



IMPROVED RISK EVALUATION AND IMPLEMENTATION OF RESILIENCE CONCEPTS
TO CRITICAL INFRASTRUCTURE

A Communication Strategy to build Critical Infrastructure Resilience

Dr Elisa Serafinelli¹
Dr Paul Reilly¹
Rebecca Stevenson¹
Laura Petersen²
Laure Fallou²
Elisabete Carreira³

1. University of Sheffield, UK
2. EMSC, Paris
3. INOV, Lisbon

Deliverable Number: D4.2
Date of delivery: May 31, 2017
Month of delivery: 24



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 653390

Coordinator:	David Lange at SP Sveriges Tekniska Forskningsinstitut (SP Technical Research Institute of Sweden)
--------------	---

Table of Contents

1	Executive Summary	3
1.1	Guidelines	3
1.2	Communication Strategy Flow chart	5
2	Nomenclature	6
3	Introduction	8
3.1	Deliverable Description	8
3.2	Methodology and Approach	9
3.2.1	Sample and update on data collection	11
3.2.2	Limitations	11
3.3	Organisational and Social Resilience concepts	11
4	Traditional Media, Crisis Communication and Disaster Resilience	14
4.1	Public expectations of crisis information	14
4.1.1	Method of communication	15
4.1.2	Content of crisis communication	15
4.1.3	Frequency of communication	16
4.2	Crisis communication and traditional media	17
4.2.1	Traditional media as a trusted source	17
4.2.2	Traditional media as a resilient source of information	17
4.2.3	Representation in traditional media	18
4.3	Impact of crisis communication upon behaviours of citizens	18
4.3.1	Traditional media and community resilience	18
4.3.2	Sensationalist framing of disasters	19
4.3.3	Emotional framing of disasters	20
4.3.4	Traditional media and disaster resilience	21
5	Social Media, Crowdsourcing and Disaster Response	23
5.1	Social media as source of crisis information	23
5.2	The problem of ‘Big Data’	24
5.3	Credibility of online information	25
5.4	Organisational limitations	26
5.5	Crowdsourcing crisis information online	27
5.6	Real-time information provision during disaster response	28
5.7	Ethical challenges of using social media during disasters	31
5.8	Social media as a tool for building disaster resilience	34
6	AESOP Guidelines for effective communication between critical infrastructure operators and members of the public during crisis situations	36
6.1	Engage key stakeholders in order to ensure message consistency across traditional and social media platforms	38
6.2	Social media should be used to provide real-time updates to citizens about ongoing efforts to restore services	39
6.3	Observe and adhere to context-specific regulatory frameworks for emergency management and resilience	41
6.4	Post-disaster learning should be employed in order to enhance and develop future communication strategies	44
7	Communication strategy flowchart for critical infrastructure operators	46
7.1	Mitigation	46

7.2	Preparedness	47
7.3	Response	48
7.4	Recovery	49
8	Conclusion	51
9	References	52
10	Appendices	64
10.1	Appendix 1: Background on case studies	64
10.2	Appendix 2: Interviews and Focus Groups: Explore the role of social media in building community resilience	65
10.3	Appendix 3: List of questions	67

1 Executive Summary

This report contributes to the IMPROVER project by providing information on the use of traditional and social media by relevant stakeholders to increase the resilience of critical infrastructures. It builds on the results of IMPROVER project D4.1 to explore the communication practices adopted by emergency managers and blue light organisations (e.g. police, fire and rescue services) to reduce uncertainty and panic amongst disaster-affected populations at each stage of an incident (see section 5 - mitigation, preparedness, response, recovery). The potential use of traditional media and social media to share and spread information is examined with a view to identifying the key components of effective crisis communication for critical infrastructure operators during such incidents. The identification of effective communication tactics is a necessary corollary for building resilience not only within critical infrastructure operators, but also amongst those communities who rely on their services every day.

This report begins by providing an overview of the key themes in the literature on traditional media, crisis communication, and disaster resilience. It considers the extent to which the connective affordances of social media sites such as Facebook can be leveraged by emergency managers in order to crowdsource crisis information; as well as the ethical challenges posed by such practices. Then, it presents key findings from the thematic analysis of 31 interviews conducted with key stakeholders (including emergency managers, representatives of critical infrastructure operators, community leaders and professional journalists) between November 2016 and January 2017. In addition, the report draws on lessons learnt from two recent incidents in which traditional media and social media were said to have contributed to disaster resilience within countries represented in the project consortium.

These were:

- 1- Floods in Porto and Coimbra, Portugal (January-February 2016);
- 2- Paris terrorist attacks, France (November 2015).

1.1 Guidelines

The report proposes a set of guidelines for critical infrastructure operators to communicate effectively with members of the public during a major incident or disaster. These guidelines, which we refer to as AESOP, were:

- 1- Analyse the information-seeking behaviours of local populations before deciding which media channels to deploy during disasters;
- 2- Engage key stakeholders in order to ensure message consistency across traditional and social media platforms;
- 3- Social media should be used to provide real-time updates to citizens about ongoing efforts to restore services;
- 4- Observe and adhere to context-specific regulatory frameworks for emergency management and resilience;

5- Post-disaster learning should be employed in order to enhance and develop future communication strategies.

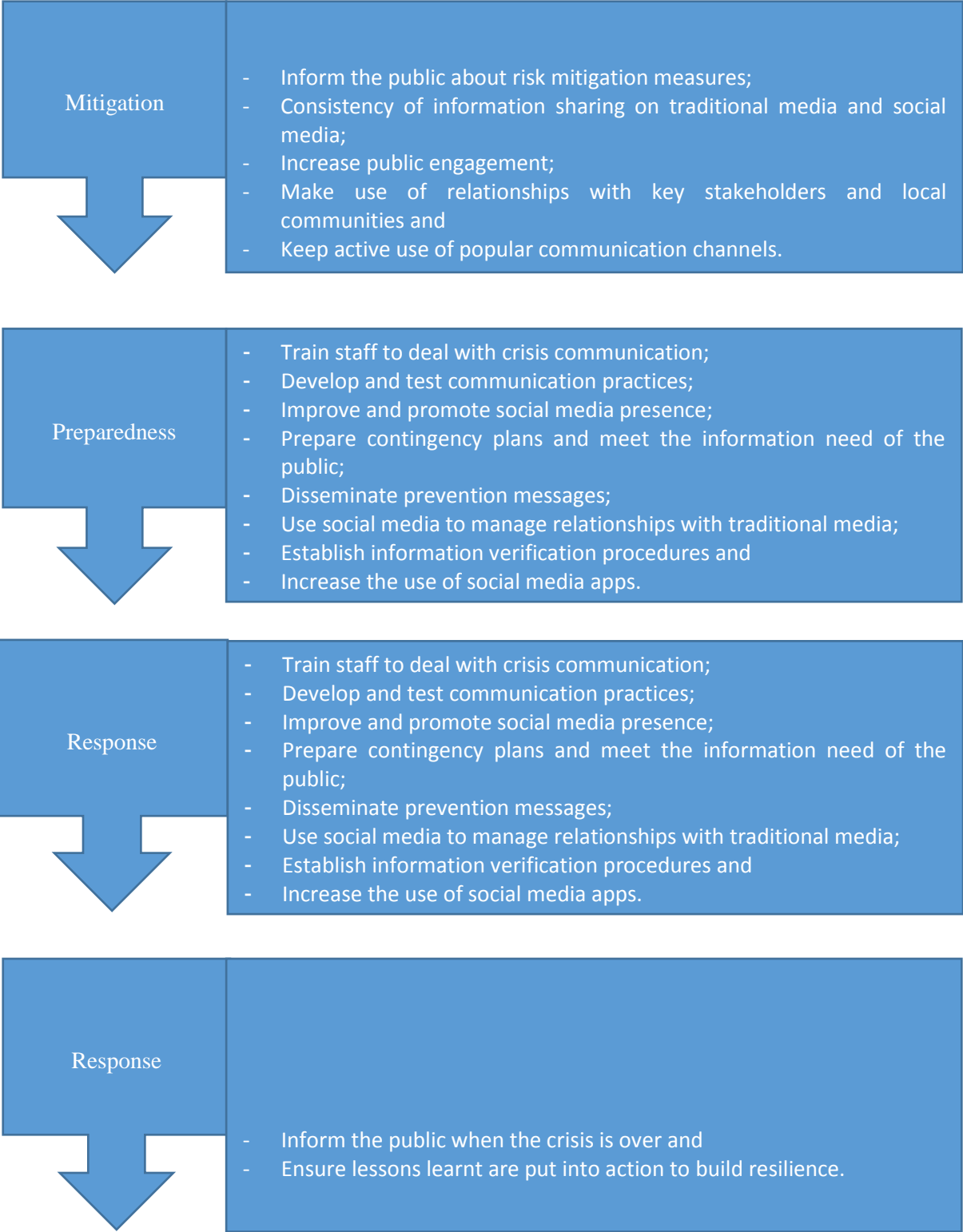
These guidelines should inform the communication practices of critical infrastructure operators at each stage of a disaster (mitigation, preparedness, response, recovery). Building on previous work conducted by the research team (Reilly & Atanasova, 2016), the proposed tactics build on existing best practices in the fields of both crisis and risk communication, with a view to establishing the most appropriate channels to be deployed during such incidents. A particular focus of these guidelines is how information shared via traditional media and social media can help build resilience in critical infrastructures, as well as the communities they serve.

Key Recommendations include:

- 1- Frequency of information: Critical infrastructure operators should frequently share information with the public about ongoing efforts to restore critical services and that there are no other updates available;
- 2- Clarity in crisis communication: Simple, easy to understand messages should be used in all communications in order to build critical infrastructure resilience and manage expectations of disaster-affected populations;
- 3- Consistency of communication through different channels (both traditional media and social media): Using a combination of media allows critical infrastructure operators to reach a wider audience making sure that the same crisis information is available to different target population;
- 4- Work with key stakeholders to ensure that information shared between critical infrastructure operators and emergency management organisations is accurate: Critical infrastructure operators should create and maintain active communication with emergency management organisations, news media operators and the general public to ensure efficacy of crisis information flow.

1.2 Communication Strategy Flow chart

A communication flow chart (see below) was created to explore the communication tactics that are applicable during each of the four phases of a disaster (mitigation, preparedness, response, and recovery).



2 Nomenclature

Asynchronous channels	Communication channels characterised by separation of message exchange by time and space e.g. e-mail ¹ .
Community resilience	Resilience refers to the existence, development, and engagement of community resources by community members to thrive in an environment characterized by change, uncertainty, unpredictability, and surprise ² .
Critical infrastructure	Asset, system or part thereof located Member States which is essential for the maintenance of vital societal functions, health, safety, security, economic or social well-being of people, and the disruption or destruction of which would have a significant impact in a Member State as a result of the failure to maintain those functions ³ .
Digital media	Any media that are encoded in a machine-readable format and can be created, viewed, distributed, modified and preserved on computers.
Disaster resilience	The ability of communities to ‘learn from and adapt to the changed realities that the disaster may cause’ ⁴ .
‘hard’ resilience	The community’s ability to thrive in contexts of change ⁵ .
JESIP	Joint Emergency Services Interoperability Programme ⁶ .
Organisational resilience	Organizational resilience is the ability of an organization to anticipate, prepare for, and respond and adapt to incremental change and sudden disruptions in order to survive and prosper ⁷ .
Resilience	A common view of resilience is to understand it as bounce back or recovery to previous or normal activities after a disturbance ⁸ .

¹ Verderber, K. S., Sellnow, D. D. & Verderber, R. F. (2015). *COMM*³. Stamford, CT: Cengage Learning.

² Magis, K. (2010). Community Resilience: An Indicator of Social Sustainability. *Society & Natural Resources: An International Journal*, 23(5), 401–416.

³ European Council (2008): Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection. 23.12.2008 Official Journal of the European Union, L345, 75–82.

⁴ Ibidem.

⁵ Magis K. (2010): Community Resilience: An Indicator of Social Sustainability, *Society & Natural Resources*, 23:5, 401-416, DOI: 10.1080/08941920903305674.

⁶ <http://www.jesip.org.uk/home>

⁷ BS 65000:2014 Guidance on organizational resilience.

A Communication Strategy to build Critical Infrastructure Resilience

Situational awareness	The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future ⁹ .
Social resilience	Ability of human groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change ¹⁰ .
Social media	The collection of software that enables individuals and communities to gather, communicate, share and in some cases collaborate or play ¹¹ .
‘Soft’ resilience	The ability of an organisation to survive certain disturbance or shock ¹² .
Synchronous channels	Communication channels which allow for message exchange in ‘real time’ e.g. telephone calls ¹³ .
Traditional media	Media introduced before the advent of the internet that are for the purposes of mass communication e.g. billboards, magazines, newspapers, radio and television broadcasting ¹⁴ .
User generated content	Content created by social media users rather than journalists/editors ¹⁵ .

⁸ Theocharidou M., Melkunaite L., Eriksson K., Winberg D., Honfi D., Lange D., Guay F., & Lin L. (2016): D1.3 Final lexicon of definitions. IMPROVER project. Deliverable 1.3.

⁹ Endsley M. R. (1998): A comparative analysis of SAGAT and SART for evaluations of situation awareness. In Proceedings of the Human Factors and Ergonomics Society 42nd Annual Meeting (pp. 82-86). Santa Monica, CA: The Human Factors and Ergonomics Society.

¹⁰ Adger, W. N. (2000b). Social and ecological resilience: are they related? *Progress in Human Geography*, 24(3), 347–364.

¹¹ boyd d. (2009): ‘Social media is here to stay... now what?’ Available at: <http://www.danah.org/papers/talks/MSRTechFest2009.html> (accessed 24 September 2016).

¹² Mallak L. (1998): Putting Organisational Resilience to Work. *Industrial Management*, 40(6), 8–13.

¹³ Verderber K. S., Sellnow D. D. & Verderber, R. F. (2015): *COMM*³. Stamford, CT: Cengage Learning.

