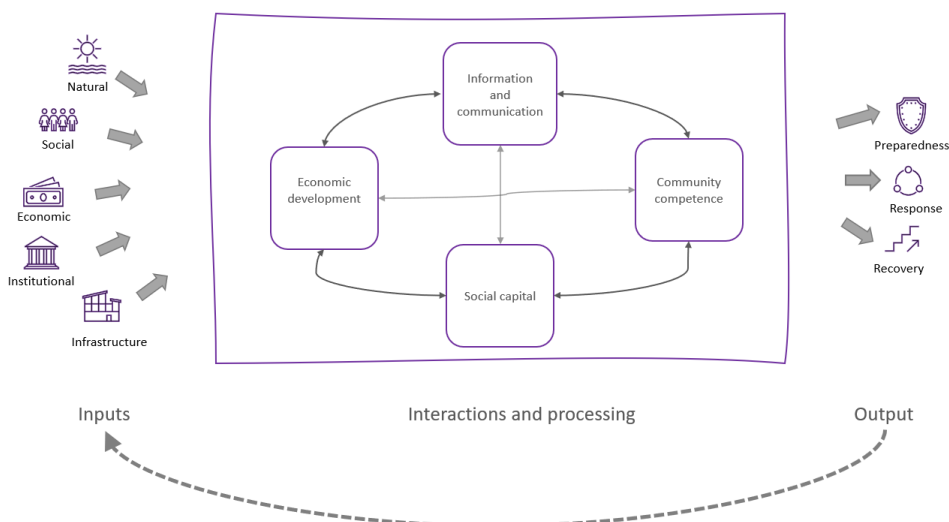


Figure 3 Societal resilience system



Two main parties of a community's stakeholders are individuals on one hand, and authorities and emergency responders on the other hand. The collaboration between these two parties does exist in normal situations -where there is no disruption- but it is magnified in case of a disaster. Citizens play a role in helping authorities and first responders facing a crisis; during a crisis, by cooperating with them in evacuation and relief work, sharing information about damage places. Before a crisis, by attending training sessions, acquiring first aid knowledge. And after a crisis, by adapting to the new situation and changing their attitudes. In the same manner, authorities provide individuals with shelters, share facts about the occurring crisis, give them the needed resources to overcome a temporary disturbance, etc.

Considering the elements of societal resilience listed in Table 2 and the community resilience system shown in Figure 3. The interactions among first responders and authorities with the population could serve the following purposes:

- improve the communication with the society,
- enhance society' risk awareness,
- facilitate the resources allocation from/to society,
- improve the information and knowledge sharing with the society,
- enhance the preparedness of the society to deal with crises,
- capitalize upon social networks and relationships among the society,
- improve the society's health and mental outlook,
- increase the level of trust of the society towards authorities and emergency organizations,
- improve the involvement of the society in dealing with crises,
- empower society in governance and leadership activities.

3 METHODOLOGY

3.1 OVERALL METHODOLOGY

This research collects the already existing formal solutions that allow improving the interaction of emergency organizations and authorities with the civil society. The methodology used to collect the formal solutions followed a triangulation approach that combines several methodologies: first, the review of scientific and grey literature, and second, solutions gathered from partner end-users and external end-users. The effectiveness of the triangulation process rests on the assumptions that the strengths of one specific method will counterbalance the weaknesses of another (Jick 1979). This way not only were we able to identify theoretical solutions defined and developed by the scientific field, but also we determined formal solutions applied in practice that have demonstrated their usefulness for improving the interaction of emergency organizations and authorities with the civil society. Figure 4 summarizes the research methodology.

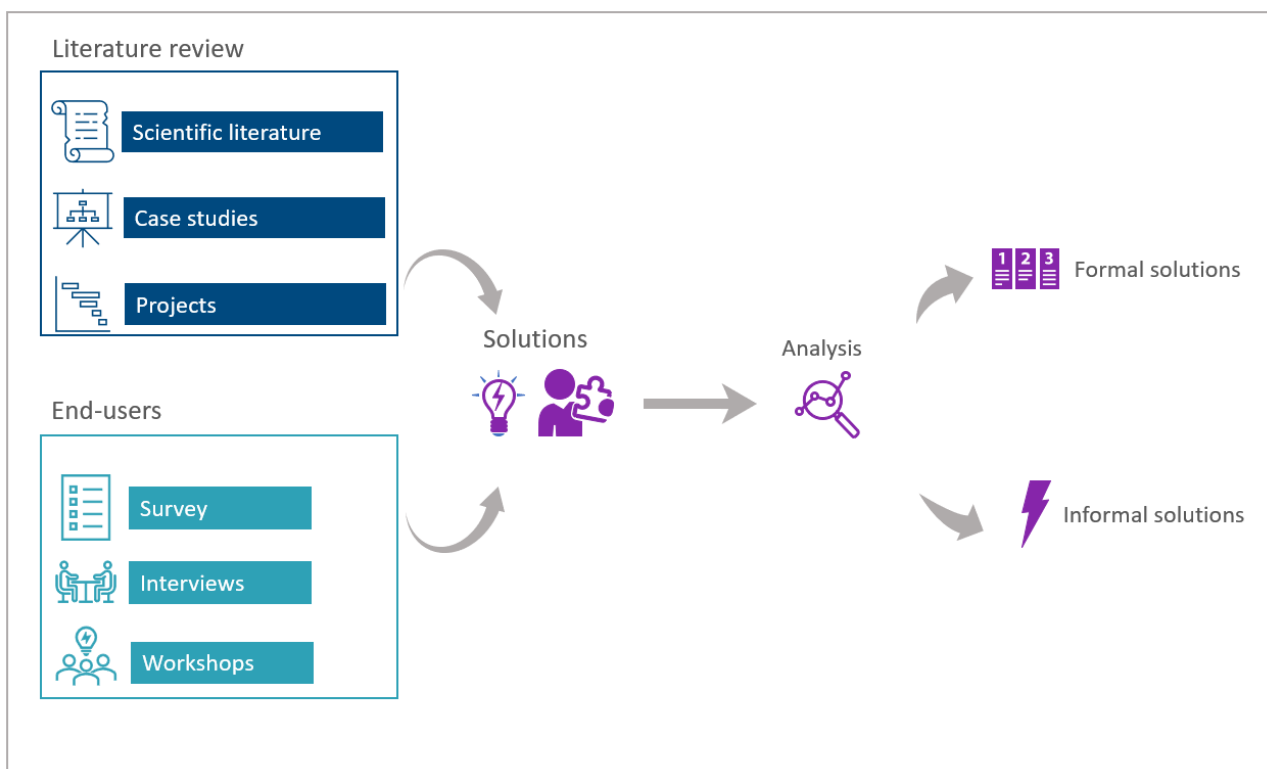


Figure 4: The research methodology of this study

3.2 SCIENTIFIC AND GREY LITERATURE REVIEW

In order to identify formal solutions, we first performed a systematic literature review in scientific journals. Second, we analysed deliverables and reports developed by European research projects and international institutions and collected the solutions adopted there. Finally, we gathered solutions from case studies. Following, we explain in detail the specific processes carried out to identify solutions from these sources.

3.2.1 SYSTEMATIC LITERATURE REVIEW

We selected the Scopus database (Guz and Rushchitsky 2009) to perform the systematic literature review since it indexes a larger number of journals than other databases and it is also the largest searchable citation and abstract source for different scientific fields. The systematic literature review was oriented towards identifying formal solutions to improve the interaction of emergency organizations and authorities with the civil society with the final target of improving societal resilience. Therefore, the following keywords combined in different ways were used in order to make the searchers: "Societal Resilience", "community resilience", "risk awareness", "tool*", "method*", "first responder*", and "authorit*". Furthermore, new references were added by the use of the snowball technique.

From all the references obtained, only scientific articles and conference proceedings published after 2000 were selected. Furthermore, to ensure the quality of the paper, articles with more than 5 cites were selected. After implementing these filters, 414 references were obtained. Then, the abstracts of the papers were read in order to see if the paper was providing any solution for improving the interaction of emergency organizations and authorities with the citizens (this was done by one member of TECNUN team). After reading the abstracts, the number of references was reduced to 130. Finally, a detailed reading of these 130 references was carried out -by all members of TECNUN team- to identify solutions suitable for the target of the ENGAGE project.

Furthermore, in order to collect the needed information in a structured way, we defined a form that we needed to fill for each solution to gather the information in a structured way (see in Appendices section 9.1). In this form, the researcher had to introduce the following information about the solution: the name of the solution, the aim/description of the solution, the users of the solutions, in which phase of the crisis the solution was implemented, and which of the interaction purposes the solution contributed to. It is important to note that although we reviewed 130 papers, only 14 formal solutions that allow improving the interaction of emergency organizations and authorities with the civilians were identified.

3.2.2 EUROPEAN PROJECTS AND INTERNATIONAL REPORTS

An analysis of European research projects and international reports was conducted to find previous relevant productions on the topic of societal resilience. The research was conducted through different sources and tools.

The main source used for researching European research projects was the Community Research and Development Information Service (CORDIS) website.¹ CORDIS is considered to be the main source of results from the projects funded by the EU's framework for research and innovation (FP1 and Horizon 2020). The platform collects and classifies all the EU research results from 1990 on a structured public repository.

Our research focused on the Project and Result section of the website. To obtain outcomes of our interest a first search was filtered on "Collection: Projects", "Domain of Application: Society, Security, Climate Change and Environment", "Programme: H2020". All the items obtained were rapidly overviewed to select the most suitable ones.

Projects on marginal topics were discarded. The outcome of the first skimming led to 66 items that were then classified in an excel file considering: name of the project, area, topic, year, link to CORDIS page, link to website, status (active or closed), main outcomes.

¹ www.cordis.europa.eu



The projects were then prioritized according to the year of conduction. Priority was given to projects from recent years (frame 2018-2021). This procedure allowed us to focus on more technologically advanced and closer to the state-of-the-art projects.

Then, the website - if still available - or the CORDIS report of each project were analysed in detail. Particular attention was given to the outcomes page to spot any solution suitable for the ENGAGE project. Relevant ones were then further investigated.

Regarding the international reports, they were mainly searched through web search and references. For the web search the following keywords: "international report" "disaster risk reduction report" "risk awareness report" "societal resilience report" "disaster management report" were cross used to look for relevant documents.

The outcomes were then classified by chronological and thematic order. Priority was given to reports closer in time. Then, each report was read to ensure the quality of the document and confirm the relevance for the project. A second way of searching for reports was to look for previous or later versions of those that were already available to us. Again, the same process of selection and reading was applied. In total, 6 European projects and 6 international reports provided formal solutions that were useful for the ENGAGE project.

3.2.3 CASE STUDIES

We included eight case studies in this deliverable which were identified in (D1.1). The case studies differ in terms of the nature of the crisis, the magnitude of the crisis, and the type of crisis management. They include:

- Nature-related disasters such as the L'Aquila earthquake in central Italy in 2009, flash floods in Israel's Negev desert in 2018, the Japan tsunami of 2011, and, the Swedish wildfires of 2018.
- Disasters related to pandemics such as the coronavirus pandemic of 2020 and 2021.
- Social disturbance and terrorist attacks such as the Utoya attack in Norway in 2011 and the Thalys train attack in Belgium and France in 2015,
- And industrial accidents such as the Fukushima Daiichi nuclear accident of 2011.

Some of the cases indicate a successful implementation of structured disaster management, while others do not, which allowed for the engagement of people and civil organizations in the crisis response.

To search for and identify information related to these case studies, Scopus, Web of Science, and Google Scholar were used. Keywords covered words related to the main disaster we were looking for (e.g. "L'Aquila", "earthquake"), and other keywords related to disaster management and coping actions ("resilience", "emerging groups", "solidarity", "grassroots", "social movement", "protest", "rescue", "recovery", "disaster management", "assistance"). Besides including publications written in English, we also included publications in the native language of the countries where the case studies took place (if possible).

However, these solutions identified in the scientific and grey literature were very theoretical and lacked the solutions that are already in place and used by emergency organizations and authorities to reach the civil society and improve their interaction. Therefore, we applied several methods to gather information from the end-users and complete these theoretical solutions with more practical solutions.



3.3 COLLECTING INFORMATION FROM THE END-USERS

This second phase of the methodology aimed to identify the solutions that the emergency organizations and authorities already used to improve their interaction with the civilians. Identifying tools, practices, methods, strategies, applications, and guidelines already applied in practice and that their usefulness is evaluated is the aim of this second phase. Furthermore, these solutions are defined at a very operational level and provide more information about in which context and for which specific benefit when improving interaction is used. First, a survey was carried out with the partner end-users to collect information about the solutions they are already using for this specific aim. Second, two workshops were carried out the first one with partner end-users and the second one with the KI-CoP members to identify solutions that could be used in a given specific scenario. Finally, semi-structured interviews with external end-users were carried out in 7 countries (France, Norway, Israel, Sweden, Romania, Italy, and Spain) to identify more solutions suitable for enhancing the interaction of emergency organizations and authorities with the society.

3.3.1 PARTNER END-USERS SURVEY

As a first step, a web-based form was created and distributed among the partner end-users of the ENGAGE project (see in the Appendices section 9.2). The aim of this form was to collect the already used solutions to improve the interaction of emergency organizations and authorities with the civil society. We asked the partner end-users to fill the form with the solutions they already used, describing the solution, who the users of the solutions were, in which phase of the crisis the solution was implemented, and which of the interaction purposes the solution contributed to. In total, 35 solutions were obtained through this web-based form.

3.3.2 WORKSHOPS

We organized two workshops – the first one with the partner end-users of the project and the second one with the KI CoP - aimed at identifying solutions the emergency organizations and authorities adopt when interacting with the civil society to solve the problems posed by the situation. In both workshops, we used scenarios to describe the situations in a less hypothetical way. On one hand, this approach helped to get more tangible and concrete solutions; but on the other, it restricted the solutions to the situation at hand. The first workshop served as a preparation for the second, thus, we introduced some changes in the second workshop to resolve the problems we encountered in the first exercise. In both workshops, we used the MIRO tool to register the contributions and ZOOM to support voice interaction. The complete report of each workshop is presented in a D2.3.

The end-user workshop took place on February 17th, 2021 with remote participation of 12 end-user members plus 5 observers of the Engage Project Team, besides the 4 facilitators from TECNUN, all part of a single group. The first workshop was meant to get feedback from the remote interaction in order to evaluate the dynamics and correct eventual problems for the next workshop. The interaction itself was organized around two scenarios, which were distributed previously to participants.

The KI-CoP Workshop took place on March 9th, 2021 with remote participation of 11 external end-users plus 5 team members of the Engage Project Team, besides the 4 facilitators from TECNUN. We divided the participants into three subgroups, according to their profiles. The exercise consisted of a general session for the initial and final presentations by the Project Coordinator and Facilitators, and three sub-sessions (rooms) to support the sub-groups' interaction, all using ZOOM.

3.3.2.1 End-user Workshop

We designed three scenarios from which we chose two of them. For each of the scenarios, we described the background, the situation at hand, the purpose of the exercise and the questions the



participants were expected to answer. We also provided a list of issues to take into consideration for the proposed solutions, including the description of barriers to the solutions. We also defined an event that was planned to release during the exercise, but we only used it in the second scenario. The scenarios used were:

» Scenario 1: Overwhelmed hospital occupation, reached the limit.

In the first scenario, there were four questions. The participants described 24 solutions in this scenario, an average of six solutions per question. They also described 13 barriers associated with these 24 solutions.

» Scenario 2: Infrastructure for food production/distribution

In the second scenario, there were three questions. The participants described 25 solutions in this scenario, an average of eight solutions per question. They also described 12 barriers associated with these 25 solutions.

After the solutions and barriers were completed for both scenarios, we asked participants to vote on the solutions proposed for each problem. The aim of the voting was not to elect the best solution but to induce participants to read all the contributions.

3.3.2.2 KI-CoP Workshop

We defined a single scenario - Adapting to the "new" normal situation- and three different situations/questions to address this scenario. During the first part of the exercise, each group worked on the solutions for two of the problems. In the second part, each subgroup received the solutions presented by the other two subgroups to the problem that subgroup did not work on. The members of the subgroup added the implementation challenges they believe exists for these solutions. The summary of the exercise is described in Table 3.

Table 3: Division of Tasks among the sub-groups

	Sub-group 1	Sub-group 2	Sub-group 3
First-Round	Solutions to Problem 1 & 2	Solutions to Problem 2 & 3	Solutions to Problem 1 & 3
Second-Round	Implementation Challenges to Problem 3	Implementation Challenges to Problem 1	Implementation Challenges to Problem 2

A total of 70 solutions were generated during the first round of the interaction, although we cannot consider all of them as solutions. The second round generated 34 implementation challenges; one challenge for every two solutions. However, the challenges were not uniformly distributed. The majority of solutions had no challenge associated with, but several solutions shared the same challenge.

3.3.3 SEMI-STRUCTURED INTERVIEWS WITH EXTERNAL END-USERS

Finally, as the last step, we performed semi-structured interviews with external end-users with the following aims: to identify solutions to improve the interaction of emergency organizations and authorities with the civil society (the results from this part are included in Deliverables D2.2 and D2.3), to identify communication channels and guidelines to reach the civilians (the results from this part are included in Deliverable D2.4), and finally, to identify needs and expectations from the civil society for emergency organizations and authorities to deal better with crises (the results from this part are included in Deliverable D2.1). In the appendix A of Deliverable 2.4 the interview guide used for conducting the interviews and in the appendix B the template to collect the information are included.