¹⁴ Lee F. L.F., Leung, L., Qiu, J. L. & Chu, D. S. C. (2013): *Frontiers in New Media Research*. New York: Taylor & Francis.

¹⁵ boyd d. (2009): ‘Social media is here to stay... now what?’ Available at: <http://www.danah.org/papers/talks/MSRTechFest2009.html> (accessed 24 September 2016).

3 Introduction

Critical infrastructures invariably bear the brunt of human-made and natural disasters. In these emergency situations crisis communication plays an important role in enhancing resilience because it aims to set communicative channels between critical infrastructure operators and the public. Within European member states, as discussed in IMPROVER project D2.2, countries and infrastructures in both normal operating systems and in the event of an incident are increasingly developing methodologies for measuring resilience (Pursiainen et al., 2016) and for implementing resilience concepts (Melkunaite et al., 2016). There remains no common approach towards the measurement of resilience within the European Union with member states and sectors choosing to use their own methodologies. There is also no shared, well-developed system-of-systems approach, which would be able to test the effects of dependencies and interdependencies between individual, critical infrastructures and sectors. This increases the risk as a result of resilience on critical infrastructures, as well as affects the ability for sharing resources for incident planning or means of expressing risk.

Both traditional and social media are components of the information and communication ecosystems that citizens access on a daily basis. This condition generates the expectation to use information and communication technologies even in relation to emergency situations. The frequency with which human-made and natural disasters have disrupted modern societies has led to a renewed focus on how information and communication technologies can be deployed by key stakeholders in order to enhance critical infrastructure resilience. Past events showed how information and communication technologies played an important role in emergency situations, because they demonstrate how effective information sharing can improve community resilience. Regarding this, recent studies report that the combined use of traditional and social media by emergency managers to share information with disaster-affected populations can increase disaster resilience within their respective areas (Oh et al., 2013). This tendency brings our focus on how the concept of resilience can be applied within social systems (Adger, 2000). Within this discourse, information sharing does not only refer to the communication between critical infrastructure operators but includes also the information shared with the general public. The public increasingly expect emergency managers to use social media to engage in real-time conversation with a wide expectation of instantaneity of two-ways-communication typical of social media, which includes the use of platforms, websites and apps. Although information and communication technologies (such as social media platforms) appear to offer great potential for such interactions, research indicates that members of the public continue to view traditional media channels (such as television and radio) as the most accurate and reliable sources of disaster information. Therefore, it may be appropriate for key stakeholders such as emergency managers and critical infrastructure operators to adopt a communication mix of both traditional and social media to prepare members of the public for the likely disruption to critical services during such incidents.

3.1 Deliverable Description

This Deliverable is described in the Description of Work (DoW) as: A communication strategy to build critical Infrastructure resilience (based on output from tasks 4.2 and 4.3).

The DoW defines these tasks as:

Task 4.2: Exploring the role of media in building community resilience

This task will focus on how social media and social networking sites (such as Facebook and Twitter) can be used by both communities and emergency services for disaster risk reduction (DRR), promoting shared responsibility in times of crises, increasing disaster preparedness and creating early-warning systems for activation during such events. The task will investigate these issues by reviewing the relevant literature on traditional media, social media and disaster resilience, and presenting the findings from a critical thematic analysis of interviews, focus groups and consultations conducted with key stakeholders (e.g. community representatives, professional journalists, critical infrastructure

A Communication Strategy to build Critical Infrastructure Resilience

operators, and agencies involved in emergency management) to identify best practice in the use of traditional and social media as a tool to increase disaster preparedness.

Task 4.3 Explore the use of social media during disaster response

Building on task 4.2, the information flows that emerge during disasters will be analysed in order to develop a communication strategy, with a particular emphasis on the potential use of traditional media and social media to crowdsource information during incidents, to aid in reducing the response and recovery times and to raise public awareness about the risks associated with these events.

3.2 Methodology and Approach

The key findings and recommendations in this report are based on information gathered from four sources, namely:

- Academic research into social resilience concepts and role of traditional media and social media in emergency management;
- Results of other EU funded research projects in emergency management, resilience and related fields;
- Exploration of two case studies in which traditional media and social media were used during disasters;
- Analysis of semi-structured interviews, focus groups and consultations conducted with key stakeholders (e.g. emergency managers, professional journalists, critical infrastructure operators, and community representatives).

1) Academic research into social resilience concepts and the role of traditional media and social media in emergency management

The first step was to conduct a literature review on social resilience concepts, as well as the role of traditional media and social media in emergency management. Academic databases including Web of Science were used to identify relevant published research in the fields of media and communication, emergency management, and resilience studies. The literature review focused also on the ethical and legal implications of using social media to promote community resilience during crisis situations.

2) Results of other EU funded research projects in emergency management, resilience and other related fields

The publications of other EU funded research projects in the fields of emergency management and crisis communication were also reviewed to explore the social dimensions of disaster resilience. These

included CascEff¹⁶, COMRADES¹⁷, DARWIN HORIZON 2020¹⁸, RESILENS¹⁹, SMR²⁰, RESOLUTE²¹, emBRACE²², COSMIC²³, and driver²⁴. The CORDIS²⁵ directory was also consulted to identify EU funded projects that address these issues.

3) Exploration of two case studies in which traditional media and social media were used during disasters

Increasingly social media have played an important role in disaster information flows over the past decade (Procter et al., 2013; Simon et al., 2015). It has been witnessed that the use of sites (such as Facebook and Twitter) to both push and pull information in disaster-affected regions can help build situational awareness for emergency managers and those agencies charged with disaster response (Vieweg et al., 2008). However, recent research continues to show that traditional media are the most trusted source of information for many citizens during disasters (Stephens et al., 2013). This data shows the necessity to examine both channels of communication.

Two incidents in which both traditional media and social media were said to have enhanced social resilience are examined in the report. These were:

- Floods in Porto and Coimbra, Portugal (January 2016 - February 2016);
- Paris terrorist attacks, France (13 November 2015).

Further information on each of these incidents can be found at the end of this report (see Appendix 1).

4) Focus groups, interviews and consultations with key stakeholders

¹⁶ <http://casceff.eu/>

¹⁷ <http://www.comrades-project.eu/>

¹⁸ <https://www.h2020darwin.eu/>

¹⁹ <http://resilens.eu/>

²⁰ <http://www.smr-project.eu/home/>

²¹ <http://www.resolute-eu.org/>

²² <http://www.embrace-eu.org/>

²³ <http://www.cosmic-project.eu/>

²⁴ <http://driver-project.eu/>

²⁵ http://cordis.europa.eu/projects/home_en.html

A Communication Strategy to build Critical Infrastructure Resilience

A critical thematic analysis of data gathered from interviews and focus groups with relevant stakeholders have been completed between November 2016 and January 2017. We conducted 14 interviews with public representatives, professional journalists and representatives of emergency management agencies in France and Portugal. We included also consultations conducted with 17 critical infrastructure operators from various EU countries. Interviewees were selected on the basis of their experience in emergency management and, in most cases, their involvement in the aforementioned disasters and major incidents.

Ethical approval for the data collection and analysis was granted by the University of Leicester Research Ethics Committee in May 2015, and re-confirmed by the University of Sheffield in October 2016 (See Appendix 2). Focus groups, Interviews (conducted face-to-face, via email/Instant Messenger, Skype or telephone) and consultations were used to investigate stakeholder perspectives on social resilience, with a specific focus on the role of traditional media and social media in emergency management. Three different lists of questions (respectively for: community representatives and community leaders, critical infrastructure providers, member of emergency services and agencies involved in emergency management, and professional journalists) were designed (see Appendix 3). These reflect the different types of individuals who were approached, i.e. a specific list of questions was asked to a specific group of interviewees. Although there were precise lists of questions, follow-up questions were included to stimulate interviewees' responses. A critical thematic analysis was used to explore the themes that emerged from the interviews (Braun & Clarke, 2006). A Research Assistant based at the University of Sheffield, alongside representatives of IMPROVER project partners (INOV and EMSC), were responsible for the transcription and translation (where necessary) of interview data. Two coders at the University of Sheffield read each transcript and compared field notes.

3.2.1 Sample and update on data collection

Participants were recruited with the assistance of IMPROVER project partners and their associates. With the collaboration of INOV we collected 6 interviews in Portugal. With the collaboration of EMSC and UIC we collected 6 interviews from a focus group held in at UIC (Paris on 10th of January 2017), 2 telephone interviews and 17 consultations with critical infrastructure operators from different EU countries.

3.2.2 Limitations

There are two main limitations of this report that should be acknowledged. First, a complete overview of every national resilience and crisis communication framework was not considered neither feasible nor necessary in order to identify the ways in which traditional media and social media can be used by key stakeholders to help build community resilience. Rather, the aim of IMPROVER project D4.2 was to recognise best practices in disaster communication and emergency management, and to reflect upon their implications for disaster resilience. Second, the interpretation of the DoW was that the report would explore what lessons, if any, could be drawn from two case studies. Therefore, it was decided that this report would make a number of recommendations for critical infrastructure operators who wish to provide accurate, effective real-time information to citizens during man-made and natural disasters.

3.3 Organisational and Social Resilience concepts

A univocal definition of "resilience" remains elusive. It can be broadly defined, as discussed in more detail in IMPROVER project D1.1 (Melkunaite et al., 2016) and D2.2 (Pursiainen et al., 2016), as the capacity to bounce-back from external shocks, seeks to secure society from unpredictable systemic shocks by improving the evolutionary capacity, or "fitness", of the population (Zebrowski, 2009).

Although the absence of a unique definition, studies showed that the notion of resilience is generally applied to various sectors that structure the conditions for a system to recover (Melkunaite et al., 2016). Specifically, this report circumscribes its focus on the concepts of social resilience and critical infrastructure resilience; and it uses these concepts to explore the role of traditional media, social media and information sharing in building critical infrastructures resilience.

As discussed in IMPROVER project D1.1 there are not many national, official definition of critical infrastructure resilience (Melkunaite et al., 2016). However, it can be identified as the “coordinated planning across sectors and networks, responsive, flexible and timely recovery measures, and development of an organisational culture that has the ability to provide a minimum level of service during interruptions, emergencies and disasters, and return to full operations quickly” (Australian Government, 2010). From this definition, organisation emerges as an important element that needs to be taken into account in discussing resilience. In fact, “the key to successful resilience is recognised in organisations’ ability to maintain adaptive, proactive and reactive strategies to deal with risks and threats” (Guarascio et al., 2011: 122).

Studies argued that organisational resilience reflects the capacity of organisations to make decisions and take actions in emergency situations (Banahene et al., 2014; Burnard & Bhamra, 2011) emphasising the organisational element of recovering from a crisis. This definition gives special importance to the way in which emergency situations are managed by critical infrastructure operators. This approach includes also the capacity to guarantee an integrated business continuity (Sahebjamnia et al., 2015) and to re-establish minimum acceptable operating levels (Losada et al., 2012). These aspects are discussed in detail in IMPROVER project D4.1 (Peterson et al., 2016). Furthermore, organisational resilience involves the adoption of best practices to provide continuity, embedding competence and capability of critical infrastructure. These conditions can be also facilitated by a “more vertical and integrated management structure that encourages flexibility and adaptation to changing conditions” (Cutter et al., 2008b:604). It is worth noting that all these elements considered in organisational resilience also implicate effective communication and engagement with other systems, such as key stakeholders and members of the general public.

Following these considerations and the importance of including the public in the discourse on resilience, this report focuses specifically on the concept of resilience in relation to communities. As research discussed, the concept of community resilience developed as part of social resilience (Wilson, 2012; Maclean et al., 2014, Keck & Sakdapolrak, 2013). From that starting point three forms of resilience were identified, namely: resistance, recovery and adaptation (Boon et al., 2012). Conceptualising community resilience raises the same concerns as the concept of resilience per se, but resilience in the community brings with it a distinct set of challenges. Much of the recent literature identified in community resilience discusses the ability of communities to recover quickly (Jung & Song, 2015) and bounce forward after a disaster (Houston et al., 2015) emphasising on the collaborative social aspect and reciprocal support (Pfefferbaum et al., 2013; 2015) of these processes.

Community resilience is also widely interpreted as the ability of social systems to respond to and recover from disasters. This include those inherent conditions that allow systems to absorb impacts and cope with events, “as well as post-event, adaptive processes that facilitate the ability of the social system to reorganize, change and learn in response to threat” (Cutter et al., 2008b: 599). In this way, the concept of resilience goes beyond the relationship between organisations, emergency managers, and critical infrastructures including also social communities’ capacity to respond and remain resilient. Within this discourse, community resilience, giving importance to sociality and communication among different agencies, includes the four domains of connection and caring, resources, transformative potential, and disaster management (Pfefferbaum et al., 2013). For example, in the

A Communication Strategy to build Critical Infrastructure Resilience

wake of incredibly destructive events such as Hurricane Katrina (2005), Joplin Missouri tornado (2011), and Hurricane Sandy (2012), the significance of community resilience to natural disasters has been underscored repeatedly showing the importance of addressing the social dimension of resilience. From Carpenter's (2013) contribution, for example, emerges the centrality of the social aspect in promoting resilience among physical and ephemeral contexts. He suggests that this combination has an impact on disaster recovery and the overall community resilience.

Previous research showed the advantages that interactions among various systems (emergency managers, critical infrastructure operators, and community leaders, for instance) have (Norris et al., 2008) in particularly when interpreting the responses of communities to disasters as processes rather than as outcomes. Discussing the advantages of collaboration, Norris et al. (2008) emphasise the importance of information and communication in their model of community resilience, which includes four components: communication systems and resources, community relationships, strategic communication processes, and community attributes. These aspects guide to see the importance of social networks in helping local groups to self-organise, learn and adapt in emergency situations (Berkes, 2004). This idea of adaptive management (Berkes, 2004) combines together the characteristics of *dynamic learning* and *linkage* (author's emphasis) to describe how social communities grow from previous mistakes. Examining the historical records from the Hurricane Betty (1965) to the Hurricane Katrina (2005), for example, it has been observed that the social memory of past disasters successfully enhances resilience (Colten & Sumpter, 2009).

Taking into account these considerations, this report presents the results of research activities carried out under Work Package 4 (WP4) and it is structured as follows: First, the main contribution of this report to the IMPROVER project is to elaborate key recommendation for effective communication. The methodological approach towards the development of AESOP guidelines is also discussed. Section 2 and 3 review respectively the recent relevant literature on crisis communication with particular focus on the employment of traditional media and social media in order to draw the appropriate theoretical framework for the analysis of the lessons learnt from communication practices employed during the two case studies taken into consideration (Floods in Porto and Coimbra, Portugal and Paris terrorist attacks, France). Section 4 presents the AESOP guidelines for effective communication practices between critical infrastructure operators and members of the public during disasters. These guidelines can also be applied to others conceptualisations of disaster cycle. In section 5 a flowchart discusses the various techniques within each of the four stages of the disaster cycle (mitigation, preparedness, response, and recovery). In its conclusions, this report summarises the key point discussed throughout the document.

4 Traditional Media, Crisis Communication and Disaster Resilience

During disasters, the everyday routines that are usually taken for granted are disrupted and the socially constructed view of ‘normal’ is no longer applicable. This uncertainty necessarily leads the members of the public to an increased information-seeking behaviour (Tierney, 2009). The aim of information-seeking is to provide relief from the sense of anxiety and distress that anticipating and experiencing a disaster can cause (Seeger et al., 2003). Information on the evolving situation and actions advised by official sources allows people to take appropriate action to mitigate harm. These options instil a sense of control reducing feelings of uncertainty due to the disaster (BBC World Service Trust, 2008).

Communication concerning disasters traditionally takes two forms: crisis communication and risk communication (Reynolds & Seeger, 2005). Crisis communication in the literature is often closely related to the field of public relations that focuses on how organisations can communicate with key stakeholders and the public during and after crises. In this, the main aims of crisis communication are usually recognised in the intention to explain an event and its effects, whilst providing information to mitigate harm (Reynolds & Seeger, 2005). This includes providing information to the public on how to keep safe and restoring public trust in emergency management organisations and critical infrastructure operators involved in responding to crises. This can aid disaster resilience, as communities learn how to act during disasters to mitigate harm, and feel confident that emergency management organisations and critical infrastructure operators are managing and aiding recovery from the disaster efficiently and effectively. Risk communication, on the other hand, is more related to making the public aware of risks and what actions they can take to manage them. It is most commonly associated with public health measures, including how to act in specific instances such as evacuation during flooding, or more general action such as wearing sunscreen for protection against UV rays that can lead to skin cancer (Lundgren & McMakin, 2009; Seeger, 2006).

Along with simply providing information, risk communication incorporates persuasive tactics to encourage the public to take appropriate actions (Murray-Johnson et al., 2001). The public might have disproportionate perceptions of risks associated with a disaster due to a lack of information or the spread of disinformation and rumours. This can in turn increase the anxiety experienced by disaster vulnerable populations and perhaps even lead to inaction when urgent preventative steps are required. Risk communication increases disaster resilience as it provides the public with an accurate assessment of hazards, and encourages them to prepare for future disasters and act in ways that reduce harm before, during and after a disaster. Taking into account these considerations, a combination of crisis and risk communication can lead to a more holistic communication strategy leading to an increase in resilience at all stages of a disaster (mitigation, preparedness, response, and recovery).

This section provides an overview of the role of the traditional media, such as television, print media and radio, as a means to disseminate crisis and risk communication (hereby referred to as simply ‘crisis communication’ (Reynolds & Seeger, 2005). This section further explores how these channels can be utilised to promote community, critical infrastructure and disaster resilience by analysing the media channels through which disaster-affected populations search for and access such information. Then, it presents an overview of the effects of news media coverage with a focus on how this communication can help increase disaster resilience in a variety of contexts.

4.1 Public expectations of crisis information

Communication during crises can aid community and critical infrastructure resilience through increasing preparedness, mitigating harm caused by disasters, and aiding with recovery. Within this

context is important to discuss what the public expect from crisis information in order for emergency management organisations and critical infrastructure operators to develop effective communication strategies that deliver information that people need through appropriate communication channels. Understanding the audience's needs and characteristics is important to make sure that crisis communication reaches as many people as possible in a format they understand, because in order to provide successful communication, communicators should know their audience well (Lundgren & McMakin, 2009). Furthermore, if expectations of communication are not met this can lead to further discontent and frustration within the affected communities (Christoplos, 2006), which in turn negatively impacts upon community resilience. This section explores public expectations of crisis information regarding method, content and frequency of communication respectively. Afterwards, it discusses what constitutes effective and efficient crisis communication.

4.1.1 Method of communication

As discussed also in IMPROVER project D4.1, during disasters people use the sources of information they are most used to, and those that they expect will best fulfil their information needs (Petersen et al., 2016). Although there has been an exponential increase in the use of social media over the past decade, studies report that traditional media is still one of the best methods to disseminate information (Lundgren & McMakin, 2009). Also, as reported in Standard Eurobarometer 84²⁶, traditional media are still the most accessed type of media. Indeed, 100% of participants reported access to a television set, with 99% reporting access to radio and print news. Although the use of the Internet and social media is increasing, 7% of participants reported that they did not go online every day. In addition, even our interviewees reported that traditional media are the first place people go to for information (during everyday life and during a disaster). Although the wide use of traditional media in information-seeking behaviours is common, the information shared should not be limited to one method. Indeed, the public are usually more likely to respond to warnings about disasters if the information is delivered over multiple channels (Lindell, 1987). The use of different channels is also important. As Standard Eurobarometer 84 reported, participants from different ages and different countries showed widely differential use of traditional media. For example, in Finland 90% of participants reported accessing print news at least once a week, compared to 34% in Greece. And whilst 92% of respondents aged 55+ watch television at least once a day, this dropped to 67% for those aged 15-24. These differences in the use of media shows the public need to utilise numerous media channels. Reasons for this include immediacy of information, credibility of traditional media as a source, and a sense of community.

4.1.2 Content of crisis communication

During disasters, the role of crisis communication through traditional media and professional journalists is crucial to share information with the general public on “what to do, how to protect themselves during crisis and how to find missing loved ones” (Hannides, 2015:5). Information needs change during the course of a crisis. Initial information needs after a disaster are mainly to understand what happened and to check on family and friends. Shortly after, instead, questions concerning overall survival in the short-term (food, water, shelter and medical assistance) emerge. Finally, people want to know what relief and recovery services are available and what they are entitled to (BBC Action Media, n.d.).

²⁶ <https://ec.europa.eu/commfrontoffice/publicopinion/index.cfm/ResultDoc/download/DocumentKy/72667>

As discussed in IMPROVER project D4.1 (Petersen et al., 2016), the public expects to be warned of impending disasters, to be kept up-to-date with how the crisis unfolds, and to be told how to react during the crisis and recovery periods. This includes information on how emergency management organisations and critical infrastructure operators are responding during and after the disaster by effectively communicating how they are dealing with the ‘expectation gap’. This expectation reflects what the public expect and what can be actually reduced. An example of this was during Hurricane Sandy in October 2012 that hit the eastern seaboard of the US. Although power was restored to customers faster than on average there was a public outcry about how long it took. This was because the energy providers did not effectively communicate how they were dealing with the disruption and how long it would take (Lacey, 2014).

Furthermore, people expect communication to be in a language that they are able to understand. Learning from Hurricane Sandy in the USA in 2012, Kaufman et al. (2012) suggest that crisis information should also be communicated in secondary languages represented in the community in order to reach efficiently as many people as possible. In addition, it is important to consider crisis communication in secondary languages in areas of high tourism, whilst avoiding information that relies heavily on local knowledge (Pennington-Gray et al., 2013). Regarding this, one of our interviewees, a representative of DEMA²⁷ (Danish Emergency Management Agency), reported that they share crisis information in Danish and English as standard. In emergency situations, however, they make sure to translate the information into various other languages, such as Mandarin for areas where there is a high number of Chinese residents. Furthermore, they ensure that their communications ‘avoid jargon’ in order to quickly and accurately broadcast information to a large population. Making sure communication is clear and concise can also help mitigate the ‘expectation gap’. During a disaster, victims that are in dire need of aid are likely to misinterpret communications in order to reassure themselves that response and recovery are imminent, ‘desperate populations are very prone to hearing what they want to hear’ (BBC World Service Trust, 2008). By making communication direct and succinct these false expectations can be managed. Having a realistic idea of what aid is available can also help communities become more resilient as they are more likely to be agents in their own recovery when they are aware of areas where emergency management organisations and critical infrastructure operators are not meeting their requirements (BBC World Service Trust, 2008).

4.1.3 Frequency of communication

The frequency of communication is also important. When the public receive regular updates, they are more likely to have realistic expectations of disaster responses by emergency management organisations and critical infrastructure operators (Christoplos, 2006). This can help reduce the negative impact of the ‘expectation gap’, where public expectations of response and recovery interventions are much higher than in reality. Moreover, community unrest over disruption to critical infrastructure can be compounded by uncertainty caused by a lack of communication from critical infrastructure operators (Pramaggiore, 2014), leading to reduced community resilience. Television and radio are particularly useful sources in crisis communication situations in which people need to quickly access real-time information (Lundgren & McMakin, 2009). This theme was supported by our interviewees who reported that the general public expects to be kept up-to-date about the progression of the disaster as well as frequently informed about recovery and restoration of critical infrastructure. However, although frequent updates are important there is evidence that a large number of warnings can cause a sense of complacency to the disaster and even the warnings related to it (Kapucu, 2008; Wang & Kapucu, 2008). Regarding this, Andersson’s (2006) study of California and Hawaii, two

²⁷ <http://brs.dk/eng/Pages/dema.aspx>

areas susceptible to Tsunamis, showed that repeated warnings in areas that frequently experience disasters can lead to high levels of public complacency about the likelihood of another incident occurring. Furthermore, as these areas are susceptible to disasters there are a higher number of false alarms, enhancing this complacency and demanding further development of communication strategies.

4.2 Crisis communication and traditional media

Traditional media are a source of emergency information for those affected by crises, and also a means of bringing disasters to the attention of the national and global public (Reilly & Atanasova, 2016). As noted above, frequency of information is key to successful emergency management, and traditional media is still considered the most effective source of real-time information (Hannides, 2015; Lundgren & McMakin, 2009). With the growing ubiquity of social media many emergency management organisations and critical infrastructure operators are implementing online methods of information into their communication strategies. However, as mentioned by our interviewees, traditional media still plays a major part in most people's everyday lives and they believe that they should not be set aside by organisations jumping on the social media bandwagon. This is supported by the findings of the Standard Eurobarometer 84. Although everyday use of the Internet and especially social media is increasing, those who do not have access to these channels have remained almost constant at around 7% of respondents, as discussed earlier. This lack of access can be due to infrastructure limitations, digital literacy or personal preference. In areas with broadband access and other high-speed networks there continue to be digital have-nots and refuseniks who are unable to avail of these services (DiMaggio & Hargittai, 2001). There are many other factors that influence the use of online technologies and what people get out of them. Although people might have Internet access the speed of the connection and the device they use can affect the experience. A less gratifying use can lead to reduced digital skills and less time spent accessing platforms that are not supported on older browsers or devices. Furthermore, digital and information literacy can affect the range of information sources accessed and the critical approach to information found online (Reinghold, 2012; Raine & Wellman, 2012). Bearing these factors in mind, traditional media are still a good way of reaching a wide proportion of society.

4.2.1 Traditional media as a trusted source

During a crisis, individuals turn to the media source that they trust and use those that they are familiar with (Kioussis, 2001). Information collected from the Oresund Region living lab revealed similar conclusions. In addition, DEMA reported that the public expects to find accurate information on communication channels that they can trust, with traditional media being recognised as one of those. Indeed, the majority of our interviewees reported that the general public considers traditional media a trustworthy source of information because it is reliable, stable, and it is recognised as official. Although trust in these traditional media has declined slightly in the past year, this has not been replaced with more trust placed in online sources. This is backed up by further research suggesting that even though social media use is becoming more ubiquitous, traditional media are still perceived as more credible (Flanagin & Metzger, 2000; Stephens et al., 2013).

4.2.2 Traditional media as a resilient source of information

In areas significantly affected by disasters where aid can be hard to deliver, information can be the initial source of help for many people (BBC World Service Trust, 2012). Past experiences have shown traditional communication networks to have vulnerabilities during disasters. For example, during the Brussels terror attack in 2013 the mobile phone network became overloaded and the crisis centre asked the public to communicate via text or social media (BBC News, 2016). However, radio still remained one of the most resilient forms of communication. For example, during Hurricane Sandy in the US in 2012, residents turned to radio as a source of information due to power outages left television and online media use unstable (Burger et al., 2013). Furthermore, radios are an easy and relatively cheap way of providing a channel of communication to disaster affected people. BBC World Service Trust (2012) reported that distributing radios to affected people and using short-wave radio in

Afghanistan, Burma and Darfur in order to disseminate information relating to disasters, encourage discussions about aid, and provide health information on disease prevention. As such, traditional media often prove to be more resilient communication channels than online media during disasters.

4.2.3 Representation in traditional media

Knowledge and understanding of the public's ability to access information is important to determine the most effective and inclusive ways to disseminate warnings and messages about disasters (Artman et al., 2011). Information shared on traditional media is filtered, viz. what information is shared and how this is framed are choices made by media organisations which may only represent a specific viewpoint or a specific group of people. For example, LGBT (lesbian, gay, bisexual, and transgender) communities are typically under-represented in mainstream media (McKinnon et al., 2016). This data is significant because, as discussed below, media coverage directly influences aid. Furthermore, because LGBT populations are not represented in mainstream media coverage of disasters, their specific vulnerabilities cannot be addressed reducing disaster resilience of these communities (McKinnon et al., 2016).