The participants were selected from different nationalities and profiles to ensure the heterogeneity of the results. The seven countries selected to carry out the surveys conducted in WP1 in Task 1.2 and in WP2 in Task 2.1 were also selected to conduct the interviews. In each country, between 4-5 interviews were carried out and the selected profiles were national or regional authority, local authority, end-user from the law enforcement field, end-user from the health sector, and end-user from the emergency response field. In total 30 interviews were carried out: 4 in Spain, 5 in Romania, 5 in Norway, 4 in Sweden, 4 in Italy, 3 in France, and 5 in Israel. The distribution of the interviewees based on the profile is the following: 20% of the participants work as a member of either national, regional, or local level authorities, 30% from the health services, 37% were emergency responders, and 13% from the law enforcement group (Figure 5).



Figure 5: Distribution of the participants based on the country and job profile

Before the interview, the participants received the script of the interview with the questions that would be addressed and discussed. The interviews were conducted online and they were recorded to be used afterward to gather the information to be extracted from the interviews. A template was developed for the researchers to compile the information obtained from the interviews in a structured way. These templates were afterward analysed by researchers in TECNUN to gather interesting solutions for the ENGAGE project. In total 70 solutions were obtained.

3.4 ANALYSIS OF THE COLLECTED INFORMATION

After conducting all these processes to gather information about the already existing solutions to improve the interaction of emergency organizations and authorities with the society, we analyzed all these solutions and classify them according to the nature of the solution. Based on the source of information, different levels of details about the solutions were covered. For example, in the case of solutions gathered from the systematic literature review process, we were able to extract the following specific information for the analysis and description of the solutions:

- » the name of the solution
- » the description and aim of the solution
- » the entities/stakeholders that interact through this solution
- » the phase of the crisis in which this solution is used and,
- » the specific interaction purposes the solution achieves when improving the interaction of emergency organizations and authorities with the civil society.

However, for the case of solutions gathered through Workshops and semi-structured interviews, we obtained fewer details about the solutions. In many cases, just the name and the aim/description of the solution were obtained. In these cases, based on the description, we inferred the rest of the

needed information: the entities that interact through this solution, the phase of the crisis in which the solution is used, and the specific interaction purposes the solution contributes to.

3.4.1 FORMAL AND INFORMAL SOLUTIONS

After collecting all the information for each solution, we classified the solutions based on formal and informal solutions. We defined formal and informal solutions as follows.

We say that **a solution is formal** when it is replicable, defined, and developed beforehand to be used in a given situation, having studied its suitability to be applied in these established situations and with specific goals. Formal solutions are used in a way that based on the situation the end-users have to handle, they choose the solution that best fits to achieve the desired outcome. Normally, these solutions are part of the recommended policies by authorities and different entities to be used in a situation.

Conversely, we say that **a solution is informal** when it is created on the fly because a formal solution is inexistent, or not suitable to handle the situation, or because it cannot be applied due to some specifics of the context. They can also be formal solutions applied in ways that are different from what was planned, they are used in a new way that was not foreseen. Informal solutions are defined and developed based on the intuition and experience of the end-users and implementers.

This deliverable (D2.2) describes the formal solutions gathered and D2.3 describes the informal solutions collected from the research.

3.4.2 GROUPING OF THE SOLUTIONS BASED ON THE SOLUTION TYPE

Once this information was obtained, the solutions were grouped based on their nature. The definition of these groups was carried out while analysing the solutions collected. Very different types of solutions were obtained based on the source. On the one hand, the solutions gathered from the scientific field were more theoretical providing solutions that are oriented towards guidelines, collaborative methods, framework, governmental programs, and communities of practice, aiming to improve the interaction with the civil society.

On the other hand, the solutions collected from the end-users were more practical and more specific to the characteristics of each region. We clustered the solutions obtained into the following types: mobile apps, web platforms, training campaigns, alert systems, specific services to reach civilians, social media accounts, and disaster management plans.

3.5 ETHICAL CONSIDERATIONS

Semi-structured interviews entail several ethical risks, especially when coping with emergencies and disasters. First, the interviewees are not always aware of the data they share with the interviewer due to the nature of a friendly conversation. Furthermore, sensitive issues can cause inconvenience to the interviewee, making the interviewer responsible for these inconveniences that can alter their health and well-being.

Following the protection measures of ENGAGE, which were set in deliverable 6.1, in the analysis of the interviews, we excluded all types of information that could identify the interviewee. All interviewees signed an informed consent form and a data privacy document.



4 RESULTS

In this section, we are going to present the solutions we obtained from different sources, namely, academic literature, European projects, case studies, end-users survey, end-user, and KI-CoP workshops and interviews. In total, we were able to identify 243 solutions, divided into 168 formal solutions and 75 informal solutions (see Table 4).

Table 4: Number of formal and informal solutions obtained from each source.

	Number of Formal solutions	Number of Informal solutions
Systematic literature review	14	0
European projects and international reports	17	0
Case Studies	11	0
Partner end-user survey	35	0
End-user workshop	20	22
KI-CoP workshop	22	32
Semi-structure interviews	49	21
TOTAL	168	75

4.1 SOLUTIONS IDENTIFIED IN THE SCIENTIFIC AND GREY LITERATURE

This sub-section describes the solutions identified in the scientific and grey literature. As it was previously explained, three main sources were used to collect the solutions: systematic literature review, revision of the European research projects and international reports, and analysis of case studies.

4.1.1 SOLUTIONS IDENTIFIED IN THE SYSTEMATIC LITERATURE REVIEW

The solutions identified in the systematic literature review are summarized in Table 5. In total, 14 solutions were identified divided into the following solution types: collaborative methods to work with stakeholders, community of practice, crowdsourcing, frameworks, governmental program, and web apps.

Most of the solutions are oriented towards engaging stakeholders in the crisis management process and improving the collaboration and cooperation among them. Different modelling techniques such as participatory modelling (Henly-Shepard, Gray, and Cox 2015; Smith et al. 2011), structured interview matrix (O'Sullivan et al. 2015), and stakeholder-driven approach (Fox-Lent, Bates, and Linkov 2015; Cox and Hamlen 2015) are identified as solutions to foster the involvement of the civil society in crisis management. Furthermore, different types of communities of practices are defined to facilitate creating social networks and relationships among all the stakeholders and also improve knowledge and information sharing:

- » a community to design and plan the community resilience actions (Wells et al. 2013), a community to share the available time of each participant to help in the response and recovery activities (Cretney 2016),
- » a community to create, assemble and disseminate geographic data among the members (Haworth et al. 2018; dos Santos Rocha et al. 2017),
- » and a community for participants and volunteers to share lessons learned (Amaratunga 2014) are the solutions gathered for this type.

Apart from this, we identified two solutions more related to technological tools, the first one related to crowdsourcing methodology to gather information from the society through social media channels (Whelchel and Beck 2016), and the other one was an application to share information about past



and current disaster events (Li et al. 2015). The primary objectives of these two solutions are improving both communication and information and knowledge sharing.

The last three solutions are divided into two frameworks and governmental programs. The first two are: a toolkit that allows engaging community representatives to measure their community's resilience and to explore and promote actions to enhance it (Pfefferbaum et al. 2013), a virtual space where users can access a range of tools for preparing to emergencies through simulation (Dethridge and Quinn 2016). These solutions enhance risk awareness and improve knowledge and information sharing. The final solution is a Community Rating System, in which the government encourages citizens to implement flood preparedness initiatives by providing economic incentives (Atreya and Kunreuther 2020b); this solution improves the community's preparedness level against floods while also improving the resource distribution process from the government to the members of the civil society.

More details about the solutions can be found in Appendices (section 9.3).



Table 5: Solutions identified in the systematic literature review.

Solutions from the systematic literature review	Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Number of Solutions
Collaborative methods to work with stakeholders	1	1		4	5	3	1	1	5
A participatory and transformative method for building community resilience to climate change				1	1	1			
Involving local actors to take part in the disaster resilience planning				1	1				
Participatory modeling for improving risk awareness				1	1				
Structured interview Matrix (SIM) technique to improve risk awareness and preparedness		1			1	1			
Utilizing stakeholder-driven approach to define the indicators to assess the community resilience	1			1	1	1	1	1	
Community of Practice	3	1	2	3	2	4		1	4
A VCoP for practitioners and volunteers	1	1	1	1	1	1			
Community based groups to design and plan the community resilience actions	1		1	1		1		1	
Timebank: each person provide its time for response and recovery activities					1	1			
Volunteered geographic information (VGI)	1			1		1			
Crowdsourcing	1			1		1			1
A crowdsourcing methodology with the help of social media to gather information	1			1		1			
Framework	2	2	1	2	1	1			2
The Communities Advancing Resilience Toolkit (CART)	1	1	1	1	1	1			
Virtual modeling for preparing to emergencies	1	1		1					
Governmental program			1		1			1	1
The NFIP's community rating system (CRS) program			1		1			1	
Web app	1	1		1	1				1
Web app to access to get information about past events and current resilience level	1	1		1	1				
TOTAL	8	5	4	11	10	9	1	3	14



4.1.2 SOLUTIONS IDENTIFIED IN THE ANALYSIS OF EUROPEAN RESEARCH PROJECTS AND INTERNATIONAL REPORTS

After analysing several European project results and solutions provided by international entities, we came up with 17 solutions that help improve the interaction of emergency organizations and authorities with the civil society (see Table 6). The solutions could be categorized into seven types: book, a community of practice, funding programs, guidelines, portfolio of solutions, and tools.

Most of the collected solutions are guidelines for different purposes such as ensure mental health and psychological support (Juen et al. 2015), organize volunteers (Juen et al. 2015), plan the use of social media in disasters (Juen et al. 2015), raise awareness to climate change ("Stories for Action – PLACARD Interchange" n.d.), develop the city resilience level (SMR 2018), develop standards (NIST n.d.), and know-how to deal with flooding and extreme weather-related events (UK n.d.). All of these aim mostly for improving communication and risk awareness, enhancing preparedness, capitalizing on social networks and relationships, improving health and mental outlook, and empowering civilians in governance and leadership activities. Very related to this type of solution, there are three solutions representing frameworks to build resilience involving different stakeholders (Basabe 2013; UNDRR 2020b; 2020a; "CARISMAND Toolkit" 2018). The primary aim of these solutions is to enhance preparedness. Two solutions fall into the community of practice category, these solutions build upon the social ties between community members to enhance their preparedness and risk awareness level. The first one is a Center of Expertise which involves experts to support practitioners in adopting new solutions to improve resilience (Berlo and Nalecz-Kobierzyck 2020; "The DRIVER+ Project for Crisis Management" n.d.) and the second one is the CMINE network, which was created by practitioners to promote innovation in crisis management within Europe (Berlo and Nalecz-Kobierzyck 2020; "The DRIVER+ Project for Crisis Management" n.d.).

Finally, four solutions are very specific. The first one is a book that explains how to manage psychological problems and mental trauma that can be originated from disasters (Eyre and Dix 2015). The second one is a tool that provides self-preparedness and self-protection tools to help people protect themselves in case of weather emergencies ("Enhancing Emergency Management and Response to Extreme Weather and Climate Events» ANYWHERE" 2019). The third one comes from the DRIVER+ project which provides a portfolio of tools to better manage crisis (DRIVER+ n.d.) and the last one is the funding program from the European project that aims to fund pilot activities on simple preparatory measures that can enhance resilience, including early warning systems, local capacity building, education, the linkage between public organization (Cristóbal, Juan, and Beltrán 2014).

In general, most of the solutions identified from this source are oriented towards enhancing preparedness (12 out of 17) and capitalizing on social networks and relationships (9 out of 12).

More details about the solutions can be found in Appendices (section 9.4).



Table 6: Solutions gathered from the European research projects and international reports

Solutions gathered from european research projects and international reports	Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Number of solutions
Book							1		1
Collective Conviction: the story of Disaster Action							1		1
Community of Practice		2			2	2			2
DRIVER+ (Driving Innovation in Crisis Management for European Resilience) (Center of expertise)		1			1	1			
DRIVER+ (Driving Innovation in Crisis Management for European Resilience) (CMINE)		1			1	1			
Frameworks	1			3	3	1	1	1	3
CARISMAND project - Culture and Risk Management in Man-made and natural disasters				1	1				1
UNDRR (United Nations Office for Disaster Risk Reduction) (The Hyogo framework)	1			1	1	1	1	1	2
UNDRR (United Nations Office for Disaster Risk Reduction) (Making Cities Resilient 2030)				1	1				
Funding programs				1	1	1			1
European commission				1	1	1			1
Guidelines	3	3	1	1	4	3	3	3	8
National Institute of Standards and Technology		1			1	1			1
Placard Interchange					1				1
Smart Mature Resilience (SMR project)		1	1	1	1	1		1	1
UK government	1	1			1				1
Operationalising Psychosocial Support in Crisis (OPSIC project) (actions for mental health)	1						1		1
Operationalising Psychosocial Support in Crisis (OPSIC project) (volunteers participation)						1		1	1
Operationalising Psychosocial Support in Crisis (OPSIC project) (social media usage)	1						1	1	1
Operationalising Psychosocial Support in Crisis (OPSIC project) (emergency mental health)							1		1
Portfolio of solutions	1	1		1	1	1		1	1
DRIVER+ (Driving Innovation in Crisis Management for European Resilience)	1	1		1	1	1		1	1
Tools					1	1	1		1
ANYWHERE project: innovating the management of weather emergencies					1	1	1		1
Total	5	6	1	6	12	9	6	5	17



4.1.3 SOLUTIONS EXTRACTED FROM THE REVIEW OF CASE STUDIES

11 solutions were extracted from the analysis of the case studies that was carried out in WP1 (see Table 7). Most of these solutions are specifically addressing disaster cases however, some can be implemented in normal situations.

Two solutions were identified related to collaborative technologies. The first one is a tool oriented to organize volunteers and brainstorm the strategies that will be implemented when a crisis occurs (Luis Felipe R. Murillo 2016). The second one is a geographical information system that helps authorities to collect, compile and visualize geographical information to better communicate with the society (Bergam and Östblom 2019). Related to this type, there are some solutions categorized as platforms: the first one helps volunteers and crisis managers sharing information and identifying suitable volunteers (Patrikakis et al. 2011) and the second one provides a database for the citizens to measure the radiation after a nuclear accident and make their own decisions (Brown et al. 2016). These two solutions are mostly oriented towards capitalizing on social networks and relationships as well as improving information sharing and communication. Together with these platforms, a mobile app is considered as a solution to show the citizens in Japan the inundation depth of the 2011 tsunami according to their current location as a tool to improve risk awareness and communication as well as prepare for future disasters (Leelawat et al. 2018).

Furthermore, very diverse solutions to reach the civil society are extracted from the case studies such as a program to help bereaved families after a disaster (Dyregrov et al. 2014), an increase of police workforce (Nilsen, Albrechtsen, and Nyheim 2018), organizing a memorial ceremony in honor of the victims of the disaster, and provide narratives of a disaster event to help in coping with the disaster (Farinosi and Micalizzi 2016; Nilsen, Albrechtsen, and Nyheim 2018). In this group, most of the solutions are oriented to improve health and mental outlook after the crisis and they are implemented in the recovery phase. Finally, one solution that represents the governmental plan to prevent radicalization and violent extremism is identified to enhance preparedness, improve health and mental outlook, and empowering civilians in governance and leadership activities (Nilsen, Albrechtsen, and Nyheim 2018).

Further details about the solutions are included in Appendices (section 9.5).



Table 7: Solutions extracted from the case studies

Solutions gathered from the case studies	Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Number of solution
Collaborative technologies	2			2	1	1	2	1	2
Different open source tools for organizing volunteers and expertise	1			1	1	1	1		
Geographical Information Systems (GIS) to communicate with the population.	1			1			1	1	
Disaster management plan					1		1	1	1
The government's action plan against radicalization and violent extremism					1		1	1	
Mobile app	1	1		1	1				1
An app for flood management	1	1		1	1				1
Service to reach society	2		2	3	1	2	4	2	5
A program to help bereaved families after crises to emergencies			1				1		
Increased manning for operation centers of the Police	1		1	1	1		1	1	
Memorial ceremony after terror events						1	1		
Public access to audit reports on ministries' societal safety work	1			1				1	
The use of localized online memories to cope with the effect of a disaster.				1		1	1		
Web platform	1		1	1	1	2	1	1	2
A collaborative citizen science platform for radiation measuring				1	1	1	1		
A platform for crisis management based on social networks and person to person multimedia streaming	1		1			1		1	
TOTAL	6	1	3	7	5	5	8	5	11



4.2 SOLUTIONS IDENTIFIED FROM THE END-USERS

This sub-section describes the solutions identified by the end-users. These solutions were collected from the following sources: a survey to the partner end-users, end-users' workshop organized with partner end-users of the ENGAGE project, KI-CoP workshop organized with KI-CoP members of the ENGAGE project, and semi-structured interviews to external end-users.

4.2.1 SOLUTIONS COLLECTED FROM THE SURVEY TO PARTNER END-USERS

In total, 35 solutions were gathered from the partner end-users classified into eight types (see Table 8). There are two kinds of solutions, technology-based solutions and, solutions that are oriented towards providing a service to the civil society.