4.3 Impact of crisis communication upon behaviours of citizens

4.3.1 Traditional media and community resilience

Traditionally, the news media has been seen as a tool in a 'top down' approach to emergency management that revolves around blue light organisations and managers sharing information with disaster-affected or vulnerable populations. However, it can also be used to represent the views of affected communities. Although the content of news media is usually reserved to professional journalists, after a disaster they are likely to include 'human interest' articles where disaster affected peoples can report their experiences and make emergency management organisations and critical infrastructure operators accountable for their response and recovery actions (Haddow & Haddow, 2008). Within this discourse news media represent a way for communities to express positive and negative opinions on how well official groups respond to crises. This feedback can help improve community and critical infrastructure resilience as it can highlight areas where recovery efforts should be focussed, and can be used to learn how to improve response and recovery in subsequent disasters.

Furthermore, traditional media can also promote a sense of community, thereby increasing community resilience. Indeed, during a disaster the audience usually turns to these sources mainly to feel a sense of companionship (Perez-Lugo, 2004). In addition to giving a voice to affected communities, traditional media can also help foster community spirit (which can increase community resilience) by empowering individuals within the community to take action and aid with recovery and preparedness. For example, during the Brisbane floods in 2011 news media reported a sense of community spirit, self-reliance and highlighted the importance of sharing experiences, all of which increased community resilience (Bohensky, 2014). The authors also noted that media framing of disasters with a focus on responsibility led to short-sightedness, which can negate community resilience. Likewise, Gortner and Pennebaker (2003) found that media coverage of the Bonfire disaster at the University of Texas in 1999, which resulted in twelve student fatalities, helped promote the idea of a unified, supportive community. This led to increased community resilience through increased social support and a sense of togetherness, and in turn better mental and physical health. By taking into consideration the ability of media to create communities, emergency management organisations and critical infrastructure operators can improve information dissemination and community resilience.

Traditional media can also help enhance the psychological resilience of communities affected or vulnerable to disasters. When trauma strikes a community, the event produces a collective experience of shock and grief. An immediate reaction to experiencing trauma, such as a disaster, is to look for other people and talk about the experience. In this, news media provide an overview of the collective trauma and can substitute this direct communication. "The newspaper can be a mirror of how such traumatic experiences are "worked through" and resolved on a collective and cultural level" (Gortner

A Communication Strategy to build Critical Infrastructure Resilience

& Pennebaker, 2003:201). This concept was reiterated also during our interviews. Sharing experiences after a disaster was seen as a way for the public to preserve their collective memory and commemorate the event. From this people can learn how to act more efficiently if they are affected by another disaster. Keeping the event in mind allows people to prepare psychologically for the possibility of other crises.

Psychological resilience in another approach that emergency managers adopt to use traditional media to share information (Pantti & Sumiala, 2009). In highly mediated societies, indeed, media do not simply report events, but affect the normative social rituals that go along with them (for example mourning) and manage associated emotions. In this sense, ritual “refers to a form of action that includes dramatic symbolism and arouses emotions through which individuals might think, feel and act as members of a community” (Dayan & Katz, 1992:120). Using events such as the Konginkangas bus accident in Finland in 2004 that killed twenty-three people, Pantti and Sumiala (2009) showed how disasters that are represented in traditional media provide a true understanding of public expressions of emotions. This in turn can increase psychological and community resilience because it gives voice, counsel and comfort to victims. They noted also the importance of the presence of rituals in traditional media reporting, adopting the notion that this reporting can create a ‘sacred centre’ of fundamental values that bind people together. For example, after the bus accident, news media showed footage of people spontaneously gathering and showing compassion by placing candles and flowers at specific memorial sites. It can be argued that these public displays of emotion illustrate the ‘sacred centre’ and can be used to construct a sense of ‘togetherness’ and community (Pantti & Sumiala, 2009). This suggests that in traditional media ‘mediatised rituals’ are structured as inclusive and affirmative, which can lead to increased community resilience.

However, this concept of the ‘mediatised ritual’ has been the focus of intensifying academic debate. Although this phenomenon can be a representation of collective sentiments, it can also be disruptive (Cottle, 2006). ‘Mediatised rituals’, in fact, can be used to ‘confront the strategic power of institutions and vested interests, and even lend moral gravitas to the projects of challenger groups within society’ (Cottle, 2006). Although Cottle (2006) described this as ‘disruptive’, this can increase critical infrastructure resilience as under-represented groups in communities can publicly voice their feedback on how critical infrastructure operators and emergency management organisations respond during disasters. As noted above, these voices are not always represented in traditional media, so this gives critical infrastructure operators and emergency management organisations a rare chance to learn what these communities need and want. Furthermore, affording minority groups a voice within the wider community can increase the feeling of inclusiveness and thus increase community resilience.

4.3.2 Sensationalist framing of disasters

How the media frame disasters (i.e. how they present disasters to the public through use of language, metaphor and negative or positive focus) can dramatically affect how the public perceive these events (Kuttschreuter et al., 2011). The ‘spectacular’ and ‘sensational’ are elements that trigger the public’s attention (Correa et al., 2016). In order to grow and sustain an audience, news media use these elements in headlines, and written, spoken, and visual content. When reporting frames disasters using extravagant claims or interpretations this is described as ‘sensationalism’ (Ransohoff & Ransohoff, 2001). These exaggerated reports can cause false information to be spread, which can in turn lead to increased anxiety and distress. This has a negative impact on communities affected by disasters, reducing resilience and making recovery efforts more difficult.

There are three relevant examples of this in the literature. Firstly, as Drache et al. (2003) report, the 2003 Toronto SARS outbreak was inaccurately reported in the American press. The event was sensationalised through traditional media reports, which overemphasised the risk of contagion and the number of affected people. This led inevitably to an increased and inaccurate perception of risk (Drache et al., 2003). Secondly, during the Enschede fireworks disaster in the Netherlands in 2000, the public’s perception of risk was increased unnecessarily due to the vast amount of traditional media coverage, the negative themes used by journalists to ‘frame’ the disaster, and the tone-of voice used in

news coverage (Kuttschreuter et al., 2011). Finally, in relation to Hurricane Katrina in 2005 in America, Tierney et al. (2006) discussed how biased reporting on traditional media over-emphasised the incidence of looting and lawlessness after the disaster. This led to an inaccurate perception of risk that had numerous negative consequences, including an overly militarised response from authorities, and reduced sympathy from the wider public. This led to less political pressure to invest in recovery and resilience (Tierney et al., 2006).

However, there are also different perspectives on the effect of sensationalisation. Cooper (2011), for instance, noted how traditional media focus much more on ‘exciting’ disasters “for every person killed in a volcano disaster, 40,000 people must die in a drought to reach the same probability of media coverage” (p. 11). This is significant since the amount of news media coverage is directly related to the amount of support from NGOs and aid donations from the public. In addition, news media often prioritise the effects of disasters on human environments, and tend to de-emphasise the impact on the natural environment as this is not seen as interesting or important to the audience (Miles & Morse, 2007). However, the impact on the natural environment arguably has more of an impact on recovery and resilience (Miles & Morse, 2007).

4.3.3 Emotional framing of disasters

Traditional media frame disasters with emotional language, images and metaphor in order to engage the audience with the suffering of disaster affected people. How the public perceive a disaster and their resulting attitude towards the event, response, and victims can be affected by written information as well as images. How traditional media use images of those affected by disasters plays a fundamental role in giving publicity to human suffering (Hoijer, 2004). Exploring people’s reaction to the emotional engagement that images provide shows mainly two negative side-effects: compassion fatigue and indifference (Hoijer, 2004). Although these negative effects, the way traditional media portray human suffering can mobilise compassion. On the contrary, if sensationalised and overused, news media can lead to indifference from overexposure.

Compassion fatigue is arguably one of the main characteristics of audience reaction to overexposure to reporting on human suffering through traditional media. This is often exacerbated by sensationalism, as discussed above. This can lead the audience to be exhausted by such reports, and can lead to a reduced capacity for compassion. As a result, the constant exposure of the audience to narratives to images and stories about disasters can generate indifference towards human suffering (Moeller, 1999). These considerations led to the necessity to take into account the public’s reaction and disposition towards disasters in traditional media to avoid compassion fatigue (Tester, 2001). However, it seems that this ‘apathetic spectator’ is not a result of the omnipresence of suffering in media. Disasters are more likely to be framed emotionally when they affect communities, which are politically, geographically or culturally homogenous (Chouliaraki, 2008). Disasters from Indonesia, Bangladesh and India, for instance, were reported in news media, but were not ‘breaking news’ and were not reported with empathy or condemnation (Chouliaraki, 2008). This data shows that representations of disasters are influenced by hierarchies of global suffering. In fact, political, sociodemographic, and geographic factors all affect whether traditional media represent a disaster as affecting ‘us’ or ‘them’. Distant suffering is not usually portrayed as comprehensible, relevant or close to the audience. Instead, it is presented as “no cause of concern or action” (Joye, 2009:45). Developing this concept, Joye (2010) argued that news coverage of international crises builds and maintains socio-cultural distances between the audience and ‘them’, with ‘them’ being communities in poor and/or distant countries. The analysis of western news media indicated the recurring image of the ‘distant others’, showing a universal portrayal of normalised inequalities. These biases in reporting can lead to ‘forgotten’ disasters that are not represented in global traditional media due to political, geographical or economical aspects (CARMA, 2006; Cottle, 2014), and therefore do not receive as much aid from the public and NGOs as higher profile disasters. This reduction in funding and support has inevitably a negative impact on recovery and resilience of critical infrastructure and communities.

A Communication Strategy to build Critical Infrastructure Resilience

Another effect of overexposure to emotional framing of disasters can be observed in the audience becoming ‘ironic spectators’ (Chouliaraki, 2013). In other words, they become an “ambivalent figure that stands, at once, sceptical towards any moral appeal to solidarity action and, yet, open to doing something about those who suffer” (Chouliaraki, 2013:2). People react to emotional framing of disasters first with pity, then with scepticism, and finally with narcissism regarding how their compassion will make them feel good and will increase their image as an active citizen of the world. This is described as ‘post-humanitarian’ behaviour, in that people’s reactions to witnessing mediated suffering is increasingly more focussed doing good for themselves rather than for others. However, by asking for appropriate emotional reactions people might be more likely to have a solid moral and intellectual engagement with the event, “to stage human vulnerability as an object of our empathy as well as of critical reflection and deliberation” (Chouliaraki, 2013:22).

Emotional content in news packages focused on disasters are by definition more subjective than other modes of reporting (Reilly & Atanasova, 2016). Confusion and uncertainty caused by disasters can be exploited by political establishments to impose controlling measures on the population that would otherwise not be acceptable (Klein 2007; Tierney et al., 2006). Henceforth, repressive political establishments would find it beneficial to use the media to spread panic rather than accurate, helpful crisis information, thus reducing community resilience.

Although the majority of the literature reviewed above concludes that frequently news media generate compassion fatigue and disinterest (Cottle, 2009), there are elements that can help negate these effects. This includes being geographically close to the affected areas, accessing other media sources, and receiving information from trusted sources (Aguirre, 1991; Drabek, 1999; Lindell & Perry, 1987; Palen et al., 2007; Younger, 2010). Whilst media reporting of disasters can be affected by how the event is framed, certain actions can increase the public awareness and empathy. This increases disaster resilience as it intensifies the amount of aid available to emergency management organisations and NGOs, whilst creating a mediated sense of community that can enhance community resilience.

4.3.4 Traditional media and disaster resilience

Traditional media has been shown above to improve critical infrastructure and community resilience through effective, accurate and wide-reaching information dissemination, creating a sense of community, and by providing a platform for feedback on critical infrastructure operators and emergency management organisation interventions during and after disasters. The ability of traditional media to enhance individual and community capacities for survival, recovery and resilience is widely reported (Cheng et al., 2015; Cooper, 2011; McKinnon et al., 2016; Miles & Morse, 2007). Considering this, this section expands on the concept of social and community resilience and it presents practical examples of how traditional media can increase critical infrastructure and overall disaster resilience.

Expanding the understanding of the social dimension of resilience, Spialek et al. (2016) analysed a series of tornadoes that struck several communities in central Illinois in November 2013. In relation to the event, they argued that disaster communication positively influenced perceptions of communities as caring and capable of learning how to improve from a disaster. The authors further explored the concept of disaster communication ecologies by providing practical solutions to foster individual disaster resilience. These include purchasing items for a home disaster kit or making an emergency evacuation plan. They added that communities were more likely to get involved in recovery efforts following a disaster if they have access to communication, whether via traditional media or social media. This analysis presented information and communication technologies as additional and necessary elements of emergency management (Spialek et al., 2016).

Information shared via traditional media can raise awareness and foster disaster resilience among affected communities. Indeed, information sharing during disasters is an important element because, it has been observed that information can save lives to the same extent as other goods and services (Hannides, 2015). An illustrative example of this is the ‘Lifeline Programming’²⁸ programme launched by BBC Media Action²⁹, an international development charity. Through accurate and audience-friendly information ‘Lifeline Programming’ aims to assist people through all phases of a disaster. Informing people about what relief services are available, how and where, ‘Lifeline Programming’ shows the importance of effective communication and managing public expectations. As discussed above, crisis reporting in traditional media can focus on negative aspects and sensationalise events (see section 2.2). Instead, ‘Lifeline Programming’ is created for the affected communities. By assisting local media and aid relief agencies to provide accurate and timely information lives can be saved, the effect of the disaster can be reduced, and recovery process can be expedited (BBC Media Action, n.d.), which in turn can increase community resilience. As discussed above, traditional media is effective at spreading general public education messages before, during and after disasters (Reilly & Atanasova, 2016), however it is not as good at addressing specific needs of local communities. Another innovative aspect of ‘Lifeline Programming’ is the fact that it works as mediator between relief providers and affected communities, trying to compensate the natural limit of traditional media as a one-to-many means of communication.

²⁸ <http://www.bbc.co.uk/mediaaction/publications-and-resources/brochures/lifeline-programming>

²⁹ <http://downloads.bbc.co.uk/rmhttp/mediaaction/pdf/LifelineProgramming.pdf>

5 Social Media, Crowdsourcing and Disaster Response

Recent research has showed that the use of social media platforms, such as Twitter and Facebook, is increasing (Standard Eurobarometer 84, 2015), and will continue to increase (Reuter & Spielhofer, 2016). One of the main reasons for this increasing use is because compared to traditional media (television and radio) and other means of communication (telephone landlines, face-to-face) the use of the Internet and social media allows easy and instantaneous access to information (Reuter & Spielhofer, 2016). People use social media for various purposes: to get information, share content, and communicate with friends, family and various institutions (Shklovski et al., 2010). During an emergency situation, this can give people the feeling of being more in control of the situation, as well as feeling more connected to the rest of the social community (Shklovski et al., 2010). This condition facilitates the use of social media by various agents involved in emergency situations, including emergency agencies, emergency organisations, critical infrastructure operators, and citizens. The use of these platforms by the general public presents opportunities for emergency managers to supplement existing strategies and reach even more members of the public.

5.1 Social media as source of crisis information

With the growing ubiquity of social media there are an expanding number of potential actors that can contribute to emergency management. In this, citizens are increasingly viewed as the first responders to such incidents (Corbin, 2012; Scifo & Salman, 2015). Users of social media platforms such as Twitter, Facebook and Flickr can provide instant eyewitness posts (Beaumont, 2008), providing information that emergency management organisations can use to establish ‘situational awareness’ (i.e., the “ability to identify, process, and comprehend critical elements of an incident or situation” (Lindsay, 2011:4)). One interviewee, a French representative of the Ministère de l’Intérieur, noted this, “[social media] allows us to have an idea of what the public are thinking of the crisis response”. Along with providing a source of information to improve situational awareness, social media can also be used to explore public opinion of disaster response and recovery (Smith, 2010). Users can contribute directly and instantaneously by providing multimedia content (video, photos, and text), bypassing professional reporters or journalists and offering unfiltered views of what happens in the world (Gordon, 2007). This new method of communication during disasters follows a bottom-up approach, contrasting with the traditional ‘top-down’ model more widely used across Europe and the US in which official organisations distribute information to the public (Reilly & Atanasova, 2016). Emergency response relies on gathering information about incidents mainly by emergency managers to support decision-making. Social media provide emergency managers with unprecedented access to eyewitness perspectives that can help build situational awareness. Traditionally, this information would have been communicated to emergency management organisations by telephone and then verified and elaborated upon by first responders. However, social media provide more information (in terms of quantity) from more people almost immediately (Yin et al., 2015; Cassa et al., 2013). Furthermore, it is not just the content of social media communication that can be of use, meta-data (such as ‘geo-tagging’ of tweets on Twitter (where the location of the device used to tweet is recorded)), and metadata (such as tags on blogs, images and videos) can all provide data to enhance situational awareness (Yates & Paquette, 2011; Pohl et al., 2016).

Social media provide platforms for many people to contribute towards crisis information. This can be more helpful than official sources because it can provide a local geographical context, especially in disasters that cover a large area or last a long time, such as hurricanes or wildfires respectively (Palen et al., 2009). Some of our interviewees reported using social media obtain information to aid in decision-making. For example, one interviewee, a French representative of the Ministère de l’Intérieur (*trans. the Ministry of the Interior* - the ministerial department of the French government traditionally

responsible for internal security, territorial administration and civil liberties) noted that they use social media information ‘to identify elements that we have not already seen in the event’. They reported that during the terrorist attack in Nice in July 2016 they found out about the hostage situation through Twitter first. Another interviewee, a French representative of COGIC³⁰ (Centre Opérationnel de Gestion Interministérielle des Crises – *trans. Operational Centre for Interministerial Crisis Management*), received reports of a terrorist attack and explosions through traditional channels, but it was discovered via social media to just be fireworks at the Bastille. This false alarm emerges here as an example demonstrating the importance of social media content verification.

5.2 The problem of ‘Big Data’

The term ‘Big Data’ is used to define a vast dataset in comparison with traditional datasets. It usually includes a group of unstructured data that need real-time analysis (Chen et al., 2014). The size and lack of structure of big data represent the most common problems for analysis (de Albuquerque et al., 2015; Imran et al., 2015). As can be seen, the use of user-generated content (UGC) to inform decision-making by disaster relief organisations and non-organisation responses is becoming more wide-spread. However, “social media does not provide an inherent coordination capability for easily coordinating and sharing information, resources, and plans among disparate organizations” (Gao et al., 2011:10). That is, although social media platforms contain vast amounts of data that could be used during disasters, extracting this data in a useable veracity that can be easily shared is not something that the platforms themselves provide. Considerations need to be made with this innovative use of social media data; quality and usefulness need to be understood, (Tapia & Moore, 2014), and limitations such as how to evaluate these data quickly in order to help identify areas and communities most in need of assistance need to be acknowledged. Social media contain a vast amount of data that requires special skills and systems to analyse effectively in order to translate it into a form, which can easily be used by emergency management organisations and critical infrastructure operators, this is known as the problem of ‘Big Data’ (de Albuquerque et al., 2015; Imran et al., 2015).

However, there is a wide range of research on developing systems that translate social media data into a usable format (Pohl et al., 2016; Caragea et al., 2011). They are being developed in response to problems associated with analysis of big data. For example, using big data and social media analysis, Kryvasheyeu et al. (2016) found a correlation between activity on social media platforms in specific locations and damages due to Hurricane Sandy in the US in 2012. However, they note that caution should be employed when using results of big data analysis of past events to inform emergency management strategy. This is because the relationship between social media usage and real-world events is not static. Data collected from social media might give a misleading impression of what is happening in disaster affected areas (Kryvasheyeu et al., 2016).

Classification of text from social media and text messaging is quite a recent researched area that includes the study of automatic classification of material to prioritise urgent information (Caragea et al., 2011). Although most of past research explored the use of social media during disasters as a stand-alone source of information, one of the ways to classify social media data can revolve around the use of metadata such as geotagged information to enhance the identification of relevant messages that relies upon georeferenced texts. Geoinformation is a type of metadata attached to social media posts that can also be used to analyse user generated content. Through a case study of the River Elbe Flood in Germany in 2013, De Albuquerque et al. (2015) explored how geoinformation can be used

³⁰ <http://previnfo.fr/sections.php?op=viewarticle&artid=32>

alongside more authoritative sources to provide comprehensive coverage of the disaster. Indeed, the analysis reported that tweets near the flooded areas have much higher probability to be related to floods. Regarding this, Pohl et al. (2016) developed a system to use geoinformation and text mining in conjunction. Alongside social media platforms such as Facebook and Twitter (text mainly), the system looked at social media sources such as Flickr (images) and YouTube (video), which are often overlooked in this area of research. Content analysis of tweets was combined with metadata from images and video to generate situational, visual reports and summaries. These data can easily be used by disaster relief organisations (Pohl et al., 2016) to understand the severity of incidents. This way of addressing issues related to the use of geoinformation is only one approach towards handling such metadata.

Our interviewees noted the problem of big data. Interviewees who had the technical skills within their organisations to develop systems to deal with big data were much more likely to use user-generated content as a source of crisis information. Various systems and tools are used, an interviewee, a representative of a French public transport company (Société nationale des chemins de fer français - France's national state-owned railway company), noted that 'the allotment of the tweets is done by a tool that allows us to categorize which theme the tweet falls under and then it will be assigned to the right team and then that team will respond', and another interviewee, a representative of VISOV³¹ (Volontaires Internationaux en Soutien Opérationnel Virtuel – trans. Digital Volunteers in Emergency Management) noted that they use a Twitter geolocalisation tool that superimposes tweets onto a map.

5.3 Credibility of online information

As discussed in the previous section, traditional media is widely perceived to be a more credible information source than social media during crisis situations (Flanagin & Metzger, 2000; Stephens et al., 2013). Arguably, one reason for this is the questionable validity of information shared online. One of the problems with user generated content is the possibility of it being inaccurate, intentionally or inadvertently (Kongthon et al., 2012). However, it can be argued that the 'wisdom of the crowd' (Sutton, 2010: 6) helps correct often misleading information. That is, online communities self-regulate and there is evidence that this self-regulation leads to only the most accurate information being circulated amongst the majority of people. This helps in all stages of disaster communication by correcting often misleading information (Sutton, 2010), validating information, giving a voice to marginalised groups (see section 3.3 for more information), and helping focus communication around crises on disaster relief (Cottle, 2014). An example of this can be seen in the use of social media during the Great East Japan Earthquake in 2011. Regarding this, "the contagion of false rumours was very rapid through Twitter, but once Tweets that negate the false rumours begins to appear, the false rumours decrease quickly on Twitter" (Kaigo, 2012: 32). During the Haiti earthquake in 2010 social media was described as "remarkably well organized, self-correcting, accurate, and concentrated" (Keim & Noji, 2011). Furthermore, there is evidence to suggest that many social media users will act swiftly to quell rumours and correct misinformation (Simon et al., 2015), making social media 'self-regulating'. For example, a study conducted on the use of Twitter during the Ardoyne protest showed that rumours and disinformation appeared to have short life on the platform. In that case, users were using Twitter to accuse other users of spreading lies (Reilly, 2016). This example shows how quickly social media users correct erroneous reports and debunk disinformation.

Furthermore, the accuracy of social media data should be viewed in the same context as offline information; both have the capacity to be true or false (Tapia & Moore, 2014). This perspective suggests that the decision to use information should not be based on the source, but should depend on

³¹ <http://www.visov.org/>

how it is used. During initial stages of disaster warning and response, information is limited. All social media data should be verified before being made actionable, i.e. converted into situational awareness. Data from social media and offline sources should be used since the risk of ignoring the information typically outweighs the risk of it being inaccurate. However, during the later stages of disaster response, such as search and rescue where information is widely available, organisations can afford to be selective, using conventionally more reliable and accurate information sources. Cassa et al. (2013) explored this idea in relation to the Boston Marathon bombings in the US in 2013 showing the importance of ensuring that emergency services respond quickly to prevent rumours from spreading and that they should verify information before sharing it with citizens. The analysis of Twitter use after the bombings concluded that getting timely information to responders outweighs the negatives of misinformation, and should therefore be developed as part of the current alerting infrastructure (Cassa et al., 2013).

Empirical research has suggested that online crowds are likely to challenge misinformation shared via social media sites during crisis situations (Dailey & Starbird, 2014; Mendoza et al., 2010). However, the high frequency with which users share corrective tweets does not necessarily lead to rumours and misinformation having a very short lifespan. For example, there was an observable lag between the sharing of misinformation and corrections on Twitter during the police manhunt that followed the Boston Bombings in 2013. The ratio between misinformation and correction on Twitter would be as high as 44:1 in relation to several rumours, which included one about an eight-year-old who had allegedly been killed during the attack (Starbird et al, 2014). Such behaviour have been identified as one of the key factors in the reluctance of emergency managers to fully engage with social media conversations during major incidents (Hughes and Palin, 2012).

5.4 Organisational limitations

Alongside the limitations of big data and accuracy of online information, the use of social media as a source of crisis information is limited by organisational factors. Inter-organisational information sharing, and having the staff, technology, skill-set and organisational culture to utilise social media data are all needed to fully utilise user generated content (Tapia & Moore, 2014). For example, Vieweg et al. (2014) monitored a trial use of social media by the Office for the Coordination of Humanitarian Affairs during Super Typhoon Yolanda in the Philippines in 2013. They found the main barriers to using social media data were not the accuracy or reliability of user generated content, but operational issues similar to the findings of Tapia & Moore (2014). Some of the operational difficulties include “data not being available in the right format, not widely dispersed, not easily accessible by [general] users, not being transmitted through training and poor information management. Also, data may arrive too late to be able to influence decision-making in real time operations, or may not be valued by actors who are more focused on immediate action” (Vieweg et al., 2014:14). One of our interviewee, a French firefighter Capitain working at the Ministry of Interior, reported the slow process of using social media in their everyday duties due to the necessity to respect internal hierarchies. They have to seek permission from senior management before they could post content or respond to queries from the public on social media. In fact, on the one hand, he stressed the necessity of accelerating internal communicative processes in order to manage information quickly enough to be useful, i.e. they need clearance before posting online. On the other hand, he reported the issue of the ability to collect and analyse social media content. A representative of a French transport company, for example, stated that they collaborate actively with other actors involved in crisis management whilst maintaining internal, hierarchical communication structures. In relation to major incidents, for instance, the DNSF (national chief for railway safety) reported that they coordinate with the prefectures, the police, and ministers about what sort of resources are needed on the ground. They do this by providing information and feedback to help them make decisions, and coordinate and facilitate further communications. The necessity of acting within internal hierarchies (information verification and validation) slows this process of communication and information sharing. All interviewees shared the same difficulty and concern in delaying emergency communication.

A Communication Strategy to build Critical Infrastructure Resilience

There has been much research to suggest that user generated content can be used to inform decision-making (Meier, 2015). However, it is safe to suggest that organisations must not ‘jump on the bandwagon’ and use social media data because of its novelty, whilst ignoring its limitations (Tapia & Moore, 2014). The caution was demonstrated by our interviewees. In France, government bodies are more likely than critical infrastructure operators to use social media as a source of crisis information. One of our interviewee, a representative of a French public transport company who is in charge of crisis communication, reported that 90% of the time they receive information about crises through the command chain and in-house information sharing. They also reported that when information arrive from social media it is usually at the same time as other more traditional sources. A representative of COGIC (Le centre opérationnel de gestion interministérielle des crises – *trans. Operational Centre for Interministerial Crisis Management*), noted the successful use of social media as a source of crisis information during snowstorms in March 2013, although this was after years of building capacity to manage this type of information. He said: ‘I went looking on the Internet and I saw that there were communities of 3 or 4 people who were successfully finding guys that were stuck in their cars in the snow and then put them in contact via Facebook with a farmer who lives roughly 150 meters away and to put them into contact so that the farmer could go and get that person. [...] by watching people look for people who were stuck in the snow, we started to see that there were people who were doing citizen crisis management’. For example, our Portuguese interviewees reported that it is not common practice for emergency managers to use social media to gather information about incidents from the public. This suggests that this is not standard practice in other EU member states.