Within the technology-based solutions, we have different kinds of applications that aim at facilitating communication and information sharing with the civilians about weather-related events and about emergencies and disasters in general.

- » Ertzaintza app aims to improve the communication between the law enforcement agency and citizens,
- » Euskalmet app targets increasing citizen awareness about weather conditions,
- » DSU app pursues informing and alerting about emergencies to the citizens,
- » RVM app is focused on managing volunteers and resources that civil society provides to the department of emergency situations,
- » Heat Warning app is a very specific one to improve population awareness on health associated risks and heat waves,
- » EV app is an application to improve survival and outcome in cardiac arrest patients, 112 app aims to keep citizens updated about events nearby,
- » and the French Citizen responder service targets to improve the handling and alerting of critical emergencies.

As it can be seen in Table 8 these solutions mostly pursue improving communication and risk awareness as well as improving information and knowledge sharing to be better prepared to deal with crises. Very related to this, we have different social media channels such as Twitter, Facebook, and Instagram that are mainly used for improving communication and risk awareness of the civil society. In this specific type, there is a solution called VOST (Virtual Operations Support Team) which aims to help emergency organizations to control their communication with the public during emergencies.

Different kinds of platforms are also used with similar objectives. In this case, these platforms are broader than the applications explained above covering more areas, providing more functionalities, and giving more information to the civil society. These platforms are created at a national or regional level and it allows the authorities to share information, help in the allocation of the resources, and improve communication, and enhance awareness. Apart from improving communication and risk awareness, they also aim at facilitating resource allocation from the society and to the society. Finally, alerting systems are also identified as solutions used for warning people through messages about potential crises and communicate with them in case they need some help. There is one solution within this type called "Traveler alert" which is specific for governmental agencies to identify citizens abroad to assist them before, during, and after a disaster; providing useful information through a trusted and reliable guidance in their national language. In addition to the already



mentioned interaction purposes, these alert systems solutions help enhance preparedness to better respond to crises.

Regarding the solutions oriented towards providing a service to the society, we can find different types of solutions. The most common ones are awareness and training campaigns to different segments of the civil society and about different types of risks. Awareness campaigns in schools, national campaign programs, local awareness sessions, and a caravan to train people on how to be ready to deal with different risks are some of the examples of this group. All of them have the aim of improving communication, improving risk awareness, improving knowledge and information sharing, and enhancing preparedness. Another type of solution is the one related to establishing services to reach the civil society. These services allow the society to get in touch with authorities and emergency services to fulfil their needs such as getting information, asking for help in case of vulnerable people, making comments and suggestions for improving public security, making complaints, and get the response for these complaints, etc. These services target the following interaction purposes: improving communication, enhancing risk awareness, facilitating resource allocation, enhancing preparedness, capitalizing social networks and relationships, and empowering civilians in governance and leadership activities. Finally, three solutions present different disaster management plans with an overall perspective of enhancing the collaboration and interaction of all stakeholders to better face future events. The regional plan on prevention and active fight against forest fires in Lazio region, Snow Emergency plan of the Rome municipality, and Heat Health action plan are the solutions identified by the end-users.

Further details about the solutions can be found in Appendices (section 9.6).



Table 8: Solutions obtained from the partner end-user survey

Solutions from the end-user survey	Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Number of Solutions
Alert systems	3	3		2	3			1	3
Public warning systems, multichannel approach including alerts to people's phones	1	1		1	1				
Ro-Alert System	1	1		1	1				
Traveler Alert	1	1			1			1	
Apps	7	6	4	5	5	4	5	3	8
112-app	1	1	1	1			1	1	
DSU Mobile App	1	1	1	1	1		1		
ERTZAINZA App	1	1	1	1	1	1	1	1	
EUSKALMET App	1	1		1	1				
Evapp	1					1	1		
Heat warning mobile APP	1	1		1	1	1	1	1	
Resource Volunteer Management (RVM App)			1		1	1			
The French Citizen Responder service (Citizen responder)	1	1							
Awareness and training sessions	8	8	3	8	8	3	4	3	8
Awareness Campaign related to Fire Risk	1	1		1	1		1		
Awareness interviews	1		1	1	1	1	1	1	
Be Ready Caravan	1	1		1	1		1		
Civil Protection informative campaign on natural disasters "Io non rischio" in Italy	1	1		1	1				
Educational Campaign	1	1		1	1		1		
EU modex	1	1	1	1	1	1		1	
National Campaign of Information and Preparedness	1	1		1	1				
Providing information on the risks in your area and the main self-protection measures	1	1	1	1	1	1		1	
Disaster management plans	3	3	3		3	3	1	3	3
Heat Health Action Plan	1	1	1		1	1	1	1	
Snow Emergency plan of the Rome municipality	1	1	1		1	1		1	
The regional plan on prevention and active fight to forest fires in Lazio region (one central region of Italy)	1	1	1		1	1		1	
Guidelines	1	1	1	1	1	1	1	1	1
Volunteer involvement	1	1	1	1	1	1	1	1	
Platforms	4	4	4	3	3	1	1	1	4
30days30waysUK	1	1	1	1	1	1	1	1	
CIM - Crisis Information Management	1	1	1	1	1				
National Emergency Preparedness Platform (filpregatit.ro)	1	1	1	1					
RoHelp	1	1	1		1				
Services to reach the society	5	5	5	4	5	5	3	6	6
BILTZEN	1	1	1	1	1	1	1	1	
EKINBIDE	1	1	1	1	1	1	1	1	
Nixde	1	1	1	1	1	1	1	1	
Red Cross Preparedness Guard			1		1	1		1	
The main two-way communication tool: 113 number	1	1		1				1	
Use of volunteers in cooperation with professional emergency teams	1	1	1		1	1		1	
Social media channels	2	2	1	2	2	1	1	1	2
Twitter, Facebook, Instagram awarness accounts	1	1	1	1	1	1	1	1	
VOST (Virtual Operations Support Teams): managing the information gathered through different social media channels	1	1		1	1				
Total	33	32	21	25	30	18	16	19	35

4.2.2 SOLUTIONS COLLECTED FROM END-USER WORKSHOP

Partner end-users that participated in the end-user workshop identified 20 formal solutions based on the proposed scenarios (see Table 9). Most of the solutions are classified as awareness and training sessions oriented towards improving communication, enhancing risk awareness, and improving knowledge and information sharing. Providing information with a high frequency, providing testimonials from victims to make people aware of the risk, explaining the reasoning of the strategies implemented, and informing people about the risks are some of the solutions identified in this group. Closely related to this group, we can find different kinds of disaster management plans and strategies that can be implemented to improve knowledge and information sharing, enhance preparedness, facilitate resource allocation, and empower the civilians in governance and leadership activities. We included solutions such as the use of volunteer organizations as Point of Care, centralizing the coordination of all crisis stakeholders including volunteers, and establishing strategies and priorities for the use of limited resources. Furthermore, specific guidelines related to law enforcement agencies are defined to better interact with the civil society as well as to manage criticism from the opposing forces; not to create a backlash in society that could complicate the crisis response process.



From the technology-based solutions, the experts suggested two apps to manage the logistics in obtaining food and doing the shopping, especially for vulnerable people. These two solutions aim at fulfilling the purposes of facilitating resource allocation and capitalizing on social networks and relationships. The first platform provides the civil society with information and knowledge about self-preparedness, first aid, and how to control infections. Moreover, the other platform is more oriented towards collecting information from witnesses in the streets for decision-making purposes. Finally, a variety of social media channels are suggested as a potential solution to improve communication and risk awareness as well as to improve the knowledge and information sharing with the civilians and capitalizing social networks and relationships. In this solution, they emphasized the involvement of influencers with different backgrounds to spread abbreviated texts in their channels to reach a broader population.

Most of the solutions identified in the workshop were oriented towards improving the information and knowledge sharing with the civil society (16 out of 20) followed by improving communication (12 out of 20).

More details about the solutions can be found in Appendices (section 9.7).

Table 9: solutions collected from the partner end-user workshop.

Solutions collected from the end-user workshop	Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Number of solutions
Apps	1		2	1		2			2
Food search			1	1		1			
SoMe	1		1			1			
Awareness and training sessions	6	5	1	5	2	1	1	1	6
Citizen Patrol Awareness Campaign	1								
Communicate de-escalation	1	1		1	1		1	1	
Covid emphatic information	1	1		1		1			
Daily briefings	1	1		1					
Provide information	1	1	1	1					
Reassure by giving valid information	1	1		1	1				
Disaster management plans and strategies			4	6	3	2		5	6
Central coordination			1	1	1			1	
Point of Care (PoC)			1	1		1			
Prioritization of combustible			1	1	1			1	
Shortage of combustible			1	1				1	
Step by step de-escalation				1				1	
Use existing volunteer organizations				1	1	1		1	
Guidelines	1	1					1	2	2
Principle of proximity police	1	1						1	
Proportional use of Force							1	1	
Platforms	2	2		2	1	1		1	2
Filing of Reports	1	1		1					
Information and education	1	1		1	1	1		1	
Services to reach the society	1			1		1		1	1
Open interaction with opposing forces	1			1		1		1	
Social media channels	1	1		1		1			1
Social Media channels	1	1		1		1			
TOTAL	12	9	7	16	6	8	2	10	20

4.2.3 SOLUTIONS COLLECTED FROM KI-CoP WORKSHOP

Table 10 summarizes the formal solutions proposed by the KI-CoP members that participated in the workshop taken into account the scenario introduced in the workshop. 19 out of the 22 formal solutions are oriented towards empowering the civilians in leadership and governance activities and 17 out of 22 improving communication with the civil society.

9 solutions are proposed within the awareness and training sessions group of solutions. Most of these solutions are focused on informing people about the strategies followed and the decisions which were taken; justifying the reasoning behind them and also making people aware of the



importance of the vaccination and the danger of spreading fake news. In relation to this, the members highlighted that targeting the people, dividing them into subgroups, and working on their specific needs is key to reach the population. These solutions mostly aim at improving communication, enhancing information and knowledge sharing, and empowering civilians in leadership and governance activities. Very related to this category, 6 solutions are identified within the disaster management plans and strategies category. Dealing with vulnerable groups, establishing an incentive system for testing and vaccination, fostering inclusion, organizing volunteers and, establishing a good communication plan with local leaders are some of the solutions provided for this group. They are very focused on involving the civil society in leadership and governance activities.

Three solutions within the group of guidelines are proposed to capitalize on social networks and relationships, improving health and mental outlook, and empowering citizens in the governance and leadership of crisis management. The three solutions are: disseminating messages and information through official sources to avoid misinformation, enhancing cooperation with civil society, and developing a transparent, understandable, precise, relevant, and suitable communication strategy to deal with catastrophic emergencies.

Finally, two apps and two social media channels are identified as proper solutions to improve communication and risk awareness and facilitate knowledge, and information sharing with the citizens. Specifically, two applications to control the fake news were suggested as suitable to improve the management of the crisis and a specific social media channel to communicate with youths.

More detailed information about the solutions can be found in Appendices (section 9.8).



Table 10: Solutions collected from the KI-CoP workshop

Solutions obtained from the KI-CoP workshop	Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Number of Solutions
Apps	1	1	1	1			1	1	2
Create tools to control the fake news like NewsBrief	1	1	1					1	
Return to campus app (Everbridge)				1			1		
Awareness and training sessions	9	2		7	1	3	2	7	9
Communication not only focused on health	1				1		1		
Dealing with: False news can be spread	1			1		1		1	
Dealing with: People less willing to follow guidelines	1			1				1	
Dealing with: People protest against vaccinations	1			1			1	1	
Explaining measures	1	1		1		1		1	
Information strategy	1			1				1	
Keeping the population informed	1	1		1				1	
Provide information about uncertainties	1			1				1	
Targeting the people	1					1			
Disaster management plans and strategies	3	2	1			4	4	6	6
Dealing with: Resource-poor groups						1	1	1	
Develop incentive system for testing and vaccination	1	1					1	1	
Focus on inclusion						1	1	1	
Unify communication efforts	1							1	
Use local community organization leaders	1	1				1		1	
Volunteers to organize logistics of care			1			1	1	1	
Guidelines	2			2		3	1	3	3
Communication from official source	1			1		1		1	
Emotional context	1			1		1	1	1	
Enhanced cooperation with civil society						1		1	
Social media channels	2							2	2
Fake news detection	1							1	
Social media channels to communicate with youths	1							1	
TOTAL	17	5	2	10	1	10	8	19	22



4.2.4 SOLUTIONS EXTRACTED FROM THE SEMI-STRUCTURED INTERVIEWS

49 formal solutions were extracted from the semi-structured interviews conducted with 30 experts from seven countries. The most common solutions are apps with different objectives. Some of them are specific to the health sector, others are more general for dealing with all kinds of emergencies but with different aims such as to alert people about an emergency, to communicate with emergency services, and to deal with crowded areas, and others are more into providing general information for a municipality. Their main purpose is to improve knowledge and information sharing but they also help in improving communication and risk awareness as well as empowering the civilians in leadership and governance activities. Closely related to these apps is using different social media channels to communicate with society and creating groups in messaging apps such as Telegram, or Whatsapp are also proposed as potential solutions to better communicate with people and share information about the situation. General web platforms such as the web page of the municipality are also used to share information and knowledge to the civilians and make the civil society aware of the possible disasters.

In addition to this, 7 different solutions within the media group are defined. Most of them present different media channels that the emergency organizations and authorities use to share information with the civil society. Brochures and newsletters, information boards in stores, using media channels to share information, organizing debriefing meetings, and arranging webinars about covid are some of the solutions identified within this group. In the same vein, call centers are suggested as suitable solutions to help in the communication with the society as well as a way to provide information to the civil society about the emergency. Different hotlines are presented as potential solutions to improve communication with the population: covid call center, police hotline, general information hotlines, and emergency services hotline.

Two alert systems one based on sirens and the other based on text messages to the mobile phones, are two solutions identified in the interviews that mainly help to alert about a potential risk to the civil society. Related to this aim of enhancing civilians' risk awareness, awareness campaigns and self-readiness campaigns were suggested as solutions that help in this aim. More specifically, awareness campaigns about different kinds of risks in schools were suggested as potential solutions to make children become aware of the different kinds of risks and improve their preparedness.

To improve the involvement of the society in the governance and leadership activities, two solutions that enhance the involvement of the society in dealing with crises are proposed: the first one is oriented towards involving opinion leaders in engaging the population in preparing for emergencies, and the second one improving the collaboration among the emergency organizations to involve civil society in the management of emergencies. Furthermore, guidelines to know how to deal with different kinds of risks, be prepared to deal with them, and be aware of the potential risks are defined. Some of them are very specific for some of the risks such as "Protocolo Ibero" which is focused on dealing with terrorist attacks and the guidelines to control haemorrhages.

Finally, there are 6 solutions focused on volunteers' management. How to organize different volunteer groups, groups of volunteers in the rural municipalities to deal with emergencies, location-based messaging for volunteers, and tools that can facilitate this organization are the kind of solutions provided by the end-users in the interviews. Their main objective is to empower them in governance and leadership activities.

Overall, most of the solutions suggested aim at improving knowledge and information sharing with the civil society and enhancing risk awareness. Further information about the solutions can be found in Appendices (9.9).



Table 11 Solutions collected from the interviews

Solutions gathered from the semi-structure interviews	Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Number of solutions
Alert systems		2							2
Sirens		1							1
text messages		1							1
Apps	4	4	1	10			3	4	13
"city-connect" (in Hebrew)	1			1				1	1
App for alerting people		1		1					1
App for dealing with allergies			1	1			1	1	1
App for dealing with crowded areas				1					1
BeReady Caravan		1		1			1		1
Corona Dashboard									1
DSU App		1							1
Epidemiological diary				1			1	1	1
krisinformation.se		1							1
municipality mobile app				1					1
My EMS	1			1					1
My112, AlertaCops, 112SOSDeiak.	1			1				1	1
Police mobile app	1			1					1
Awareness campaigns		2			1				2
campaigns of awareness		1							1
self-readiness campaigns		1			1				1
Call centers		1	2	5			1	1	7
Covid Call center		1					1		1
emergency call center				1					1
Emergency reporting service 113			1					1	1
Emergency service hotline (112)				1					1
Information hotlines				1					1
Operation center			1	1					1
Police hotline (100)				1					1
Community relations	1		1	1	1			2	2
Collaboration with other emergency organizations			1		1			1	1
Relationships with opinion leaders	1			1				1	1



Solutions gathered from the semi-structure interviews		Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Number of solutions
Guidelines		2	4	1	1	3	2	2	2	4
	Norwegian Index for emergency call service	1	1				1		1	1
	Action protocol in case of a terrorist attack. "Protocolo Ibero"	1	1	1	1	1	1	1	1	1
	Guidelines of how to act in case of an emergency, for example control of the hemorrhage		1			1		1		1
	MSB shares guides about how to handle a crisis		1			1				1
Media		2	7		7			2		7
	Brochures and newsletters		1		1					1
	Debriefing meeting		1		1			1		1
	Information boards in stores		1		1					1
	Newspapers and TV	1	1		1					1
	Press conferences.		1		1					1
	Radio	1	1		1					1
	Webinars about Covid		1		1			1		1
Messaging apps		1	1		1					1
	Whatsapp, telegram	1	1		1					1
School campaigns			2	1		2		1	1	3
	Currently there are some risk awareness and training campaigns:		1							1
	Firefighters recruitment			1		1				1
	School training campaigns		1			1		1	1	1
Social media channels		1	1		1				1	1
	Accounts on Facebook, Tiktok, Twitter, Instagram and Youtube	1	1		1				1	1
Volunteers management			1		2	3		1	5	6
	Community patrols								1	1
	Corona loyals		1		1	1		1		1
	Location-based messaging for volunteers				1				1	1
	the community emergency and resilience team					1			1	1
	Volunteer groups								1	1
	Volunteers from passion					1			1	1
Web platforms			1		1					1
	Web pages of the municipality.		1		1					1
TOTAL		11	26	6	29	10	2	10	16	49



5 DISCUSSION

5.1 GENERAL ANALYSIS OF THE RESULTS

In this deliverable, we are listing all the formal solutions identified for improving the interaction of emergency organizations and authorities with the society. These solutions have been gathered from different sources and they have been classified into different groups of solutions based on their nature. These solution groups were merged and unified to have just one classification for the overall analysis. Table 12 shows the merging and the unification carried out.