Using social media as a source of crisis information presents various challenges including the credibility of user generated content, the ability to deal with vast amounts of data produced on social media platforms (the problem of ‘big data’), having personnel within the organisation to manage social media communications, and the conflict between providing real-time information whilst adhering to time consuming, internal verification procedures. Among these challenges, credibility as well as the perceived lack of a clear purpose for using social media in emergency management are seen as the main problems (Reuter & Spielhofer, 2016). The benefit of access to vast amounts of real-time information from various actors involved in a disaster goes towards mitigating them.

5.5 Crowdsourcing crisis information online

Although, there is research on developing systems to deal with the problem of ‘big data’ and the (in)accuracy of user generated content as discussed above, another solution is to use these systems with input from people. This is known as ‘crowdsourcing’. ‘Crowdsourcing’ in this context refers to “the power of the Internet and social media to “virtually” harness the power of individuals and bring them together in support of a disaster” (Riccardi, 2016:123). In other words it is the aggregation of crowd-generated inputs such as text messages and social media feeds with geographic data to provide real-time, interactive information on events such as wars, humanitarian crises, crime, elections, or natural disasters. It refers to the gathering of information from the crowd in all phases of a crisis, and most often results in crowdsourced ‘crisis mapping’, where information from social media is translated onto a map in a format that can be easily utilised by emergency management organisations and relief agencies (Schimak et al., 2015). The potential of crowdsourcing in emergency management has been observed in past events such as the Haiti earthquake (Zook et al., 2010; Gao et al., 2011). It is considered a powerful tool because resources offered by volunteers can be rapidly organised, and volunteers can be employed to provide, verify and organise information (Schimak et al., 2015). Our interviewee, a representative of COGIC (Le centre opérationnel de gestion interministérielle des crises – *trans. Operational Centre for Interministerial Crisis Management*), noted that using people alongside technology to analysis social media data improved the process significantly. He explained: ‘so there is a need for a tool, even at a billion euros, but we still need 50 random people to look at and read that information and algorithms can't replace that’.

The 2010 earthquake in Haiti was the first crisis where social media played a significant role in disaster response and recovery, and it has been widely researched. In relation to that event, Meier (2015) provided an overview of how the global digital revolution is permanently changing disaster

response, describing a new actor, the ‘digital humanitarian’. The network created by ‘digital humanitarians’ is a system formed by networks of volunteers and technical communities, which work with humanitarian organisations to help make sense of ‘big data’ and to assess the accuracy of social media crisis data. This guides towards the necessity of “humanitarian technologies that combine the wisdom of the crowd with the power of artificial intelligence” (Meier, 2015:97); where collaboration between humans and machines can be used to solve the problems associated with using social media as a source of crisis information.

The results are sometimes referred to as crisis maps, an innovation that builds on crowdsourcing and complements it. ‘Crowdmapping’ uses digital volunteers to collect, classify, and geotag messages, translating social media data into usable, actionable maps. During the earthquake in Haiti in 2010 one of the most commonly used platforms for this was Ushahidi³² (Starbird, 2011). This used volunteers to verify SMS and Twitter messages concerning request for aid (medical, shelter and food for example), and then plot these requests on a map which was openly available to humanitarian and emergency management organisations to help them determine where to send aid. Ushahidi was also used during the 2010 Russian wildfires, however the aim was to serve more as a “self-help map” (Meier, 2015: 50) matching individual needs with local aid volunteers. ‘Crowdmapping’ are relatively new concepts and require a certain amount of time, technological skill and organisational support to develop. From our interviews, only participants from VISOV and COGIC mentioned using these as they are from organisations with a specific remit for working with technology during emergencies. The representative of VISOV reported a wide use of ‘crowdmapping’ in social media monitoring to collect information from user and crowdsourced data. However, it needs to be clarified that it is still a technique used by organisations that do not have a direct role in emergency management operation.

5.6 Real-time information provision during disaster response

Real-time crisis communication, that is the information sharing about when events happen, is essential to emergency management. During a disaster, it has been reported that when the public have access to adequate information, they are able to make evidence-based decisions that allow them to save their own lives as well as help those around them (Mitchell et al., 2000). Technological advances are already transforming how emergency managers deal with information sharing with affected communities (Buehner et al., 2011). Emergency situations are by nature chaotic, thus the effective use of social media to deliver information during crises becomes crucial in order to raise awareness of situations and to involve the public (Wendling et al., 2013). Citizens increasingly turn to social media to supplement news media coverage of disasters and to obtain real-time information about such incidents. This is a trend that is expected to increase in future. A study by Reuter and Spielhofer (2016) collected questionnaire data from over 1000 European residents. They found that social media as an information source is considered faster (76%) and more accessible (54%) than traditional sources of information, i.e. newspaper, television and radio. Furthermore, as discussed in IMPROVER project D4.1, members of the public increasingly expect critical infrastructure operators and emergency management organisations to use social media to communicate directly with civilian populations at each stage of a disaster (Petersen et al., 2016).

Immediacy, ubiquity, and visibility are the elements that make social media a powerful force in crisis communication (Ely & Vardeman, 2015). These characteristics can be used to enhance crisis communication in several ways. First of all, they are collaborative and participatory. For example, established social media connections between emergency management organisations and the public allow disaster preparedness information to be disseminated ahead of an event (Vieweg et al., 2010; Lindsay, 2011; Rive et al., 2012). These sites allow people to connect with other citizens and with

³² <https://www.usahidi.com/>

A Communication Strategy to build Critical Infrastructure Resilience

emergency organisations, and participation in disaster information from the public allows emergency management organisations and critical infrastructure operators to tailor their messages to meet local as well as national needs (Laituri & Kodrich, 2008; Simon et al., 2015). Yet our interviewees reported that they use sites, such as Facebook and Twitter mainly to share information rather than to interact directly with the public. A representative of VISOV, for example, reported that they work to give advice and provide links to let the public find the information they need. Another of our interviewees (a representative of Barreiro city council), however, emphasised that social networks like Facebook allow direct contact and interaction that other means of communication do not provide.

Moreover, our interviewees from COGIC and VISOV discussed their active use of social media with online communities by guiding community managers and working on user engagement. Along with collaborating with the public, they reported that they also offer a platform for emergency management organisations and critical infrastructure operators to interact with each other, helping to spread crisis information and coordinate responses (Latonero & Shklovski, 2010). Messages that are deemed useful to an online community can be retweeted or reposted by members, thus social media can be described as “amplifiers of ‘official’ information” (Taylor et al., 2012:20). Our interviewees reported that on platforms like Twitter, official accounts were much more widely followed by other emergency management organisations. However, messages publicised on Twitter were likely to be ‘retweeted’ by other emergency management, critical infrastructure and government accounts, thereby extending their reach. For example, through a comparative study of Western and Pakistani Twitter users, it has been reported that the top 100 hubs and authorities from around the world significantly prefer linking to other user generated content, thus the initial information reaches a wider audience (Murthy & Longwell, 2013). Furthermore, connections between citizens offers the potential for users to access disaster information unintentionally if the message is retweeted or reposted by someone in their online community (Houston et al., 2012). During the terrorist attack on the Bataclan nightclub in Paris in November 2015, one of our interviewees, the journalist Sylvain Lapoix, tried to reach as many people as possible by tweeting something similar to: ‘If you are looking for or offering shelter due to the Paris attacks, add the hashtag #PorteOuverte’. He believed that launching that hashtag on Twitter could be an alternative to phone calls, providing people an alternative communicative tool. What made the hashtag #PorteOuverte visible and thus successful was the fact that other journalists followed by high number of followers (50,000) followed Lapoix, and they retweeted the message. This hashtag appeared to perform a similar function to other online campaigns that have emerged in the wake of man-made or natural disasters. For example, social media was used to direct support to those most in need after Hurricane Katrina, the 7/7 terror attacks in London and the Mumbai attacks in 2011 (Potts, 2014).

Second, social media have the ability to share information in real-time. Crisis information can circulate very quickly among actors, thanks to RSS feeds or Tweets, which are immediately available online to multiple organisations and citizens (Simon et al., 2015). Sutton (2010), whilst discussing Twitter as a platform for sharing updates and breaking news to audiences in real-time, found that during the TVA Ash Spill crisis in the USA in 2008, messages via Twitter often reached the public before those disseminated through traditional media. As discussed above, among emergency management organisations in our interviews, however, it emerged that internal hierarchies can affect the immediacy of communication, i.e. individuals higher up in the structure need to be consulted (and have to sign off on content) before information can be shared on social media. Within this discourse, responsibility is a crucial element that affects the timing of information sharing. An interviewee in charge of crisis communication for a French transport company reported that any communications planned should be checked before being issued in order to protect the organisation’s reputation. Although this procedure causes constraints in terms of reaction time, the interviewee reported that the company ensures that they communicate any information about the likely waiting time.

Emergency services can extend their reach when sending information or a warning. For example, during Hurricane Irene in the USA in 2011 Twitter was used as one of the primary resources for information sharing (Freberg et al, 2013). Regarding this, Keim & Noji (2011) discussed one of the positives of social media over traditional media, viz. it is representative of more vulnerable and

marginalised groups. Through the democratisation of information these groups can participate in disaster reporting and recovery as stakeholders. However, it needs to be acknowledged that social media is not inclusive as “it remains less widespread and accessible than traditional media” (Keim & Noji, 2011). Furthermore, a study by Liu et al. (2014) concluded that even among young adults there is no single information platform that can adequately warn the public about disasters (Liu et al., 2014). Indeed, just because people use social media does not mean that they follow accounts that will share crisis information. One vulnerable group that has been studied is disabled people (Morris et al., 2014). This study found that biggest influencer on use of social media was age, and for disabled people this divide is even greater. Morris et al. (2014) found that older disabled people overwhelmingly use traditional media (television) to get information before during and after a disaster. However, another digitally marginalised group are people who are not located near the epicentre of the disaster or in a big city affected by the disaster. They tend to be under-represented in mainstream media, and official messages may not be appropriate, or may be too general.

Caution must be placed on the extent to which social media can give marginalised communities a ‘voice’. Madianou et al. (2015) note that digital technologies are more likely to be used by middle-class populations to publicise their needs, whereas poorer people, through lack of infrastructure and skills, are less likely to use technology to attract attention. Furthermore, people from lower socioeconomic groups are less likely to form a confident, sustained and wide-reaching voice via social media (Madianou et al., 2015). Instead, the authors found that their voice tends to lack confidence due to their status, be reactionary and immediate rather than sustained, and is limited to communication with peers rather than humanitarian organisations and governments.

Fourth, online networks are resilient to different disturbances in critical infrastructure compared to traditional media. This can be seen in various disasters, for example during Hurricane Katrina in the US in 2005 it has been found that people turned to social media for information when critical infrastructure such as power and telephone lines became disrupted (Procopio & Procopio, 2007). Furthermore, during the terrorist attack in London in 2007 the Internet and social media were an important source of information after police shut down traditional communications networks. It has been observed that “for many Londoners, especially those who were deskbound in their workplaces, the principal source of breaking news about the attacks was the Internet. In contrast with the mobile telephone companies, internet service providers were largely unaffected by the blasts” (Allan, 2007:5).

Our interviewees also reported they have used social media during disasters when other traditional forms of communication were disrupted. VISOV reported using smartphone applications, such as WhatsApp (a free messaging app that allows to send and receive messages, calls, videos, documents and voice messages through the phone’s Internet connection (4G, 3G, 2G, EDGE or Wi-Fi, as available), which was available to use during the bombings in Brussels in 2016 when mobile phone networks were overwhelmed with traffic. Mobile phone networks were also saturated during the Bataclan terrorist attack in 2015, which is one of the reasons that Sylvain Lapoix used Twitter to help people find shelter. In addition, at COGIC they believe that social media was a more resilient means of communication than basic telephone lines because they do not get congested. This is the reason why they emphasised the importance of the creation and maintenance of online communities through practices of user engagement.

Finally, social media provide an alternative to traditional media that substitute normative social responses to information seeking during and after a disaster. Recent studies show that crisis managers can provide effective messages and strategic communication through social media, where these platforms support ‘backchannel’ communications, that is, informal communication channels which are often the primary means by which hazard information first reaches members of the public (Sutton, 2010). During the floods in Australia in 2011, for instance, local communities set up Facebook pages to offer aid and share stories and images, and was the most important sources of information accessed by these local residents (Bird et al., 2012). Social media represent a growing and effective means of communication that can add an additional level of communication to emergency situations (Heat et al., 2009; Dillard et al., 2007).

Although the use of social media for information seeking during a disaster is increasing, traditional media is still relied upon by the majority of the population (see section 2). Regarding this, Thelwall and Stuart (2007), analysing *three case studies from 2005 (the July 7 London attacks, the New Orleans hurricane, and the Pakistan-Kashmir earthquake)* found that although new technologies such as Web 2.0 was utilised at the early stages of a crisis, mainstream, traditional media were more trusted and useful in covering the aftermath. Even the majority of interviewees reported a mixed use of traditional and social media in information sharing. They recognised that both mediums are likely to be used by citizens seeking information about crises and disasters. They reported also that institutional official websites are recognised and used by the general public as a reliable channel of crisis information, and can be used by emergency management organisations to interact with the public. For instance, to communicate with IPMA³³ (Instituto português do mar e da atmosfera) the public is able to communicate via email (using the email address available on the website) and/or via messages using the specific section on the website.