Table 12: Final types of solutions

Final type of solution	Types of solutions included within this group				
Web platform	Web app	Platforms	Web platforms	Portfolio of solutions	
Apps	Apps	Mobile apps			
Guidelines	Guidelines	Book			
Framework	Framework				
Media	Social media channels	Messaging apps	Media		
Community of practice	Community of practice				
Services to reach society	Services to reach society				
Awareness and training campaigns	Awareness and training sessions	Awareness campaigns	School campaigns		
Plans and strategies	Disaster management plans and strategies	Disaster management plans			
Collaborative methods and technologies	Collaborative methods to work with stakeholders	Collaborative technologies	Community relations	Volunteers management	Crowd-sourcing
Alert system	Alert systems				
Call centers	Call centers				
Incentives	Funding program	Governmental program			

As we can see in Figure 6, “awareness and training campaigns” and “apps” are the categories that include the highest number of solutions. “Awareness and training campaigns” is a category of solutions that includes the highest level of direct/face-to-face contact with the members of the community, which could imply that this face-to-face interaction could be one of the most effective types of solutions. “Apps” on the other hand, do not provide a high degree of face-to-face contact, but they do provide a high level of reachability; officials can send a request via the app and people will be alerted in less than a second.

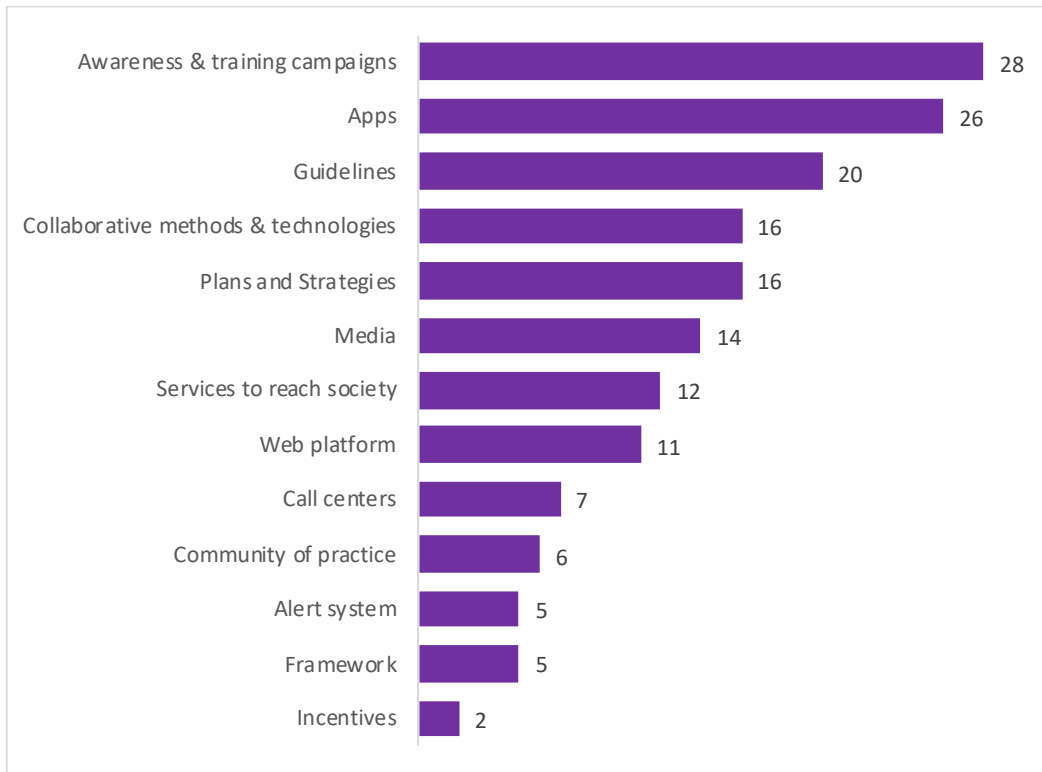


Figure 6: Distribution of the collected formal solutions based on the source

Related to this information, Figure 7 presents an overview of the magnitude of the solutions identified from each source. 49 solutions were obtained from the interviews, 35 from the end-user survey and 42 from the workshops, concretely 20 from the end-user workshop, and 22 from the KI-CoP workshop. In total, 126 solutions come from methods applied involving end-users, and only 42 come from the scientific and grey literature. From this, we can derive that there is a lack of research about the solutions to improve the interaction of emergency organizations and authorities.

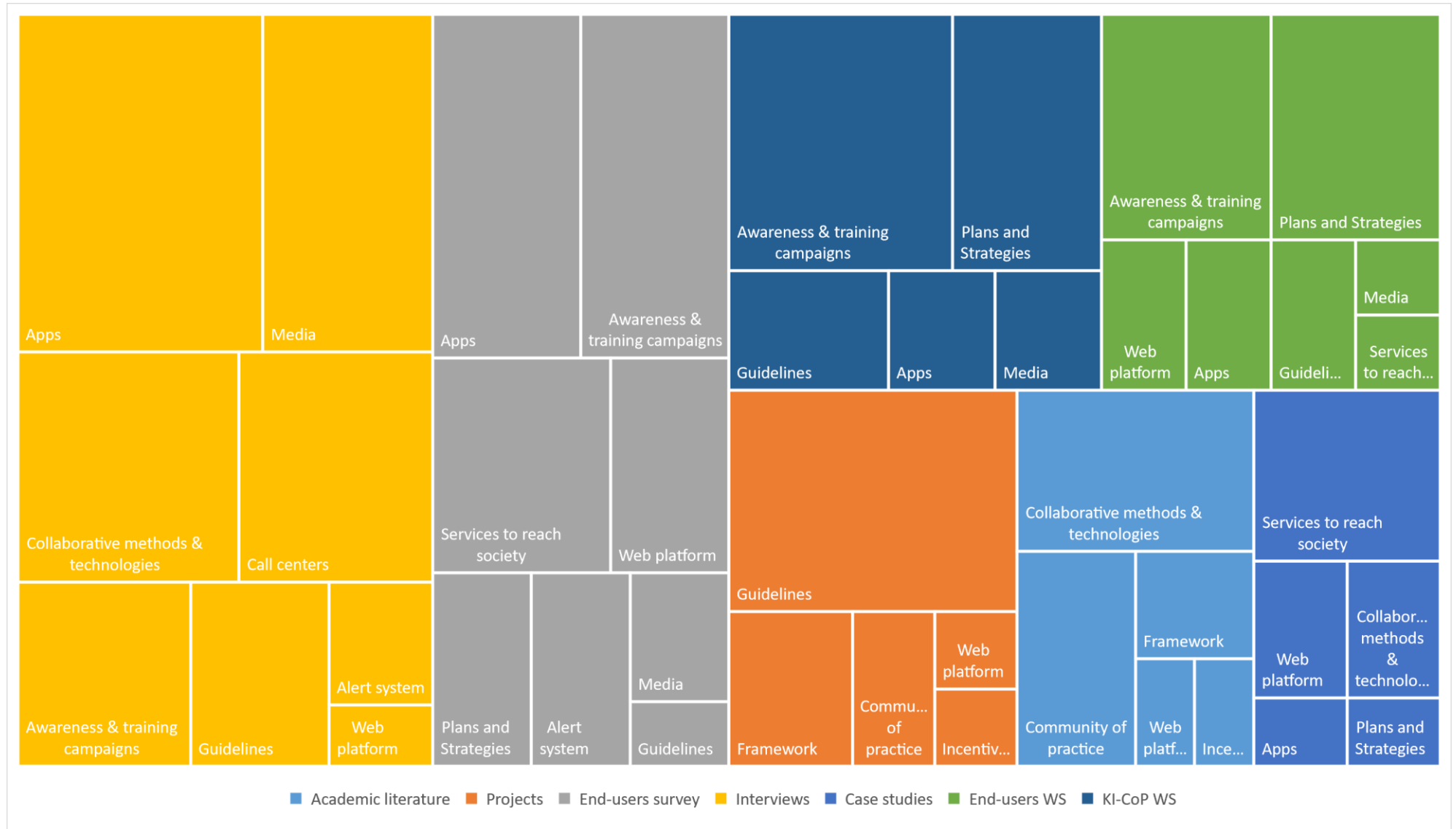


Figure 7: Distribution of the solutions based on the type of solution and the source from which they were identified



Regarding the interaction purposes addressed by the identified formal solutions, we can say that improving knowledge and information sharing is the purpose that most solutions contribute to. 104 out of 168 solutions fulfil this aim of facilitating the information and knowledge sharing between emergency organizations and authorities with the civil society. The second interaction purpose that solutions contribute to more is improving communication, in this case, 92 out of 168. As we know communication is an important aspect to improve interaction and nowadays with the available technologies this became more important and essential. Enhancing risk awareness is the third purpose more addressed by the solutions followed by empowering the civilians in governance and leadership activities, and enhancing preparedness. Starting from the bottom, facilitate resources allocation purpose is the objective least addressed by the solutions followed by improving health and mental outlook. Many end-users confirm that there are not formal solutions to facilitate the allocation of resources and if they need it then they decide at the moment based on the needs. Table 13 resumes the number of solutions that address each interaction purpose based on the type of solution.

Table 13: Distribution of the solution types across the interaction purposes

	Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge & information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Total
Web platform	9	9	5	9	7	5	2	4	11
Apps	14	12	8	18	6	6	9	8	26
Guidelines	9	9	3	5	9	10	10	11	20
Framework	3	2	1	5	4	2	1	1	5
Media	9	12	1	12	2	2	3	4	14
Community of practice	3	3	2	3	4	6	0	1	6
Services to reach society	8	5	7	8	6	8	7	9	12
Awareness and training campaigns	23	19	5	20	14	7	8	12	28
Plans and Strategies	6	5	8	6	7	9	6	15	16
Call centers	0	1	2	5	0	0	1	1	7
Collaboration methods and technologies	5	2	1	10	10	5	4	9	16
Alert systems	3	5	0	2	3	0	0	1	5
Incentives	0	0	1	1	2	1	0	1	2
TOTAL	92	84	44	104	74	61	51	77	168
Percentage	55%	50%	26%	62%	44%	36%	30%	46%	

5.2 SOLUTIONS TO IMPROVE COMMUNICATION

More specifically, Figure 8 presents the percentages of solutions in each group that contribute to improving communication with the civil society. As it can be seen, awareness and training campaigns and web platforms are the types of solutions that contribute more to this aim (82%). Solutions that provide services to reach civil society, media-related solutions, alert systems, and some frameworks also help in improving communication at a lower level.

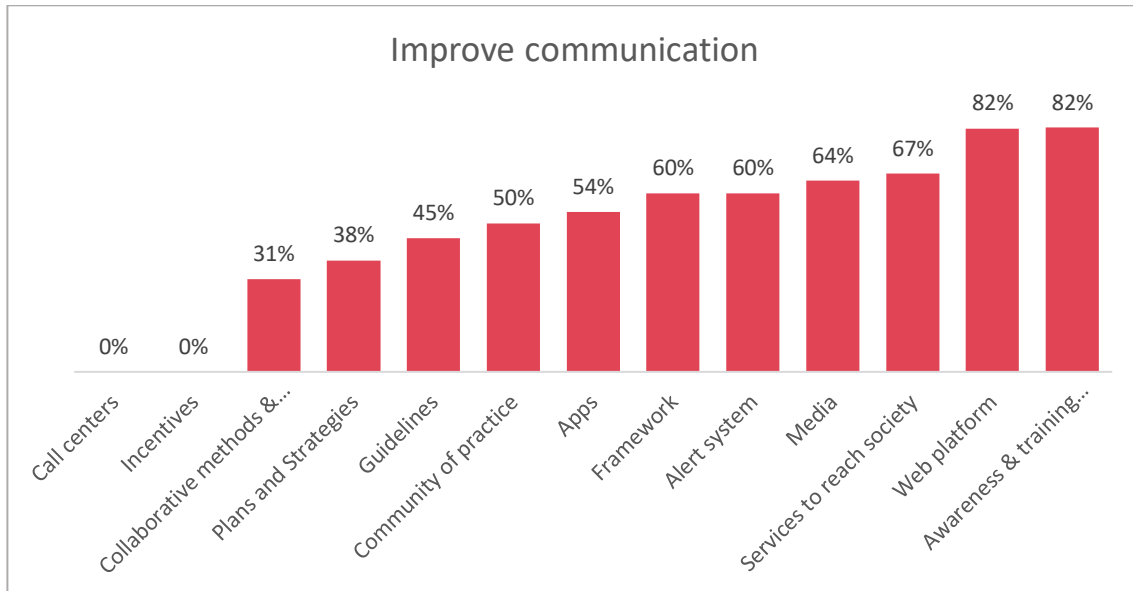


Figure 8: Percentage of solutions in each type of solution that help improving the communication with the society

5.3 SOLUTIONS TO ENHANCE RISK AWARENESS

In the interaction purpose of enhancing risk awareness, all the solutions within the alert system group help in achieving this purpose (see Figure 9). This result was to be expected since the main aim of alert systems is to make aware people of the potential risks. At a lower level, many of the solutions in the media and web platform groups aim also to improve risk awareness, followed by solutions in the awareness and training campaigns. Therefore, in case the authorities and emergency organizations want to enhance the risk awareness level, they should implement these kinds of solutions.

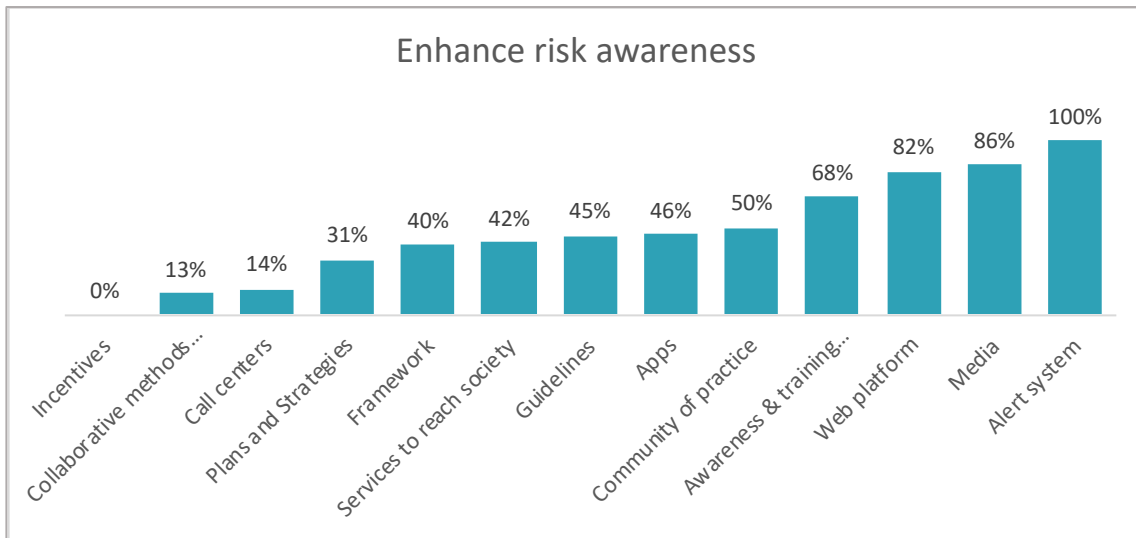


Figure 9: Percentage of solutions in each type of solution that help enhancing risk awareness.

5.4 SOLUTIONS TO FACILITATE RESOURCES ALLOCATION

Solutions within the services to reach society type are the ones that contribute more to this interaction purpose (58% of the total solutions). Some examples of these services are initiatives to help vulnerable people to ask for resources, programs to help victims after a crisis, etc. Solutions within the incentives type can also cover this aim of facilitating resource allocation.

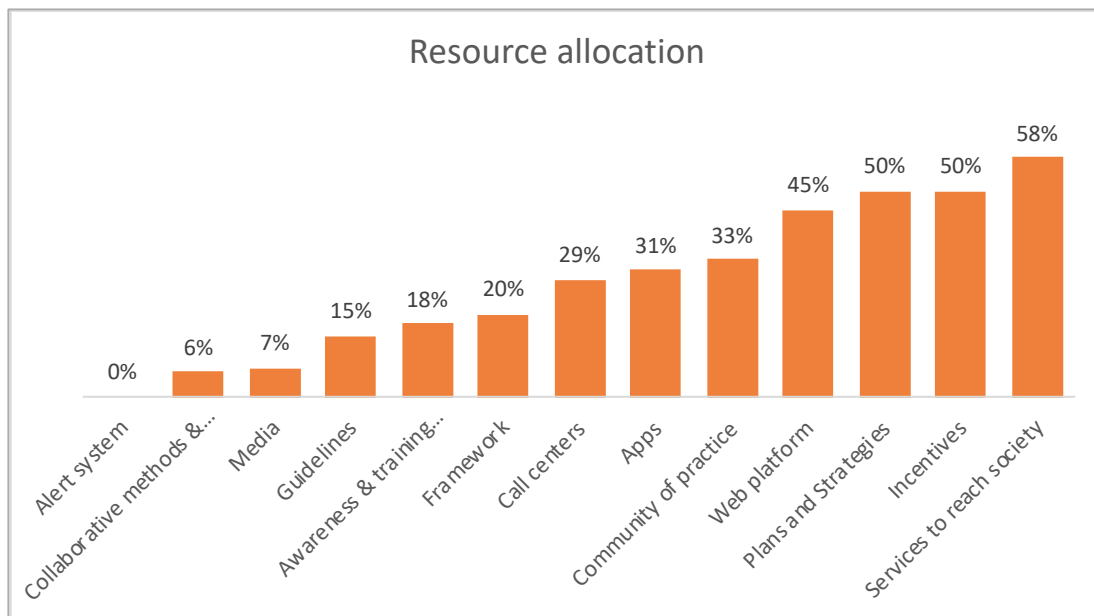


Figure 10: Percentage of solutions in each type of solution that facilitates resource allocation

5.5 SOLUTIONS TO IMPROVE KNOWLEDGE AND INFORMATION SHARING

Improving knowledge and information sharing is the interaction purpose more addressed by the solutions. All the identified solutions within the framework type contribute to this aim. Furthermore, all solution types have at least one solution that serves this purpose. At a lower level, most of the

solutions within media and web platforms groups cover this aim of sharing information and knowledge with the civil society.

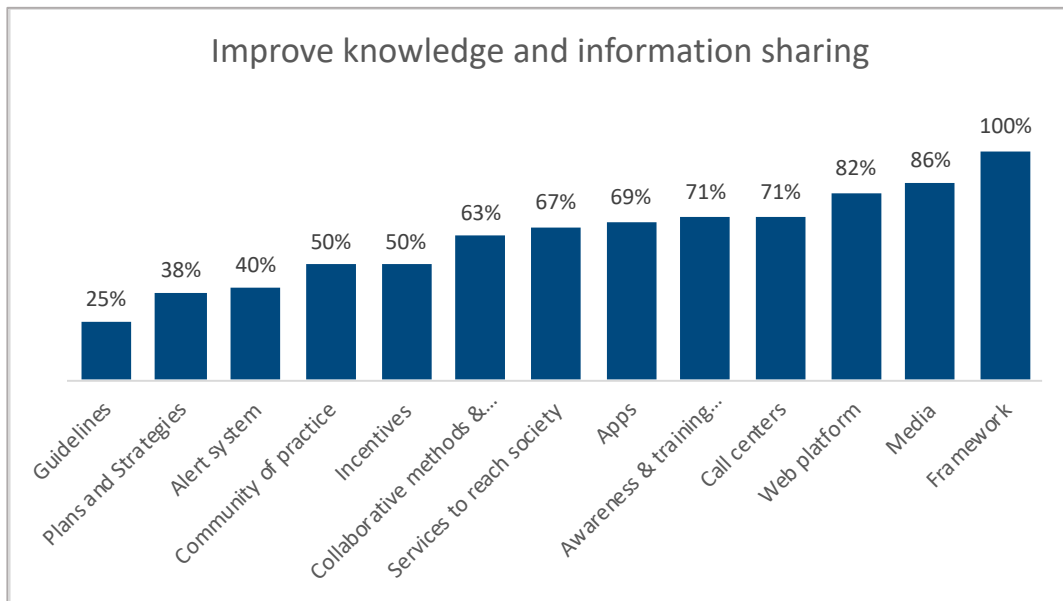


Figure 11: Percentage of solutions in each type of solution that help improving knowledge and information sharing

5.6 SOLUTIONS TO ENHANCE PREPAREDNESS

All the solutions within the incentives group help achieving this purpose since the solutions within this group are focused on providing funding to improve the preparedness for future disasters, such as the ECHO and DIPECHO Programme. Furthermore, most of the frameworks defined in the literature also serve the purpose of enhancing the preparedness of the civil society to better deal with crises. The Hyogo Framework and Making Cities Resilient 2030 framework are some clear examples of these solutions. Most of the solutions within the community of practice type also pursue this aim since they involve the civilians in the preparation activities for future crises.

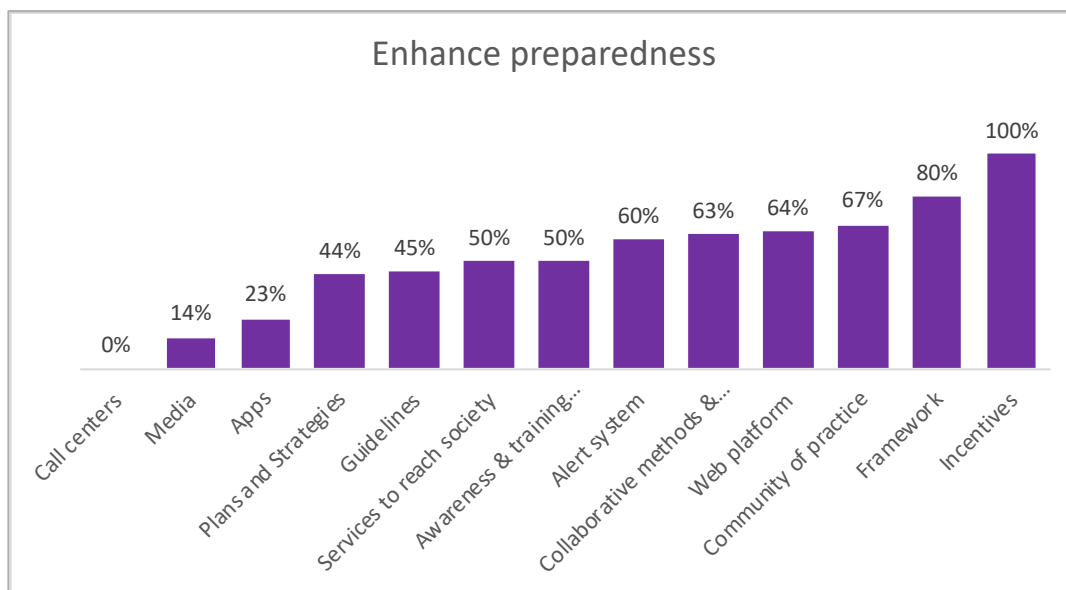


Figure 12: Percentage of solutions in each type of solution that help enhancing preparedness.

5.7 SOLUTIONS TO CAPITALIZE SOCIAL NETWORKS AND RELATIONSHIPS

To capitalize on social networks and relationships, the group of solutions that mostly affect this aim is “community of practice”; this makes perfect sense as the core of community of practices is social networks and collaboration between community members. Several services and activities are carried out in many regions that aim at improving social cohesion and mutual assistance among the civil society. Some examples of these are: the memorial ceremony organized after any disaster event, the use of victim’s memories to cope with the effect of disasters, BILTZEN which is an initiative created to improve the integration and enjoyment of the citizens in the Basque Country, and the regional list of persons with various competencies or resources to contact in case of a crisis.

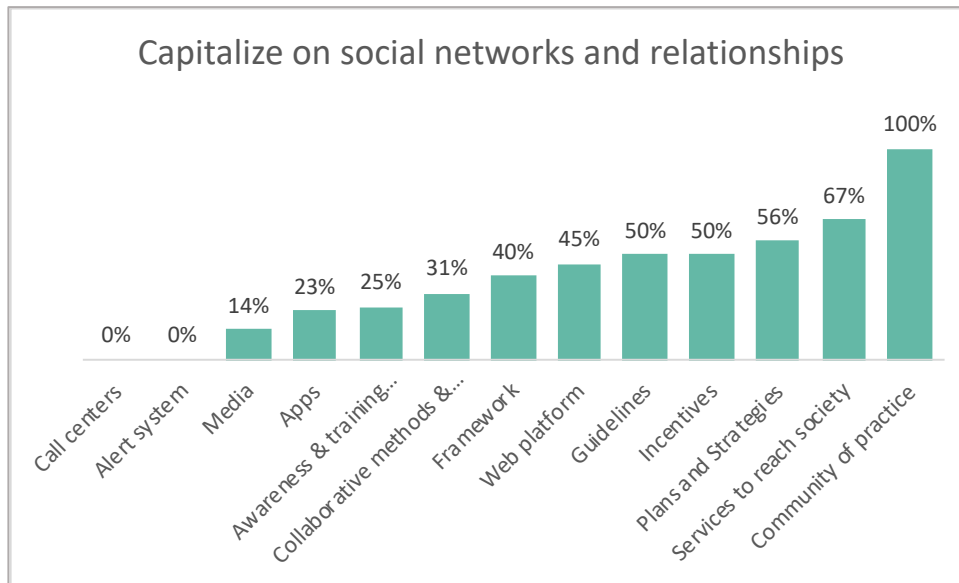


Figure 13: Percentage of solutions in each type of solution that help on capitalizing on social networks and relationships

5.8 SOLUTIONS TO IMPROVE HEALTH AND MENTAL OUTLOOK

In this case of improving health and mental outlook, the types of solutions that contribute more to this aim are the services to reach the society and guidelines. Examples of solutions that cover this purpose are guidelines presented in the Operationalising Psychosocial Support in Crisis project (OPSIC project) and activities performed to cope with the psychological post-disaster trauma and services established by the different governmental levels to facilitate the recovery from a disaster.

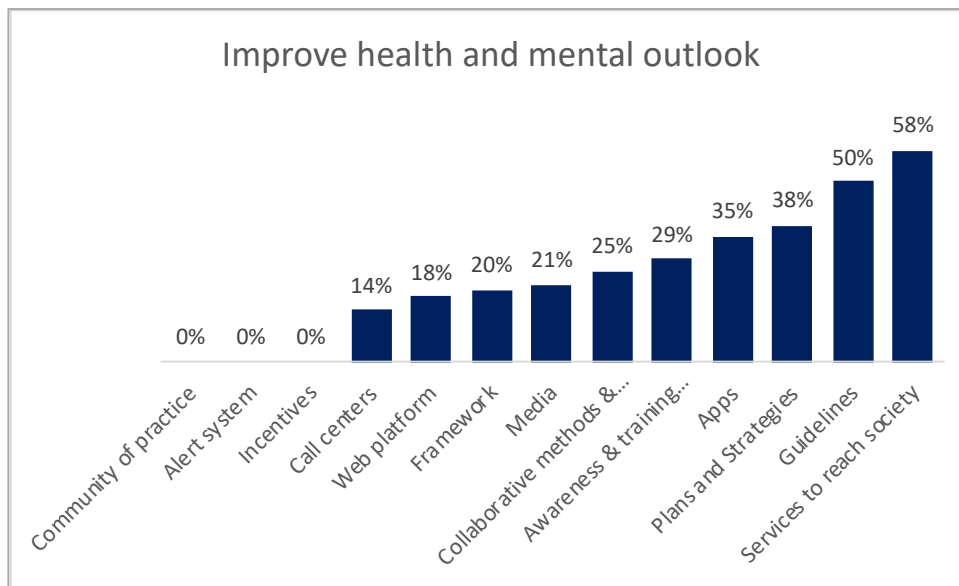


Figure 14: Percentage of solutions in each type of solution that help improving health and mental outlook.

5.9 SOLUTIONS TO EMPOWER THE PUBLIC IN GOVERNANCE AND LEADERSHIP

Finally, solutions within the plans and strategies type are the solutions that mostly address this interaction purpose followed by services to reach the society. Plans and strategies to deal with crises define how the involvement of the civil society in managing crises should be. These plans and strategies give the civil society an active role in governance and leadership activities. Collaborative methods and technologies category also serves this interaction purpose as they involve civilians in the development of strategies and plans to deal with disasters.

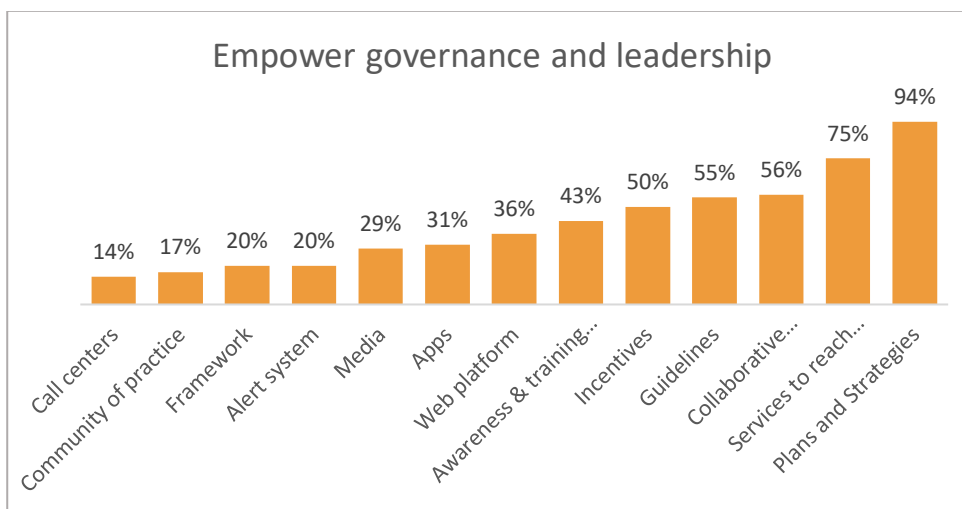


Figure 15: Percentage of solutions in each type of solution that help empowering the public in governance and leadership

5.10 CORRELATION BETWEEN PURPOSES

We conducted a correlation analysis between the different purposes, to investigate the relationship between them; the extent to which, one variable increases, the other variable tends to increase or decrease. We used the data in Table 13 to calculate the correlation matrix shown in Figure 16. The graph shows no surprises in some aspects such as the strong correlation between communication and risk awareness ($\rho = 0.95$) and between communication and knowledge and information sharing

($\rho = 0.89$); and between information sharing and risk awareness ($\rho = 0.83$); and social networks with health and mental outlook ($\rho = 0.79$). Based on these strong correlations, it is advisable that we merge the three purposes (communication, risk awareness, and knowledge sharing) into one purpose. What was interestingly surprising is the weak correlation between social networks and knowledge and information sharing ($\rho = 0.32$). We thought that social networking and relationships would highly increase knowledge and information sharing, but it has the lowest correlation value across all dimensions. This could be due to the nature of the solutions we have, for example, a mobile application is used by authorities and emergency organizations to share information with the civilians which has no real impact nor a relationship to their social networks. Therefore, considering the interacting parties is key in understanding and justifying the relationships between these purposes.

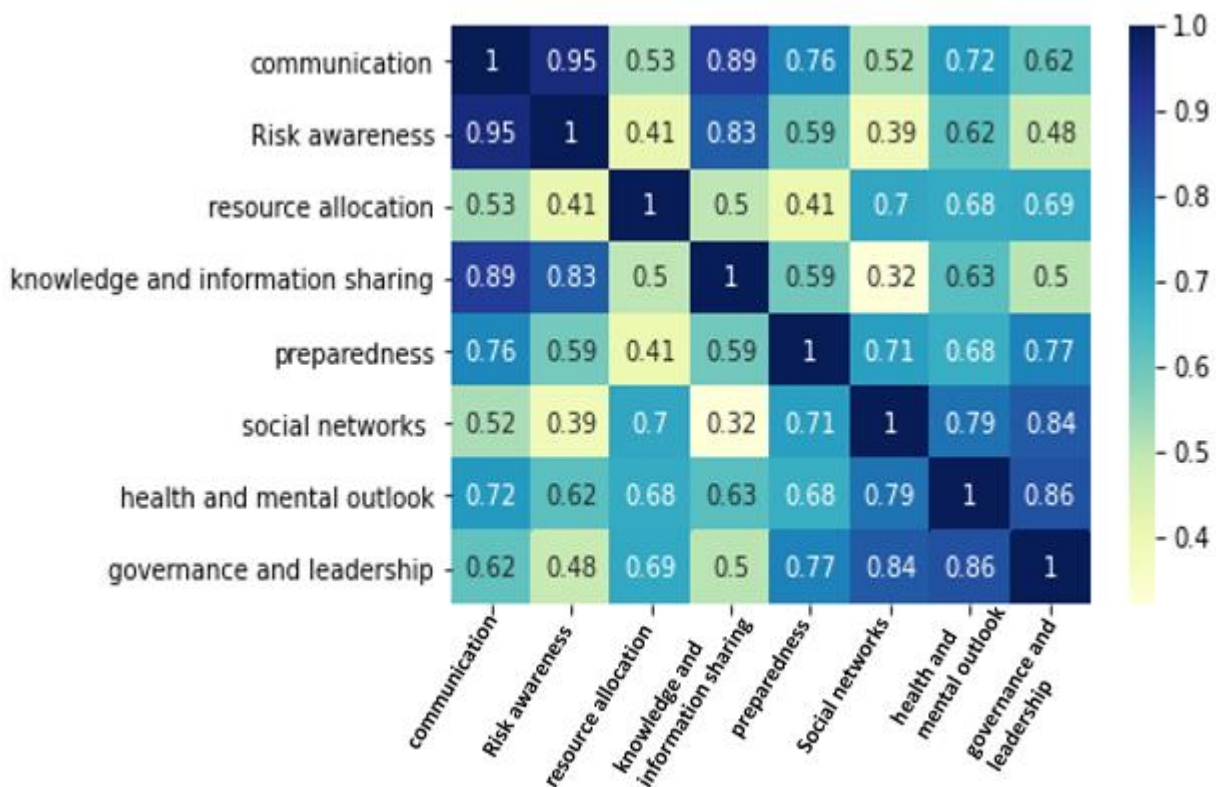


Figure 16 Purposes' correlation matrix

6 STRENGTHS & LIMITATIONS

6.1 STUDY LIMITATIONS

This study has the following limitations. Regarding the formal solutions identified for improving the interaction of emergency organizations and authorities with the civil society, little information can be found regarding the implementation level and the effectiveness level of these solutions in fulfilling their objective. Regarding the solutions identified from scientific and grey literature, most of the time there is no information about to what extent these solutions are implemented in practice and if they are effective in improving the interaction. For the ones obtained from the end-users, we might assume that if they are already implemented in practice, they should be useful. However, when speaking with the end-users some of them confirmed that some solutions were not fulfilling the expectations they were created for. Therefore, as future steps, we need to further analyse the implementation level of these solutions and their effectiveness in improving the interaction of emergency responders and authorities with the civilians.