5.7 Ethical challenges of using social media during disasters

In computer network security, there is an interwoven ethical debate related to what can and cannot be done online. Through the *contagion theory*, for instance, Sampson (2012) emphasises the difficulties that communication theory encounters in approaching the issues related to the virality and connectivity of the Internet. In the age of networks, the visibility afforded by the Internet makes daily communication and information publicly available. This is an aspect that constitutes an increased fragility for the majority of online services. In this environment, online platforms benefit from the connectivity afforded by platforms but, at the same time, expose themselves to issues about privacy and ethics. The notion of virality theorised by Sampson (2012) clarifies the dynamics that guide the expansion of online information. It is precisely within this debate that is important to address also the benefits for emergency managers of using social media to share information. Although Sampson (2012) presented the notions of connectivity and virality in relation to online social communication, they can also influence relevant ways to approach online information exchange. Sociality online shows individuals' necessity to communicate and share information on a daily basis. The connective affordances of social media allow information to be shared quickly, setting the conditions for challenges and concerns. For emergency management organisations, the notion of virality is important because it shapes their use of social media. Emerging from interconnected social media usage, this notion guided recent research to theorise the creation of 'dynamic social infrastructure' (Nahon & Hemsley, 2013). Although widely used, the viral metaphors seem to fail to illustrate precisely the active role of users in disseminating media content. Users share content that are meaningful to them and that have a special relevance in the context they interact. Considering this, media texts are seen as viral media. However, this conception of "self-replicating" culture, according to Jenkins et al. (2013), "is oxymoronic, as culture is a human product and replicates through human agency" (p.19). Although the criticism, virality explains how culture is becoming increasingly participatory and this is an additional aspect to consider when discussing crisis communication.

Risks are usually related with unregulated Internet-based systems, which could potentially damage people's reputation (Boogs & Edwards, 2010). It could also involve invasion of privacy and unauthorised dissemination of personal information (Alexander, 2014). In addition, another possible ethical challenge for emergency management could be identified in the misrepresentation of disasters (Singer & Endreny, 1994) that, through the virality of the Internet, can deliberately or inadvertently spread false information. These are only few of the reasons why before the information is shared online, it is crucial to take into consideration the potential effects caused by the virality of the Internet. When applied to crisis communication, this kind of conceptualisation finds a social media landscape

³³ <https://www.ipma.pt/en/>

that needs new regulations. A discourse on ethical approaches adds the basis for critique and a clear normative reference point for stakeholders, communicators, and critical infrastructure operators.

As discussed above, the Internet and social media allow the sharing of real-time information and this aspect is seen in emergency management as an opportunity to facilitate and accelerate crisis communication. The creation of webpages and social media profiles has become a common practice among emergency organisations and critical infrastructure operators. The interactive nature of the Internet provides the ability to engage with the general public more directly than other means of communication. Nonetheless, these affordances pose important legal and ethical challenges that slow the information sharing. Moreover, the level of confidentiality of the data provided by users could be threatened because it is difficult to assess whether social media users consent to the analysis/use of their data (Wendling et al., 2013). The challenges in using social media during emergency situations are located between the benefits of openness and privacy protection.

However, social media remain less widespread and accessible than traditional media and that they carry several issues such as the absence of verification procedures that regulate traditional media (Kein & Noji, 2011). It follows that privacy rights violations can occur as people use social media to describe personal events and circumstances (Kein & Noji, 2011). Indeed, challenges related to surveillance, (unrestricted) collection and processing of personal and sensitive personal information are central concern for professional organisations (Watson & Rodrigues, 2017).

Social media blurs private and public boundaries when individuals' personal information and opinion enter the public domain. This condition complicates the work of emergency services (Alexander, 2014). As discussed in section 3.1, social media has not only changed the perception of risk and crisis, but also citizens' expectations towards emergency response officials, private sector and volunteer organisations. In this change, a wider use by crisis communication experts of Twitter, Facebook and Ushahidi among others has been witnessed (Wendling et al., 2013). In this context, the scope and speed of social media make it an effective medium through which emergency management organisations can share information and bring awareness to their services. However, with any form of content sharing, they have a duty to share responsibly.

A study conducted by Moynihan (2009) on network governance in crisis response discusses the efficacy of using the Incident Command System (ICS). The Incident Command System³⁴ is a standardized approach to emergency response that provides hierarchy within so that the various agencies can be effective. Moynihan (2009) discusses how this approach ignores the importance of decentralised flexibility to deal with the turbulence of crisis situations (Tierney & Trainor, 2004). All our interviewees shared the same difficulty and concern in delaying emergency communication. This delay is given mainly by the need to protect the image of the body they work for.

Discussing ethical frameworks in relation to the use of big data to engender resilience, Crawford et al. (2013) stated the necessity to draft a set of guidelines at the beginning of the process to ensure the effectiveness of community-oriented data projects. This is in contrast to considering ethics and privacy only in disaster response and merely as a "compliance process" (Montjoye et al., 2012), because potentially the collection and use of online data can produce further risks for affected victims. Indeed, a study conducted by Montjoye et al. (2012) showed that even anonymised data can be used to re-identify people despite the importance that the notion of privacy protection has and this can be a problem in emergency management. The Internet and mobile phones, in fact, widely challenge this notion of privacy as individuals' movement tracking is widely used.

³⁴ <https://www.fema.gov/incident-command-system-resources>

A Communication Strategy to build Critical Infrastructure Resilience

Two French interviewees, discussing the ethical use of social media mentioned the idea of “doing the right thing”. They agree with the free use of social media contents because ‘the right to information is superior to copyright law’ (representative of VISOV) and because ‘even images, for instance, are considered information, not private property. So, they have the right to use them as an information’ (representative of COGIC). These considerations show how technological advancements generate ethical questions as well as new opportunities, mainly because advances appear faster than the discussions around privacy laws and personal security. During emergency situations, ethical challenges of communicating accurately and strategically are usually considered a matter of prime importance.

There is a general consensus in the emergency management community on what is right and ethical to think, say, and do in the immediate aftermath of an emergency situation (Alexander, 2013). Alexander (2014), theorising the contemporary communication society, advanced the notion of ‘death of discretion’ to describe the ubiquity of everyday computer-mediated activities. By doing this, he emphasised the general lack of online privacy. Regarding this, according to Nissenbaum (2004), the notion of privacy is subject to a set of norms about what can be shared and how. These norms change in relation to different social contexts defining so the theory of ‘contextual integrity’. This is one aspect that clearly affects the way information is shared in emergency management in terms of contents (privacy protection) and timing (internal hierarchies). This is important for crisis communicators since the data shared and used during emergency situations will be different from everyday life. A recent study conducted on Hurricane Katrina and the Californian Bushfires, discussed the legal liabilities of using information generated on social media and other web 2.0 technologies by disaster relief organisations (Low et al., 2010). These are identified in misinformation, failure to warn, negligence, and inadequate response. Although there are legal risks, as long as these are assessed and a risk minimisation strategy is in place, then social media can provide a useful source of information and a useful information dissemination tool during emergency situations. Additionally, a study conducted by Raikes and McBean (2016) argues that a lack of standards in emergency management regulation, restrictive access to compensation and reduced government exposures to civil liability exposes private sectors and the general public to extreme vulnerability to disaster. In these conditions, the absence of clear regulations and assistance guidelines cause inevitably unfair financial risks. It follows that the development of minimum safeguards for the public is an essential part of the preventive planning for disasters (Raikes & McBean, 2016).

However, the public nature of social media messages shared during crises do not make their use automatically ethical (Meier, 2015). Instead, social media content needs to be assessed considering their (in)accuracy, and following cross-referencing with other sources of information such as journalistic reports and information received via other crowdsourcing mechanisms. Another challenge rises around the fair use of individuals’ personal private information as well as traumatic images. In relation to ethics, emergency management organisations have communication departments and report the support of internal legal teams; issues about copyright, and the ethical use of multimedia content are managed and controlled internally, i.e. all information is verified before being shared with the public. With these legal implications, it is important not to think that social media can be fully controlled, or that the legal issues are clear-cut. In relation to people affected by disasters, there should be a reasonable expectation of privacy.

A recent study reports that photos presenting identifiable victims from recent terrorist attacks in Brussels and Istanbul were uploaded on Twitter within few minutes of the explosions, with the potential to reach any emergency authorities (Simon et al., 2016). This showed that the privacy of the victims and their families had already been violated by accidental and citizen journalists at the scene. However, these events show that emergency management organisations need to change policy concerning ethics in emergency situations. They show also how social media can be seen as an opportunity to improve the response of emergency services and improve the emergency management decision-making (Simon et al., 2016). Twitter, in particular, played an important role as communication channel that, in similar situations, can help victims provide visual and/or written information that can help rescue activities. Analysing those events, Simon et al. (2013) believe that the

general public should be better educated in relation to the sharing of information that might cause harm. Furthermore, there should be a better knowledge on how to use social media as tool to build disaster resilience.

5.8 Social media as a tool for building disaster resilience

As discussed in section 1.1 the main objective of task 4.2 is to explore the use of social media to build disaster resilience. Most of this resilience building relates to the use of social media to enhance community resilience. This section builds on the literature reviewed above and the data analysed to form a critical interpretation of how social media can be an effective communicative and informative tool during crises. Considering that individuals and organisations communicate and perceive information differently during a crisis (Freberg et al., 2013) there are not univocal rules and/or practices to follow. Rather, there are guidelines that can be followed and adapted by various communicative actors (see section 4).

Using social media to inform and prepare populations can increase their resilience to a disaster (Norris et al., 2008; Houston, 2012). As noted above social media are a useful tool in real-time information dissemination, and communities developed online between emergency management organisations and the public can help disseminate disaster preparedness information beyond the organisations' initial reach. Other studies confirm the increasing use and potential of social media in emergency situations where the public demands constant updates. People accept that a situation evolves as long as they know what is going on (see section 2.4). This includes needing information about whether friends and family are safe. It has been observed that nearly 25% of the general public and 33% of the online population would definitely use social media to let loved ones know they are safe (Wendling et al., 2013). Another example can be observed in Japan after the March 2011 earthquake and tsunami, social media facilitated public alerts, helped locate missing people (Hjorth & Kim, 2011). In addition, during the California wildfires, Twitter was used as a primary crisis communication tool for the public to communicate with family and friends. This was also seen during the Haiti earthquake (Meier, 2015; Veil et al., 2011) and the Japanese tsunami (2011) (Freberg, 2011). Being able to contact loved ones reduces the feeling of uncertainty that experiencing a disaster can cause, and provides people with information to make informed decisions. As discussed in section 2, this can increase disaster resilience by allowing people to react appropriately and safely during and after disasters (BBC World Service Trust, 2015).

This idea of connecting people and communities goes further than just ensuring loved ones are safe. During disasters, mass evacuations can take place which can lead to people losing contact, and traditional community ties being broken (Houston et al., 2012). Social media allows these community links to be reformed online, and can even facilitate the creation of online groups (Procopio & Procopio, 2007). This can increase community resilience by enhancing social capital and connections (Norris et al., 2007; Procopio & Procopio, 2007). Furthermore, at least in the short term there appears to be some evidence to suggest that it unites communities affected by such incidents. This might provide the basis on which community disaster resilience might be built. This can improve disaster resilience as the community becomes responsible for aiding in the recovery stage after a disaster. This is especially prevalent in relation to post-riot recovery, for example after the riots in England in 2011, communities on Twitter were able to mobilise and organise the riot 'cleanup' (Proctor et al., 2013). Furthermore, online groups can also help mobilise citizens to contribute towards first aid, search and rescue and evacuation (Palen & Liu, 2007; Simon et al., 2015). By promoting actions that help recovery, social media can increase disaster resilience.

This concept of online groups not only mobilises peoples to aid in disaster recovery, it can also go further and provide a 'mentality of self-governance during emergency situations' (Kaufman, 2015: 984). Self-governance and self-organisation allows people and organisations to be more resilient as it increases their ability adapt to cope with extraordinary events such as disasters. The networked character of social media contributes to the sharing of information, thus making individuals more independent from official information channels. The independence gained through everyday

A Communication Strategy to build Critical Infrastructure Resilience

information sharing on social media can give people the confidence to search and select relevant information during a disaster from official and non-official sources (Kaufman, 2015). For example, Kaufman (2015) notes that during the 2011 Norway gun attacks people took responsibility for seeking information that was relevant to them, and used this information to help themselves and their community.

Psychological resilience can also be enhanced through the use of social media. Keim & Noji (2011) note that through social media affected populations are able to contribute to the online discourse surrounding the event. This can increase resilience by “replacing their helplessness with dignity, control, as well as personal and collective responsibility” (p.47). Social media can be used as a source of crisis information during the first phases of a disaster (mitigation, and preparedness), and also during post-disaster communication phases (response, and recovery). Two interviewees, researchers and volunteers in charge of the management of social media at l’IHMEC³⁵ (Histoire et la Mémoire des Catastrophes – trans. History of the Memory of Disasters), emphasised the importance of using social media in the disaster recovery phase. At IHMEC, their use of social media is focused on gathering information to build collective memories. The aim is to collect people’s testimonies from Facebook and Twitter, and then share these with others to help people become psychologically prepared for disasters, able to deal with crises better, and provide online support to survivors and their communities.

Social media can increase resilience of disaster affected individuals, but it can also increase resilience of emergency management organisations and critical infrastructure operators. Post-disaster people look to understand the event and analyse recovery efforts by emergency management organisations and critical infrastructure operators. By analysing information shared on social media, and by contributing towards the online discourse around the events, these organisations can learn which areas of their response was effective, and communicate their perception of events (Houston et al., 2012). Furthermore, by playing an active role in social media discourse surrounding a disaster, emergency management organisations can more easily disseminate information about the current crisis, and utilise these online connections to coordinate recovery and encourage preparedness for future crises (Dufty, 2012). This post-disaster monitoring of social media is also useful to gather feedback that can provide lessons to make emergency management organisations, critical infrastructure operators and the public more resilient against future crisis (Perko, 2011; Cheng et al., 2015).