Another limitation of this study is the one more related to the level of details available for each solution. In some cases, there was little information about what interaction purposes the solution is contributing to. This problem was especially significant when classifying solutions gathered from the end-user workshop, from the KI-CoP workshop, and the semi-structured interviews. In these cases, the scientific team has to infer what interaction purposes the solution is contributing to.

This limitation is even higher if we consider that the selection of the interaction purposes could be very subjective. The interaction purposes are very interdependent with each other and therefore, it is sometimes hard to differentiate among them. Therefore, selecting the interaction purposes each solution is contributing to might be subjective based on the person who is making the classification.

In Task 2.5 (revision and update of the proposed solutions for first responders and authorities), we will handle these limitations and go deeper in providing more details about the effectiveness of the solutions and the interaction purposes the solutions are contributing to. Also, in WP3, the solutions will be covered in more details, providing a catalogue of solutions and their detailed implementation guide.

6.2 STUDY STRENGTHS

Although this study has several limitations, it also has several strengths that should be highlighted. The first one is the variety of sources from which we collected the information to identify the formal solutions already existing to improve the interaction of emergency organizations and authorities with the civil society. Regarding the scientific and grey literature, three different sources of literature were analysed: academic papers, reports and documents from European projects and international reports, and literature from the analysed case studies in WP1. These solutions obtained from scientific and grey literature were complemented with more practical solutions obtained from the end-users. In this second part, we conducted four different activities of different types involving both internal end-users partners of the ENGAGE project and external end-users. Two workshops, semi-structured interviews, and a survey were carried out to gather solutions that can improve the interaction of emergency organizations and authorities with the civil society.

Another strength of this study is the high number of end-users that contributed to identifying existing solutions that could be beneficial to improve the interaction of emergency organizations and authorities with the civilians. In total, 52 different end-users from diverse backgrounds contributed to identifying the solutions. Besides, some of them participated in more than one activity. Therefore, we can say that this study is the result of a co-creation process in which we involved very different profiles to collect the maximum variety of possible solutions that could be implemented.



7 CONCLUSIONS AND FUTURE STEPS

The main objective of this deliverable was to identify formal solutions that are used to enhance the interactions between authorities and emergency responders with the civil society. To achieve this, we first identified what kind of solutions is considered formal and what kind is considered informal. The main difference between both types is that the formal solutions usually follow a well-defined, repeatable process, however, the informal ones are more into improvised solutions.

Second, we gathered solutions from several sources: academic literature, European projects, case studies, interviews, workshops, and from our partners' end-users. These various sources allowed us to cover a huge set of solutions from different perspectives; from purely theoretical solutions on one extreme to totally practical and applicable solutions on the other extreme. Moreover, it enriched our understanding of how authorities, emergency organizations, and civil society act in the face of a crisis.

Third, we identified some dimensions where the formal solutions could be beneficial for the interaction of authorities and emergency services with the society in case of a disaster. These benefits span the following aspects: improving communication, enhancing risk awareness, enhancing preparedness, facilitating resource allocation, improving information and knowledge sharing, capitalizing social networks and relationships between civil society members, improving health and mental outlook, and empowering civilians in governance and leadership activities.

Fourth, we mapped the identified solutions to these benefits, the importance of this step unfolds as follows. The distribution of solutions across purposes gives us a good idea of which solutions serve which kind of benefit and which purposes are lacking solutions. This could help policymakers, authorities, and emergency responders to identify areas of improvement based on their goals. Moreover, it highlights the solutions that serve multiple purposes but are not widely used –across different first responder-. This opens the door for adapting these kinds of solutions to different contexts and countries so their advantages are maximized.

Finally, we clustered the solutions into different groups (types) and classified them based on the disaster phase they are utilized in. As a future step, we need to assess the effectiveness of these solutions in improving the interaction of emergency services and authorities with the civil society and selecting the most promising solutions for each situation. The solutions will be contextualized assessing in which contextual aspects identified in WP1 they are more suitable and effective to improve the interaction of emergency services and authorities with the civil society. This will be done in WP3.

This catalogue will provide to the authorities and emergency services a list of potential solutions that they could implement in practice to improve their interaction with the civilians. In turn, which solutions could best fit the specific requirements and needs of each case will be defined to facilitate the authorities and emergency services the selection of solutions they should implement.

This catalogue of solutions will be validated with end-users in WP4 and they will be incorporated into the ENGAGE knowledge Platform. This platform will allow the authorities and emergency services to select the most suitable solutions for the specific situation they are coping with based on the contextual and target aspects of the case.



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9 APPENDICES

9.1 LITERATURE REVIEW FORM

SEARCHING FOR SOLUTIONS

The following link takes you to a friendly document of the literature review process:

In this form our main target is to gather information about solutions that improve the interaction between authorities/first responders and the citizens; with the aim of improving the societal capacity for resilience.

The form is mainly divided into two main sections. In the first one we record information about the document under investigation. And in the second section we mention information about the identified solution(s) itself (themselves).

Documents can be research papers, reports, webpages or information from authorities.

You are allowed to add up to 3 different solutions. If you need to add more, please fill the form another time (We hope that you wouldn't need to do it :))

* Required

1

Document title *

2

Publication year *

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3

Document authorship *

4

Please determine the type of document you have analyzed to start the forms *

- Academic article (journal/conference)
- Report (project/strategies)
- Web or authorities

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SOLUTIONS IN ACADEMIC ARTICLES

5

Article Keywords

6

Publishing journal or conference

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SOLUTIONS IN WEB PAGES OR SHARED BY AUTHORITIES

7

Source (link to the webpage or contact of the authority that shared the information)

8

Access or contact day

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IDENTIFIED SOLUTION

9

What is the identified solution that contributes to the improvement of societal resilience? *

Please keep in mind that we are looking for solutions that improve the interaction between authorities/first responders and the citizens; with the aim of improving the societal capacity for resilience. .

- Web app
- Mobile app
- Index
- Assessment survey
- Guidelines
- Framework
- Virtual modeling
- Assessment framework
- Volunteered geographic information (VGI)
- Center of Expertises
- Other (please specify in the following question)

10

In case you have marked "other", please mention here the identified solution

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11

What is the aim of the identified solution? *

12

The solution is designed to be used in which of the following phases? *

You can choose multiple answers

- Before the crisis occurs
- During the crisis
- After the crisis occurs (recovery)
- Does not say

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13

What interaction is targeted with the solution?

If you are not sure just mark "Other-Other" please.

For example: a mobile application that gathers car accidents targets the interaction between communities and 1st responders.

Note: here the order is not so important but to relate the stakeholders interaction

	1st responder	Authorities	NGOs	Communities	Other
1st responder	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Authorities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
NGOs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Communities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

14

In case you picked "Other-Other", please mention what you mean by this

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15

The following is a list of dimensions of community resilience (Patel et al. 2017: <https://bit.ly/38nEBfd> (<https://bit.ly/38nEBfd>)). Please mark which dimensions you believe the solution is related to: *

LOCAL KNOWLEDGE	COMMUNITY NETWORKS AND RELATIONSHIPS	COMMUNICATION	HEALTH	GOVERNANCE /LEADERSHIP	RESOURCES	ECONOMIC INVESTMENT	PREPAREDNESS	MENTAL OUTLOOK
Factual knowledge	Connectness	Effective communication	Health services	Infrastructures & services		Post-disaster economic development	Planning and mitigation	Hope
Training and education	Cohesion	Risk communication	Physical and mental health	Public involvement and support		Post-disaster economic programming		Adaptability
Collective efficacy & empowerment		Crisis communication						

- Local knowledge
- Community networks
- Communication
- Health
- Governance & Leadership
- Resources
- Economic Investment
- Preparedness
- Mental Outlook
- Does not say or its not clear

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16

If you have further comments regarding what aspects (contextual/target) the solution contributes to, please write it here

17

What are the main limitation of the solution (if any is specified)

For example: the solution is not used as planned as it is too complicated for the end users; the solution stopped to be used because it is not updated since it was launched...

18

In case there's a web link referring to the solution, please put it here

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19

Do you want to add another solution that is introduced in same document? *

- Yes (you will be asked about this additional solution)
- No (the form ends)

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9.2 PARTNER END-USER SURVEY FORM



SEARCHING FOR SOLUTIONS TO BUILD SOCIETAL RESILIENCE

This survey is part of ENGAGE project which is a Horizon 2020 funded project (<https://twitter.com/EngageH2020> (<https://twitter.com/EngageH2020>)).

In this form our main target is to collect solutions (either formal or informal) from authorities and emergency organizations. These solutions are being used to improve the interaction with population. They can be either technological such as mobile apps, citizens platforms.. etc. Or not technological, such as training sessions, methods to better communicate with society, emergency phone numbers to interact with citizens.. etc. These interactions among the first responders and authorities with the citizens is unfolding in different dimensions:

- to improve the communication with the population,
- to enhance citizens' risk awareness,
- to facilitate the resources allocation to/from the population,
- to improve the information and knowledge sharing with the population,
- to improve the population preparedness to deal with crises,
- to promote social networks and relationships within the population,
- to improve the population trust towards authorities and emergency organizations,
- to improve the population involvement in dealing with crises,
- to empower population in governance and leadership activities.

Therefore, we would like to gather solutions that would help to improve the interactions in all over these fields.

The form is composed by 14 questions, some of them are multiple choice, other are text. In case you do not feel comfortable when answering, you have always the opportunity to answer "other" or "do not know".

If you would like to record more than one solution please answer the survey from the beginning for every solution.

The option to answer will be closed at the end of January 2021

Any question or regard contact us: llabaka@tecnun.es (<mailto:llabaka@tecnun.es>)

* Required

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1

What is the identified solution that contributes to the improvement of societal resilience? *

Please keep in mind that we are looking for solutions that improve the interaction between authorities and emergency organizations with the population; with the aim of improving the societal capacity for resilience.

2

What is the aim of the solution? *

3

The solution is designed to be used... *

You can choose multiple answers

- Before the crisis occurs
- During the crisis
- After the crisis occurs (recovery)
- All of them
- Does not say

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4

The solution is focused on the following risks: *

- Extreme weather (cyclones, snow, flooding...)
- Nature related events (earthquake, volcanic eruption...)
- Social disruption (attacks)
- Critical services dependencies (water, energy...)
- Pandemic (communicable disease)
- Disaster management in general
- Not sure

5

Who is the end user of the solution? *

- Emergency organizations
- Authorities
- NGOs
- Population
- Others

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6

What interaction is targeted with the solution?

If you are not sure just mark "Other-Other" please.

For example: a mobile application that gathers car accidents targets the interaction between communities and emergency organizations.

Note: here the order is not so important but to relate the stakeholders interaction

	Emergency organizations	Authorities	NGOs	Population	Other
Emergency organizations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Authorities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
NGOs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Population	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7

In case you picked "Other-Other", please mention what you mean by this

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8

The following is a list of dimensions of community resilience (Patel et al. 2017: <https://bit.ly/38nEBfd> (<https://bit.ly/38nEBfd>)). Please mark which dimensions you believe the solution is related to: *

LOCAL KNOWLEDGE	COMMUNITY NETWORKS AND RELATIONSHIPS	COMMUNICATION	HEALTH	GOVERNANCE /LEADERSHIP	RESOURCES	ECONOMIC INVESTMENT	PREPAREDNESS	MENTAL OUTLOOK
Factual knowledge	Connectness	Effective communication	Health services	Infrastructures & services		Post-disaster economic development	Planning and mitigation	Hope
Training and education	Cohesion	Risk communication	Physical and mental health	Public involvement and support		Post-disaster economic programming		Adaptability
Collective efficacy & empowerment		Crisis communication						

- Local knowledge
- Community networks
- Communication
- Health
- Governance & Leadership
- Resources
- Economic investment
- Preparedness
- Mental Outlook
- Does not say or its not clear

9

If you have further comments regarding "question 8: list of societal resilience dimensions", please write here:

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10

Is there any web, document or source where further explanation or info about the solution can be found. If so, please write it here:

11

Could you please add an example of how the solution is used:

12

What is the main contribution do you believe this solution makes to societal resilience in disaster management? Please describe.

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13

What are the main limitation of the solution (if any is specified)

For example: the solution is not used as planned as it is too complicated for the end users; the solution stoped to be used because it is not updated since it was launched...

14

Other comments:

This content is neither created nor endorsed by Microsoft. The data you submit will be sent to the form owner.

 Microsoft Forms

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9.3 SOLUTIONS IDENTIFIED IN THE SYSTEMATIC LITERATURE REVIEW

Table 14 presents the solutions identified in the publications obtained from the systematic literature review. The solution has been classified into the following solution types: collaborative methods to work with stakeholders, community of practice, crowdsourcing, Framework, Governmental program, Web app.



Table 14: Solution identified in the systematic literature review.

	Solution	Aim/description of the solution	Interacting entities	Reference	Interaction purposes								Crisis Phase			
					Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis	
Collaborative methods to work with stakeholders	Utilizing stakeholder-driven approach to define the indicators to assess the community resilience	This solution proposes utilizing a stakeholder-driven approach to identify the relevant metrics, indicators and thresholds specific to the community under consideration to assess system performance.	Emergency organizations, authorities and civil society	(Fox-Lent, Bates, and Linkov 2015)	X			X	X	X	X	X	X		X	
	Involving local actors to take part in the disaster resilience planning	This solution allows local actors in rural and remote communities to have a systematic way of defining and assessing disaster resilience, not only for local planning purposes but also to increase their capacity to engage with other state actors in conversations and decisions about disaster and resilience planning.	Authorities and civil society	(Cox and Hamlen 2015)				X	X				X	X	X	
	Participatory modelling for improving risk awareness	Participatory modelling with stakeholders to represent, explore and actively question communities' beliefs about the natural hazards that their community faces.	Emergency organizations, authorities and civil society	(Henly-Shepard, Gray, and Cox 2015)				X	X					X		
	Structured interview Matrix	SIM is an effective technique to enhance connectedness,	Emergency organizations,	(O'Sullivan et al. 2015)		X			X	X				X		



	Solution	Aim/description of the solution	Interacting entities	Reference	Interaction purposes							Crisis Phase					
					Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis		
	(SIM) technique to improve risk awareness and preparedness	common ground, collaborative action, and awareness of existing services and supports in each community. They use an open-ended questionnaire to document experiences.	authorities and civil society														
	A participatory and transformative method for building community resilience to climate change	Participatory and transformative method to work with communities in responding to climate change and variability within rapidly urbanising coastal locations	Emergency organizations, authorities and civil society	(Smith et al. 2011)				X	X	X				X			
Community of Practice	Community based groups to design and plan the community resilience actions	This solution suggest applying community based groups to design and plan the community resilience building process in Los Angeles County	Civil society and authorities	(Wells et al. 2013)	X		X	X		X		X	X				
	Time bank: each person provide its time for response and recovery activities	This solution helps in providing an already established network for active participation by citizens in the response and recovery establishing the available time of each participant for the response and recovery.	Civil society	(Cretney 2016)					X	X			X	X	X		
	Volunteered geographic information (VGI)	VGI is the harnessing of tools to create, assemble, and disseminate geographic data provided voluntarily by individuals. VGI aids in building community resilience	Civil society and Emergency organizations	(Haworth et al. 2018; dos Santos Rocha et al. 2017)	X			X		X					X		



	Solution	Aim/description of the solution	Interacting entities	Reference	Interaction purposes								Crisis Phase			
					Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis	
		very focused on communication.														
	A VCoP for practitioners and volunteers	This solution proposes a VCoP where practitioners and volunteers can share lessons learned, anticipate risks and threats through the sharing of experiences and promising practices, and resilience planning for communities.	Emergency organizations and volunteers	(Amaratunga 2014)	X	X	X	X	X	X						
Crowdsourcing	A crowdsourcing methodology with the help of social media to gather information	A crowdsourcing methodology with the help of social media tools to gather information from citizens in case of emergency and help to monitor the effectiveness of actions taken that incorporate Eco-DRR/CCA during major events.	Emergency organizations, authorities and civil society	(Whelchel and Beck 2016)	X			X		X					X	
	Virtual modelling for preparing emergencies	This solution provides a virtual space where users can access a range of tools as a means of informing, educating, empowering and warning participants in emergency scenarios, both real and simulated.	Emergency organizations, authorities and civil society	(Dethridge and Quinn 2016)	X	X		X							X	
Framework	The Communities Advancing Resilience Toolkit (CART)	This toolkit engages community representatives to measure their community's resilience and to explore and promote actions to enhance it.	Authorities and civil society	(Pfefferbaum et al. 2013)	X	X	X	X	X	X					X	



	Solution	Aim/description of the solution	Interacting entities	Reference	Interaction purposes								Crisis Phase			
					Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis	
Governmental program	The community rating system program (CRS)	Community Rating System (CRS) is a voluntary incentive program introduced by the National Flood Insurance Program in USA. CRS recognizes and encourages community floodplain management activities that exceed the minimum National Flood Insurance Program requirements.	Authorities and civil society	(Atreya and Kunreuther 2020a)			X		X			X	X			
Web app	Web app to access to get information about past events and current resilience level	This web-app solution allows citizens and authorities to visualize the historical natural hazards exposure and damages in the areas of their interest, compute the resilience indices, and produce on-the-fly maps and statistics.	Authorities and civil society	(Li et al. 2015)	X	X		X	X						X	X



9.4 SOLUTIONS IDENTIFIED IN THE ANALYSIS OF EUROPEAN RESEARCH PROJECTS AND INTERNATIONAL REPORTS

Table 15 presents the solutions identified in the reports obtained from the analysis of European research projects and international entities related to crisis management. The solution has been classified into the following solution types: guidelines, book, community of practice, framework, portfolio of solutions, funding program, tool.



Table 15: Solutions identified in the revision of European research projects and international reports.

	Project / International institution	Aim/description of the solution	Interacting entities	Reference	Interaction purposes								Crisis Phase		
					Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis
Guidelines	Operationalising Psychosocial Support in Crisis (OPSIC project)	The solution represents a practical guidelines suggesting the actions to ensure mental health through the support of community and family members	Emergency organizations, authorities and civil society	(Juen et al. 2015)	X						X		X	X	
		The solution provides key principles to organise volunteers participation in disaster management.	Civil society, volunteers and authorities	(Juen et al. 2015)						X		X		X	X
		The solution identifies aspects to be considered when planning the use of social media in disaster management	Civil society and authorities	(Juen et al. 2015)	X						X	X		X	X
		This solution provides guidelines on mental health and psychological support in emergencies	Emergency organizations, authorities and civil society	(Juen et al. 2015)							X			X	X
	Smart Resilience project)	Mature (SMR) The European Resilience Management Guideline aims at training and supporting municipalities and relevant stakeholders in implementing an integrated management process that enhances city resilience.	Emergency organizations, authorities and civil society	(SMR 2018)		X	X	X	X	X		X		X	



	Project / International institution	Aim/description of the solution	Interacting entities	Reference	Interaction purposes								Crisis Phase		
					Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis
	Placard Interchange	A solution to raise awareness to climate change related risks by using storytelling	Civil society	("Stories for Action – PLACARD Interchange" n.d.)					X				X		
	National Institute of Standards and Technology	A solution that involves a community-level methodology to develop performance goals, quantitative science-based resilience assessment tools and metrics, and guidance and pre-standard documents for mitigating risks to communities.	Emergency organizations, authorities and civil society	(NIST n.d.)		X			X	X			X		
	UK government	The solution provides guidelines to the population regarding how to deal with flooding and extreme weather phenomenon.	Authorities and civil society	(UK n.d.)	X	X			X				X	X	X
Community of Book	Collective Conviction: the story of Disaster Action	The book explains how to manage psychological problems and mental trauma that can be originated from disasters (especially between survivors).	Emergency organizations, authorities and civil society	(Eyre and Dix 2015)							X			X	X
Community of Practice	DRIVER+ (Driving Innovation in Crisis Management for European Resilience)	The Center of Expertise is a community of practice involving experts to support practitioners in adopting new solutions to improve resilience	Emergency organizations and civil society	(Berlo and Nalecz-Kobierzyck 2020; "The DRIVER+ Project for Crisis Management" n.d.)		X			X	X			X	X	X



	Project / International institution	Aim/description of the solution	Interacting entities	Reference	Interaction purposes								Crisis Phase		
					Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis
	DRIVER+ (Driving Innovation in Crisis Management for European Resilience)	CMINE, Crisis management Innovation Europe, is a network created among practitioners	Emergency organizations and civil society	(Berlo and Nalecz-Kobierzyck 2020; "The DRIVER+ Project for Crisis Management" n.d.)		X			X	X			X	X	X
Framework	UNDRR (United Nations Office for Disaster Risk Reduction)	The Hyogo Framework for Action 2005-2015 that aims to build the resilience of nations and communities to disasters	Authorities and civil society	(Basabe 2013)	X			X	X	X	X	X	X		
	UNDRR (United Nations Office for Disaster Risk Reduction)	Making Cities Resilient 2030 program presents a long term strategy that aim to reduce risk and build resilience through sharing knowledge and experiences and connecting different layers of city governance including the citizens.	Authorities and civil society	(UNDRR 2020b; 2020a)				X	X				X		
	CARISMAND project - Culture and Risk Management in Man-made and natural disasters	Carismand Cultural Map provides a cultural map to manage differences in disaster management	Emergency organizations and civil society	("CARISMAND Toolkit" 2018)				X	X				X	X	X



	Project / International institution	Aim/description of the solution	Interacting entities	Reference	Interaction purposes								Crisis Phase		
					Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis
Funding program	European commission	ECHO and DIPECHO Programme is a strategy to improve preparedness and it funds pilot activities on simple preparatory measures that can enhance resilience, including early warning systems, local capacity building, education, linkage between public organization.	Emergency organizations and civil society	(Cristóbal, Juan, and Beltrán 2014)				X	X	X			X		
Portfolio solutions	DRIVER+ (Driving Innovation in Crisis Management for European Resilience)	The DRIVER+ project offers a repository of best solutions to improve crisis management, support the development of trials and sharing user experience	Emergency organizations and civil society	(DRIVER+ n.d.)	X	X		X	X	X		X	X	X	X
Tool	ANYWHERE project: innovating the management of weather emergencies	This project provides self-preparedness and self-protection tools to help people protect themselves in case of weather emergencies	Emergency organizations and civil society	(“Enhancing Emergency Management and Response to Extreme Weather and Climate Events » ANYWHERE” 2019)					X	X	X			X	



9.5 SOLUTIONS EXTRACTED FROM THE REVIEW OF CASE STUDIES

Table 16 presents the solutions identified in the review of case studies. Concretely these solutions were obtained from the Utoya terrorist attack case and the Fukushima nuclear accident case. The solutions have been classified into the following solution types: mobile apps, web platforms, services to reach society, collaborative technologies and disaster management plans.



Table 16: Solutions identified in the revision of case studies.

Solution type	Solution	Aim/description of the solution	Interacting entities	Reference	Interaction purposes								Crisis Phase			
					Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis	
Mobile app	An app for flood management	A mobile app that shows users in Japan the inundation depth of the 2011 tsunami in reference to their current location	Civil society and authorities	(Leelawat et al. 2018)	X	X		X	X					X		
Web platform	A platform for crisis management based on social networks and person to person multimedia streaming	This solution aims at information sharing and identification of adequate volunteers improving the communication between crisis managers and volunteers.	Emergency organizations, authorities and volunteers	(Patrikakis et al. 2011)	X		X			X		X			X	
	A collaborative citizen science platform for radiation measuring	This solution provides the tools and a database for radiation measuring after nuclear disasters in order to make their own informed decisions.	Authorities and civil society	(Brown et al. 2016)				X	X	X	X				X	X
Service to reach society	Public access to audit reports on ministries' societal safety work	This solution aims at improving the openness and trust towards authorities handling of societal safety.	Authorities and civil society	(Nilsen, Albrechtsen, and Nyheim 2018)	X			X				X	X	X	X	
	A program to help bereaved families after crises to emergencies	This solution provides a process to recover psychologically after a disaster and learn about grief	Authorities and civil society	(Dyregrov et al. 2014)			X				X					X
	Memorial ceremony after terror events	To rebuild national community and tolerance after terror	Authorities and civil society							X	X					X



Solution type	Solution	Aim/description of the solution	Interacting entities	Reference	Interaction purposes								Crisis Phase		
					Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis
	The use of localized online memories to cope with the effect of a disaster.	To provide diverse narratives of a disaster event and help in coping with the disaster.	Authorities and civil society	(Farinosi and Micalizzi 2016)				X		X	X				X
	Increased manning for operation centers of the Police	This solution implies Improving the capacity for operation centers to handle vast amount of tasks and information loads during crises, including calls from citizens	Emergency organizations and civil society	(Nilsen, Albrechtsen, and Nyheim 2018)	X		X	X	X		X	X	X	X	X
Collaborative technologies	Different open source tools for organizing volunteers and expertise	This solution aims at providing platforms for international and local volunteers to brainstorm solutions	Authorities, volunteers, and civil society	(Luis Felipe R. Murillo 2016)	X			X	X	X	X			X	X
	Geographical Information Systems (GIS) to communicate with the population.	The goal is to present a new way of collecting, compiling and visualizing geographical data in order for the authority to communicate with the public during a crisis.	Authorities and civil society	(Bergam and Östblom 2019)				X			X	X		X	
Disaster management plan	The government's action plan against radicalization and violent extremism	This solution provides a governmental level plan to prevent radicalization and violent extremism	Emergency organizations, authorities and civil society	(Nilsen, Albrechtsen, and Nyheim 2018)					X		X	X	X		



9.6 SOLUTIONS COLLECTED FROM THE SURVEY TO PARTNER END-USERS

Table 17 shows the solutions collected from the survey to partner end-users. The solutions have been classified into the following solution types: apps, platforms, alert systems, awareness and training sessions, services to reach society, social media channels, guidelines, and disaster management plans.



Table 17: Solutions identified in the survey to the partner end-users

	Solution	Aim/description of the solution	Interacting entities	Interaction purposes								Crisis Phase		
				Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis
Apps	ERTZAINZA App	To improve the communication between the law enforcement agency and citizens.	Emergency organizations and civil society	X	X	X	X	X	X	X	X	X	X	X
	EUSKALMET App	To increase citizen awareness about weather conditions in the Basque Country	Emergency organizations, authorities and civil society	X	X		X	X				X	X	
	DSU Mobile App	To inform (news), alert (emergencies), report (sending picture from the field to the dispatch), useful information for emergency management and to self-assess about educational exercises.	Emergency organizations, authorities and civil society	X	X	X	X	X		X		X	X	X
	Resource Volunteer Management (RVM App)	To manage volunteers and resources that civil society provides to the Department of Emergency Situations. It allows inventory management of available resources and the status of volunteers organized on distinct specializations.	Emergency organizations, authorities and civil society			X		X	X			X	X	X
	Heat warning mobile APP	To improve population awareness on health risks associated to heat waves and improve adaptation and response.	Authorities and civil society	X	X		X	X	X	X	X	X	X	
	Evapp	To improve survival and outcome in cardiac arrest patients.	Emergency organizations and civil society	X						X	X		X	



	Solution	Aim/description of the solution	Interacting entities	Interaction purposes								Crisis Phase		
				Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis
	The French Citizen Responder service (Citizen responder)	To improve the critical emergencies handling by locating and alerting citizen responders	Emergency organizations and civil society	X	X								X	
	112-app	To keep citizens updated of events nearby. People in distress can call 112 from the 112-app and their location will be presented for the call taker.	Emergency organizations and civil society	X	X	X	X			X	X	X	X	X
Platforms	National Emergency Preparedness Platform (fiipregatit.ro)	To provide extensive information to the population regarding various types of risks. The information is provided based on multiple guidelines with the same structure.	Emergency organizations and civil society	X	X	X	X					X	X	X
	30days30waysUK	To Inform and engage the public towards personal and community resilience.	Emergency organizations, authorities and civil society	X	X	X	X	X	X	X	X	X		
	CIM - Crisis Information Management	Standard tool for emergency preparedness and crisis management in Norwegian municipalities. It enables for information logging, information sharing, notification and mobilization of citizens and other preparedness organisations.	Emergency organizations, authorities and civil society	X	X	X	X	X				X	X	X
	RoHelp	To help organizations collect the resources they need. To be used by all organizations which are actively involved in halting the spread of Covid-19. The platform will help you find the most pressing needs that organizations face across the country.	Authorities and civil society	X	X	X		X				X		



	Solution	Aim/description of the solution	Interacting entities	Interaction purposes								Crisis Phase			
				Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis	
Alert systems	Ro-Alert System	To send Cell Broadcast messages to warn and alert citizens in case of emergency	Emergency organizations, authorities and civil society	X	X		X	X					X	X	
	Traveler Alert	To offer government agencies the ability to identify citizens travelling abroad to assist them before, during and after disasters by providing useful information with trusted and reliable guidance and in their national language.	Authorities and civil society	X	X			X				X	X	X	X
	Public warning systems, multichannel approach including alerts to people's phones	To quickly alert of a current or upcoming threat and also to give instructions during a crisis on how the population should act in order to stay safe. Two technologies make it possible to reach everyone: Cell Broadcast and Location-based SMS.	Emergency organizations, authorities and civil society	X	X		X	X					X	X	X
Awareness and training sessions	Be Ready Caravan	Consists of moving a mobile training center where training courses are organized for the population to provide first aid in emergency situations.	Authorities and civil society	X	X		X	X			X		X		
	Awareness interviews	To educate and Increase the awareness of problems faced by certain groups of society	Emergency organizations, authorities and civil society	X	X	X	X	X	X	X	X	X	X	X	X
	National Campaign of Information and Preparedness	"Don't Shake At Earthquake" - campaign related to earthquakes (preparedness, behavior change, how to react in different places)	Authorities and civil society	X	X		X	X					X		



	Solution	Aim/description of the solution	Interacting entities	Interaction purposes								Crisis Phase		
				Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis
	Educational Campaign	To inform the population regarding the risks related to food allergies (mainly for children), but also how and when to use epipen adrenalin auto-injector	Emergency organizations and civil society	X	X		X	X		X		X		
	Awareness Campaign related to Fire Risk	To make aware the population about the risks they face at their homes, mostly fires, explosions and improvisations that can create victims and damages	Emergency organizations and civil society	X	X		X	X		X		X		
	Civil Protection informative campaign on natural disasters "To non rischio" in Italy	To raise awareness and improve knowledge basis and promote best practice response measures for citizens	Emergency organizations and civil society	X	X		X	X				X	X	
	EU modex	To test emergency services capabilities and interoperability, enhance society risk awareness, improve the population trust towards authorities and emergency services	Emergency organizations, authorities and civil society	X	X	X	X	X	X		X	X		X
	Providing information on the risks in your area and the main self-protection measures	To increase the resilience of the population getting involved in their self-protection and avoid collapsing the emergency services in moments of impact through neighborhood associations and communities.	Emergency organizations and civil society	X	X	X	X	X	X		X	X		
Services to reach the society	EKINBIDE	Service responsible for receiving, studying and responding to complaints, comments and suggestions for improving the public security system and the services provided to citizens	Emergency organizations, authorities and civil society	X	X	X	X	X	X	X	X	X	X	X



	Solution	Aim/description of the solution	Interacting entities	Interaction purposes									Crisis Phase		
				Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis	
	BILTZEN	The integration and enjoyment of the rights of citizenship by all persons resident in the Basque Country, regardless of their racial and/or ethnic origin, language, religious affiliation, etc.	Emergency organizations, authorities and civil society	X	X	X	X	X	X	X	X	X	X	X	
	Red Cross Preparedness Guard	A regional list (digital) of persons with various competencies or resources to contact in case of a crisis. It uses available resources among citizens not volunteering on a fixed basis, but can be mobilized in acute situations.	Emergency organizations and civil society			X		X		X		X	X	X	
	The main two-way communication tool: 113 number	To provide a link for communication between the public and authorities and has played an important role in events like big forest fires and now, covid-19.	Emergency organizations and civil society	X	X		X					X	X	X	
	Nixle	To keep citizens updated with relevant information from local public safety departments & schools	Emergency organizations, authorities and civil society	X	X	X	X	X	X	X	X	X	X	X	
	Use of volunteers in cooperation with professional emergency teams	To reduce crisis for society and population. Help and prevent human suffering and loss.	Authorities, volunteers, and civil society	X	X	X		X	X		X	X	X	X	
Social media channels	Twitter, Instagram accounts, Facebook, awareness	To communicate with the public on a day to day basis and also during an emergency or disaster providing some advice to the public.	Emergency organizations, authorities and civil society	X	X	X	X	X	X	X	X	X	X	X	



	Solution	Aim/description of the solution	Interacting entities	Interaction purposes								Crisis Phase			
				Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis	
	VOST (Virtual Operations Support Teams): managing the information gathered through different social media channels	To help emergency response organisations by taking over their communication with the public during emergencies by monitoring and collecting online information, filtering, evaluating it and forwarding it to through a Person of Contact (POC). Also to share useful information with citizens & amplify dissemination of key messages.	Emergency organizations and civil society	X	X		X	X					X	X	X
Guidelines	Volunteer involvement	How to put people first: complementing and assisting communities in their own efforts, respecting local ownership, ensuring the needs are met, prioritising the most vulnerable people, improving partnership with other actors.	Authorities, volunteers and civil society	X	X	X	X	X	X	X	X	X	X	X	X
Disaster management plans	Heat Health Action Plan	To improve awareness and reduce heat related health impacts	Emergency organizations, authorities and civil society	X	X	X		X	X	X	X	X	X	X	
	The regional plan on prevention and active fight to forest fires in Lazio region (one central region of Italy)	To coordinate the prevention through summer surveillance of wild and green areas, and help in case of active fire	Emergency organizations, authorities and civil society	X	X	X		X	X		X	X	X	X	
	Snow Emergency plan of the Rome municipality	To be prepared to handle snow events in the center and south of Italy	Emergency organizations, authorities and civil society	X	X	X		X	X		X	X	X	X	



9.7 SOLUTIONS COLLECTED FROM END-USER WORKSHOP

Table 18 shows the solutions collected from the end-user workshop conducted with the partner end-users of the ENGAGE project. The solutions have been classified into the following solution types: apps, platforms, alert systems, awareness and training sessions, services to reach society, social media channels, guidelines, and disaster management plans and strategies.



Table 18: Solutions collected from the End-user workshop with partner end-users

Solution type	Solution	Aim/description of the solution	Interacting entities	Interaction purposes								Crisis Phase			
				Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis	
Apps	Food search App	Using a food search and reach App A mobile phone App should receive requests only from registered users while answers can be provided by everybody in the community and by food grocerys	Authorities and civil society			X	X			X				X	
	SoMe	Use of SoMe and web Volunteers do shopping/deliver food to beneficiaries	Volunteers and civil society	X		X				X				X	
Platforms	Information education and	Information regarding ongoing situation (SoMe, web). Offer the population knowledge on self-preparedness, first aid and infection control - digital courses. Cooperation between governmental authorities and volunteer organisations	Authorities and civil society	X	X		X	X	X			X	X	X	
	Filing of Reports	Law Enforcement field agents will fill reports on what they are witnessing in the streets in order to translate this info eventually to decision makers and seek for more efficient measures from a top down approach	Emergency organizations, authorities and civil society	X	X		X							X	
Awareness and training sessions	Citizen Patrol Awareness Campaign	Direct contact with citizens with use of loud speakers in areas of high density population	Emergency organizations and civil society	X										X	
	Covid information emphatic	Testimonials from covid survivors or relatives of died persons collaborate in information campaign raising awareness in	Authorities and civil society	X	X		X			X				X	



Solution type	Solution	Aim/description of the solution	Interacting entities	Interaction purposes									Crisis Phase		
				Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis	
		the need to calm people and do rational choices. Expert communicators, scientific journalists and psychologist are involved in defining contents and means.													
	Daily briefings	Daily briefings on interpretation of the situation and assumptions on how measures will improve the situation	Authorities and civil society	X	X		X							X	
	Provide information	Informing the public about the current situation and what Resources are working with this. Also, try to visualize the extent that the Resources are used. For example, "99% of nurses are occupied with managing patients."	Authorities and civil society	X	X	X	X							X	
	Communicate de-escalation	Communicate de-escalation of efforts and restrictions When whatever measures are implemented they should be time limited (known time) and/or tied to an outcome a measurement. They should be removed in a stepwise manner and relate to fulfillment of the outcome goals.	Authorities and civil society	X	X		X	X		X	X				X
	Reassurance by giving valid information	Valid information should be given to the population.	Authorities and civil society	X	X		X	X						X	
Services to reach the society	Open interaction with opposing forces	Identify strong voices of belligerent opposition in open communication in public forums. Admit fault if true, and explain that further aggressive / destructive actions aggravates the situation and that even less	Authorities and civil society	X			X		X		X		X		



Solution type	Solution	Aim/description of the solution	Interacting entities	Interaction purposes								Crisis Phase			
				Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis	
		people can get much needed aid in that way.													
Social media channels	Social Media channels	Do not solely rely on press conferences or web pages. Make sure to directly involve influencers with different backgrounds to spread abbreviated texts in their channels. Unify them and their followers.	Authorities and civil society	X	X		X			X					X
Disaster management plans and Guidelines	Principle of proximity police	Our task as law enforcement agents tries to be pedagogical before adopting coercive measures like sanctions, complaints, reports. One to one conversation with citizen	Emergency organizations, authorities and civil society	X	X								X		X
	Proportional use of Force	We are always having in mind that the chaos is created by people in real need. In this case relation with citizens will be comprehensive and use of force as the last resource.	Authorities and civil society								X	X			X
Disaster management plans and strategies	Point of Care (PoC)	Use of volunteer organizations as PoC: Example: The Red Cross used gift certificates that was handed out to public in need of money/food as an opportunity to get in touch with agitated people. That made us able to reassure and calm the public.	Authorities, volunteers, and civil society			X	X			X					X
	Step by step de-escalation	Develop a step by step de-escalation process based on triggers	Authorities and civil society				X					X	X		
	Central coordination	Central coordination, specific funding and means (e.g. for food transportation) volunteers need to be coordinated with institutional efforts	Authorities and volunteers			X	X	X				X			X



Solution type	Solution	Aim/description of the solution	Interacting entities	Interaction purposes								Crisis Phase			
				Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis	
		specific funding to reimburse their deliveries (e.g. fuel) specific means (mobile phones, autocar for food transportation) specific training to deal with stressed persons lacking with primary food													
	Shortage of combustible	Governmental rationing supply of the combustible	Authorities and civil society			X	X				X		X		
	Prioritization of combustible	Prioritized quota of combustibles	Authorities and civil society			X	X	X			X		X		
	Use existing volunteer organizations	Use existing organizations of volunteers . For example, the Red Cross, Missing People, etc	Authorities, volunteers, and civil society				X	X	X		X		X		



9.8 SOLUTIONS COLLECTED FROM KI-CoP WORKSHOP

Table 19 shows the solutions collected from the KI-CoP workshop conducted with the external end-users who are part of the KI-CoP of the ENGAGE project. The solutions have been classified into the following solution types: apps, awareness and training sessions, services to reach society, social media channels, guidelines, and disaster management plans and strategies.



Table 19: Solutions collected from the KI-CoP workshop

Solution type	Solution	Aim/description of the solution	Interacting entities	Interaction purposes								Crisis Phase		
				Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis
Apps	Create tools to control the fake news like NewsBrief	Provide the correct tools to survive in the pandemic.	Authorities, emergency organizations and civil society	X	X	X					X		X	
	Return to campus app (Everbridge)		Authorities and civil society				X			X			X	
Awareness and training sessions	Targeting the people	Targeting the people, dividing them in subgroups and work on their specific needs	Emergency organizations and civil society	X					X				X	
	Communication not only focused on health	Example: Red Cross COVID information, addressing also mental health, social life, etc.	Authorities and civil society	X				X		X			X	
	Explaining measures	Start explaining why certain measures have to be taken. This will improve your support base.	Authorities and civil society	X	X		X		X		X		X	
	Keeping the population informed	When population is given information, their behavior improves, they respect sanitary measures.	Authorities and civil society	X	X		X				X		X	
	Provide information about uncertainties	We have to prioritize info about citizens' uncertainties and monitor how the perception is changing to evaluate message efficiency and to readapt them if necessary.	Authorities and civil society	X			X				X		X	
	Dealing with: People less willing to follow guidelines	a. Adapting the guidelines make them clearer and more logical. b. Lead by example - make sure all formal and informal leadership, volunteers, public works people, anyone you can convince or	Authorities and civil society	X			X				X		X	



Solution type	Solution	Aim/description of the solution	Interacting entities	Interaction purposes								Crisis Phase		
				Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis
		enforce to show an example. Analyze the information consumption patterns of each segment and sub-culture of population and identify the best influencers. c. Instead of putting together health administrators to work out the problem in hand put together a group of best marketing people in the country.												
	Dealing with: People against protest vaccinations	Being open about risks, advantages, necessities and uncertainties while maintaining vaccination requirements for social participation.	Authorities and civil society	X			X			X	X		X	
	Dealing with: False news can be spread	It is important that the population receive information from someone they trust, preferably via text message from their private doctor or local authorities	Authorities and civil society	X			X		X		X		X	
	Information strategy	Most of the essential information and communication should take place locally, via local authorities.	Authorities and civil society	X			X				X		X	
Social media channels	Social media channels to communicate with youths	Using popular social media channels to communicate with youths. Reach out to youths on the channels that they use.	Authorities and civil society	X							X		X	
	Fake news detection	One must locate those who spread false news and incorrect information, and make them aware of their responsibilities.	Authorities and civil society	X							X		X	
Guidelines	Communication from official source	Communication from official source to avoid misinformation	Authorities and civil society	X			X		X		X		X	
	Enhanced cooperation with civil society	At national or local level. There are difficulties at local level	Authorities and civil society						X		X	X		
	Emotional context	Large emergencies have a significant emotional impact on the population that	Authorities and civil society	X			X		X	X	X		X	



Solution type	Solution	Aim/description of the solution	Interacting entities	Interaction purposes								Crisis Phase			
				Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis	
		can affect how the facts are perceived and even their critical thought surrounding the circumstances. Regular communication techniques are no longer effective. Large emergencies require immediate reaction transparency, understandable, precise, relevant, suitable timeline information.													
Disaster management plans and strategies	Unify communication efforts	Unify communication efforts, make people realize that first responders, governments are all on the same line	Emergency organizations, authorities and civil society	X								X	X		
	Focus on inclusion	Need to address vulnerable groups, different means to reach them	Authorities and civil society						X	X	X		X		
	Use local community organization leaders	Use local community organization leaders as role models and mediators for raising awareness Local authorities identify e.g. religious leaders, minority representatives, different NGOs and establish information strategies that they will integrate/communicate with their members.	Authorities and civil society	X	X					X		X	X		
	Dealing with: Resource-poor groups	Elderly people, pregnant women and other vulnerable groups need to be reassured by people close to them. One must avoid that any riots create unnecessary fear among resource-poor groups.	Authorities and civil society							X	X	X		X	
	Develop incentive system for testing and vaccination	Develop incentive system for testing and vaccination. Incentive citizens for testing for corona virus, so that authorities could detect cases despite lower risk awareness and compliance with test regimes. Similar could be done for vaccination.	Authorities and civil society	X	X							X	X	X	



Solution type	Solution	Aim/description of the solution	Interacting entities	Interaction purposes							Crisis Phase			
				Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis
	Volunteers to organize logistics of care	Support medical services with volunteers to organize logistics of care (vaccination, waiting lines, enforcing hygiene measures).	Authorities, volunteers, and civil society			X			X	X	X		X	



9.9 SOLUTIONS EXTRACTED FROM THE SEMI-STRUCTURED INTERVIEWS

Table 20 shows the solutions extracted from the analysis of the semi-structured interviews conducted with the external end-users. The solutions have been classified into the following solution types: apps, alert systems, messaging apps, call centers, media, social media channels, awareness campaigns, school campaigns, community relations, guidelines, and volunteers management.



Table 20: Solutions extracted from the semi-structured interviews

Solution type	Solution	Aim/description of the solution	Interaction purposes								Crisis Phase		
			Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis
Apps	My EMS	an app for communication and information sharing	X			X						X	
	Epidemiological diary	an app for the public to list all the people they see daily, so if they do not feel well, they can notify them before making the corona test. To make sure that they will not meet other people before they let them know whether they are positive or not				X			X	X		X	
	App for dealing with allergies	A program that connects people with EpiPen to people with allergies. Suppose they receive information about someone with an allergic attack that needs EpiPen. In that case, they can send a message to the closest person with EpiPen, to ask him to use it on that other person and then provide him with a new EpiPen instead. But they do not yet have enough registers. They haven't published it yes in a significant way.			X	X			X	X		X	
	"city-connect" (in Hebrew)	Municipalities use this app to distribute information for the public according to the specific area in which they reside and they allow them to distribute also information bottom-up.	X			X				X	X	X	X
	municipality mobile app					X					X	X	X
	Police mobile app			X			X					X	
	App for dealing with crowded areas	During covid-X9: reporting on the app for crowded parties				X							



Solution type	Solution	Aim/description of the solution	Interaction purposes							Crisis Phase		
			Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis
	BeReady Caravan	trains people in both urban and rural areas, Be-Ready portal that is constantly updated with various guides related to different types of risk – it has been used quite a lot during the pandemic as we launched a series of guides on how to behave during the pandemic based on particular scenarios,		X		X				X		
	DSU App	Is accessed by more than X million people and contains useful information on risk prevention and management.		X						X		
	App for alerting people	to send the alerts and share emergency plans		X		X				X	X	
	MyXX2, AlertaCops, XX2SOSDeiak.	apps for the society to communicate with the emergency services	X			X				X	X	X
	krisinformation.se	established crisis websites		X						X	X	
	Corona Dashboard	We have developed an infection control dashboard (Corona) on our website where we communicate the development in infection. Here you can access different geographical areas and monitor trends in the areas you are interested in, at the district level for the whole Norway. The dashboard is actively and daily used by the media.										
Platform	Web pages of the municipality.			X		X				X	X	



Solution type	Solution	Aim/description of the solution	Interaction purposes								Crisis Phase			
			Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis	
Messaging apps	Whatsapp, telegram	These apps could be used either among decision makers, or among decision makers and the population	X	X		X						X	X	X
	Alert systems	text messages		X									X	
	Sirens	Using "sirens/typhoons" to notify the population to seek further information during a crisis.		X									X	
Call centers	Covid Call center	For information and questions regarding the Corona virus situation. They gave information and instructions to people, such as when to quarantine themselves, what to do if they have symptoms. The call center made phone "triage."		X						X			X	
	Police hotline (X00)					X							X	
	Information hotlines	This line is not for emergencies, but for information. This is also very effective because it reduces the number of non-emergencies calls for the emergency line				X							X	
	emergency call center					X							X	
	Emergency reporting service XX3	The emergency central have a questionnaire (43 pages) with questions that are asked while emergency response team is sent. Answers may be both verified and not, but everything is recorded.			X						X		X	X
	Operation center				X	X							X	X



Solution type	Solution	Aim/description of the solution	Interaction purposes								Crisis Phase			
			Improve communication	Enhance Risk awareness	Facilitate resource allocation	Improve knowledge and information sharing	Enhance preparedness	Capitalize social networks & relationships	Improve health and mental outlook	Empower governance and leadership	Before the crisis	During the crisis	After the crisis	
	Emergency service hotline (XX2)					X						X		
Awareness campaigns	self-readiness campaigns	self-readiness campaigns		X			X					X		
	campaigns of awareness	campaigns to inform people about how to deal with crises. These campaigns are developed in neighbors, schools, retired people, etc.		X								X		
School campaigns Media	Brochures and newsletters	Sharing information through brochures and newsletters		X		X						X	X	X
	Press conferences.			X		X							X	X
	Information boards in stores			X		X							X	
	Radio		X	X		X					X	X	X	
	Newspapers and TV		X	X		X					X	X	X	
	Webinars about Covid	Webinars held by the EMS. Many people watched them and participated by asking questions in Q&A sessions. This helped the organizers to know what kind of information the public are interested in, and how they can adapt solutions to these questions.		X		X				X			X	
	Debriefing meeting	Debriefing meetings to gather lessons learned.		X		X				X				X
School campaigns	Firefighters recruitment	when it comes to staff recruitment, we go in high school and present the educational offer for a			X		X				X			



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		military career as a firefighter. Students show their interest in pursuing this career path.											
	School training campaigns	"teach students how to perform CPR, what to do in a terrorist attack.		X			X		X	X	X		
	Currently there are some risk awareness and training campaigns:			X							X		
Social media channels	Accounts on Facebook, Tiktok, Twitter, Instagram and Youtube	These could be used to share information or gather information through public posts and commetns	X	X		X				X	X	X	X
Community relations	Colloboration with other emergency organizations				X		X			X	X	X	X
	Relationships with opinion leaders	They maintain a routine relationship with religious leaders, Arab leaders and other opinion leaders that can help in crises.	X			X				X	X	X	X
Guidelines	Action protocol in case of a terrorist attack. "Protocolo Ibero"		X	X	X	X	X	X	X	X	X	X	X
	Norwegian Index for emergency call service		X	X				X		X			
	Guidelines of how to act in case of an emergency, for example control of the hemorrhage			X			X		X		X	X	
	MSB shares guides about how to handle a crisis			X			X				X		
Volunteers management	Corona loyals	EMS trained what they defined as "corona loyalists", who were in charge of mediating the information for community members.		X		X	X		X			X	



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	the community emergency and resilience team	In the rural municipalities in Israel, they have what they call "the community emergency and resilience team". It works better, in rural municipalities than in big cities. They include volunteers from the community that helps in facilitating crises and in helping making the community ready for the disaster before it – and after.					X			X	X	X	X
	Volunteer groups									X		X	X
	Community patrols	Community patrols formed from volunteers to help the police								X		X	X
	Volunteers from passion	A program that aims to increase resilience at the community level by training paramedics. In this way, the volunteers involved can become small ambassadors of their community. It started as a pilot project and evolved on a very large scale (allowing to periodically enroll people, from youth to people coming from different socio-professional categories). This program also indicates our success.					X			X	X		
	Location-based messaging for volunteers					X				X		X	