³⁵ <http://memoiresdescatastrophes.org/>

6 AESOP Guidelines for effective communication between critical infrastructure operators and members of the public during crisis situations

Communication and the exchange of information is a crucial element in today's crisis management (Neuhaus, 2010). When talking about crisis communication one has to consider the whole flow of information including the people, the messages, the environment and the stakeholders involved. Critical infrastructure operators should understand which technology is used and the communicational preferences of the public to be able to define the best communicative channels to use with citizens during emergency situations. As discussed earlier, there is not a single 'killer app' or a platform when it comes to which communication channel(s) should be deployed during incidents. Rather, this report recommends a 'communication mix' formed by the co-presence of traditional media and social media, similar to that proposed for blue light organisations (Reilly & Atanasova, 2016). In addition to considering the co-presence of traditional media and social media, critical infrastructure operators should consider the differences in information seeking among the different target populations. For example, a study conducted by Austin et al. (2012) on college students showed that teenagers are more likely to use traditional media rather than social media at the early stage of the crisis. But they are more likely to seek information from friends' Facebook pages whether they learn about the crisis through social media. In addition, a similar experiment conducted on information sharing showed that college students had a more positive approach when they received information from organisations through traditional media (Liu et al., 2013). Despite developments in communication technologies, other studies demonstrated that traditional media are still perceived as a more credible source than social media and online information (Flanagin & Metzger, 2000; Stephens et al., 2013). A finding from IMPROVER project D4.1's questionnaires reported that Portuguese respondents were much more likely to expect critical infrastructure operators to have a hotline than other agencies, once again showing the importance of knowing the communication habits of the stakeholders (Petersen et al., 2016). Considering existing differences in information seeking, we advise that critical infrastructure operators should analyse information-seeking behaviours of local populations before designing their communication strategies.

In the United States, for example, Liu et al. (2014) found that 75% of respondent to a 2010 American Red Cross survey expected to receive assistance within one hour if they have made such a request via social media. Yet, less than one in six emergency managers has personnel dedicated to social media communication (Su et al., 2013). In addition to this example, as discussed in IMPROVER project D4.1, a survey of European citizens undertaken for the EU FP7 Project EmerGent (Emergency Management in Social Media Generation) found that 43% of citizens have used social media in the past to look for information during an emergency and that 58% will do so in the case of a future disaster (Petersen et al., 2016). Although there is a need to increase the use that critical infrastructure operators make of social media, it is essential to understand how the public uses social media during a disaster and what information they expect from official sources (Liu et al., 2014).

Another important aspect that critical infrastructure operators should analyse is what type of information the public expect to receive. As discussed in IMPROVER project D4.1, the public expect to find accurate information on different channels and from a range of organisations that they trust (Petersen et al., 2016). In fact, when dealing with information seeking during crises the presence of trustworthy sources is recognised as fundamental more than the choice of the channel.

A study conducted by Palen and Liu (2007) testified this behaviour showing that people are most likely to seek information from their own social networks. From this, it seems that official sources of information are only used if these initial sources are unavailable (Stiegler et al., 2011), and these official messages are sought alongside unofficial messages through any available medium, be that traditional or social media (Hughes et al., 2008). One problem with this behaviour is that the public learns about disasters through messages created from sources other than professional journalists and

A Communication Strategy to build Critical Infrastructure Resilience

disaster relief organisations. This means that official sources have less control over the messages than they were previously used to, and thus they have to adapt (Cooper, 2011). As these studies show, there is not a uniform information-seeking behaviour. It varies substantially in relation to the target population. Regarding this, critical infrastructure operators should study the information seeking behaviours of local populations regularly in order to identify changes.

Knowledge about the information-seeking behaviours of local populations can help improve the efficacy of future communication practices of critical infrastructure operators during major incidents (Artman et al., 2011) (see section 4.5). There are a number of important lessons that can be learnt from citizens' information-seeking behaviours. Social media monitoring is one example and it can be useful to both pull and push information to match public expectations and needs. This allows critical infrastructure operators to analyse discourses on social media in order to adjust crisis information sharing according to public expectations. Regarding this, two interviewees (representatives of Barreiro City Council and a French public transport company) reported that during emergency situations they do not tend to respond directly to the general public (person-by-person). Rather they prioritise the emergency event itself. However, they report that they usually post information and updates about disruptions on their official websites. This data does not show the presence of multiplicity of communication channels and, as discussed in IMPROVER project D4.1, this gap is considered one of the most negative aspects in public expectations of crisis communication (Petersen et al., 2016). The public expect to receive regular updates from critical infrastructure operators, especially in relation to the time required before their services are fully restored. This aspect is related to real-time information sharing and it is discussed more in detail in section 4.3.

A more distinctive interpretation of the co-presence of traditional and social media in information seeking behaviours is given by the fact that people are most likely to use the means of communication that is available at the moment of the crisis. Therefore, people's access to communication channels does not depend only on the target population (e.g. gender, age, culture) but also on functionalities. An example of this is that during Hurricane Sandy residents in the area used every method available (peer networks, radio, television, and social media) to obtain information (Burger et al., 2013). Following this, critical infrastructure operators should also consider a strategic use of multiple channels. This should involve the analysis of the communication infrastructure available in the area and the analysis of the type of media used by local residents. Surveys are one way to identify which communication channels are mostly used by the public, such as the one carried out in IMPROVER project D4.1 (Petersen et al., 2016).

A 2014 study showed that the use of social media is growing and counted 300 million active users across Europe at the time (Kemp, 2015). As discussed in Section 3, there is an expectation of increased use of information and communication technologies in everyday life. This suggests also an intensification of social media use during crisis. This is supported by the social media usage observed during various disasters, such as Haiti earthquake (Meier, 2015) and Super Typhoon Yolanda in the Philippines (David et al., 2016). Therefore, critical infrastructure operators should also take into consideration the information-seeking behaviours of their audience in order to adhere to technological developments and applications.

Critical infrastructure operators should look into the analysis of information-seeking behaviours as a starting point to engage with the public. For instance, Artman et al. (2011) emphasised the concept of 'dialogical emergency management' in order to stress the dual relationship between emergency management and the public. This concept is important to demonstrate the need to redirect the focus on the relationship between critical infrastructure operators and the general public. Regarding this, indeed, critical infrastructure operators should use the study of traditional and social media to define how to interact and engage with citizens during crises. This aspect is discussed in detail in section 4.2.

Recommendations:

- Critical infrastructure operators should collect and analyse data about traditional and social media use at local, regional and national levels;

- Critical infrastructure operators should identify the communication channels that their target audience is able to access;
- Critical infrastructure operators should identify the platforms (traditional and social media) that their target audience uses on a regular basis;
- Critical infrastructure operators should review current communication strategies and information seeking behaviours of your audience on annual basis in order to meet changes and technological advancements.

6.1 Engage key stakeholders in order to ensure message consistency across traditional and social media platforms

Critical infrastructure operators should understand how emergency management organisations and crisis communication teams are organised, and how organisations communicate with each other and with the members of the public. However, there are challenges that slow down these relationships. According to our interviewees (representatives of COGIC and Ministry of Interior), in emergency management organisations, the presence of an internal hierarchical structure is often seen as the factor that slows the process of crisis communication, as also noted in section 3.1. Collaboration between critical infrastructure operators, emergency management organisations, and news media organisations is crucial to ensure that information shared is accurate and provides citizens with advice on how to mitigate effects of these incidents (Sutton et al., 2014). This can help enhance resilience where the lack of consistency might reduce the effectiveness of the information sharing.

In some EU member states, the national emergency management structure may restrict the ability of critical infrastructure operators to collaborate with other emergency management organisations. For example, as noted above, our study found that in Portugal, Barreiro City Council does not communicate directly (person-to-person) with the general public during emergencies because they consider the restoration of services a priority. Conversely, emergency management organisations, such as DEMA, inform the public regularly across different channels and platforms. To create a uniform and effective approach critical infrastructure operators should design their communication strategies to include collaborations with emergency management organisations, benefitting from the way they share information. The serial transmission can ensure a more accurate spread of information. For example, they could engage with social media platforms (such as Twitter) used by emergency management organisations to post and retweet crisis information. To support this, a previous study has shown that a repetitive sharing of the same information via different channels is more likely to reach a wider number of citizens during emergencies (Stephens et al., 2013). This data suggests that crisis information consistency from key stakeholders is important to enhance critical infrastructure resilience.

Moreover, critical infrastructure operators should ensure that the most accurate information is widely spread across different platforms and channels. Research conducted by Carey (2003), for instance, showed that during crises the public prefer to receive information from local government sources because they trust these sources. Carey (2003) also reported that the public will engage with other communication channels if their preferred one has no information about the event they are looking for. This data again confirms the necessity for critical infrastructure operators to engage with other stakeholders.

A study by Liu et al. (2014) argued that even among young adults there is no single information platform that can adequately warn the public about disasters. Through an empirical study conducted on Boston Marathon Bombings, for instance, it has been observed that the general public's behaviour in receiving and sharing information about the event through online channels (e.g. online videos, Facebook posts, blogs, and emails); identifying in these a range of opportunities to enhance resilience through 'effective widespread crisis communication' (Liu et al., 2014:62). In addition, during the floods in Australia (2011), local communities set up Facebook pages to offer aid and share stories and images; which was reportedly the most important source of information accessed by local residents during that event (Bird et al., 2012). In addition, a study conducted on floods in Germany (2013)

reported that Twitter, Facebook, Google Maps and other services were frequently used by victims and volunteers to coordinate the rescue activities (Kaufhold & Reuter, 2016). As these studies showed, there is a significant expectation from the public to receive information through various social media channels. For this reason, critical infrastructure operators should play an active role together with emergency management organisations and professional journalists in sharing consistent information across platforms in order to establish trust and maintain their image.

Critical infrastructure operators should also cultivate good relations with news media to enrich and simplify crisis communication with citizens. Although social media use may have grown significantly in Europe over the past few years, critical infrastructure operators may reach more citizens in disaster-affected areas through the use of traditional media channels (Keim & Noji, 2011). Social media remains less widespread and accessible than traditional media. As discussed above, there is still a high number of the population that believes traditional media to be more credible. Also, a survey results from IMPROVER project D4.1 reported that 96% of responders expect critical infrastructure operators to use traditional media (higher than website or social media, even though both were higher than 50%) (Petersen et al., 2016). News media organisations, through their visibility, can help critical infrastructure operators to share information and inform the public about crises. We can also mention the work done by Sylvain Lapoix during the 13th of November 2015 terrorist attacks. Thanks to his popularity as professional journalist using social media, he was able to share information on Twitter. The hashtag #PorteOuverte that was widely used during the event in order to connect people who were in the area of the attack and looking for shelter. This event showed how the visibility offered by social media can be employed to enhance resilience and share information. Following the terrorist attacks, Sylvain Lapoix reported that the same hashtag was mentioned on television after the Nice terrorist attack. In that case, the general public benefited from the impact of news media. During these two events, the visibility offered by news media organisations and professional journalists increased the potential of information sharing. Considering this, critical infrastructure operators should benefit from the same affordances from engaging with these agencies.

Recommendations:

- Critical infrastructure operators should engage with the emergency management organisations in their respective area;
- Critical infrastructure operators should engage with professional journalists and media channels to ensure consistency in information sharing.

6.2 Social media should be used to provide real-time updates to citizens about ongoing efforts to restore services

Critical infrastructure operators should benefit from the same affordances of social media that have enhanced emergency management organisations over the past decade. A study conducted by Keim and Noji (2011) showed two main advantages of social media for disaster resilience: the flexible and proactive nature, and the immediacy of information. The flexibility of social media can help during disaster response and information dissemination. As discussed in IMPROVER project D4.1, in crises there is a wide expectation from the public to find up-to-date information (Petersen et al., 2016). This expectation is mainly given by the contemporary expectation to access a real-time flow of information (Unger, 2015). Therefore, to fulfil citizens' expectations, critical infrastructure operators should use social media as a space to share information about the restoration of services during crisis. The majority of interviewees reported that they do not tend to respond to queries raised by the public on social media mainly because it is time consuming. A representative of a French public transport company, for instance, reported an active use of Facebook, Twitter and Instagram. Although they did not report a direct communication with individual citizens, they regularly provide general information on their platforms. The information they share is always verified internally by a legal team and worked by the crisis communication team ensuring the validity of information.

Critical infrastructure operators can also benefit from the fact that smartphones can be used to access the Internet independent of infrastructure such as power and telephone lines. During disasters, loss of communication can occur due to loss of mobile phone signal (Palen & Liu, 2007), damage to communication infrastructure (Low et al., 2010) and loss of access to traditional media due to disruptions to power (Stiegler et al., 2011). Owning a smartphone can enhance resilience because, as discussed in IMPROVER project D4.1, it can keep working for a short period even if there is no access to the central power grid (Petersen et al., 2016). The immediacy of information is not something that traditional media can offer, therefore it has been argued that social media is a unique platform in providing real-time disaster information (Gupta et al., 2013; Lerman & Ghosh, 2010).

Critical infrastructure operators can utilise social media to give updates on efforts to restore services. As social media is collaborative it also offers a way for people to engage with disaster recovery services. Some disaster victims have a psychological need to contribute to recovery efforts in order to better cope with the situation. Furthermore, the control and dignity that come from helping with the recovery efforts, and the sense of collective responsibility can increase community resilience (Keim & Noji, 2011), as discussed also in section 3. Following this discourse, engaging with information communication technologies, traditional media and social media during a disaster can increase people's awareness of and engagement with the community, which can in turn help recovery and increase resilience (Cheng et al., 2015).

Regarding the use of social media during disasters, the Federal Emergency Management Institute³⁶ (FEMA) is a good example of best practices. FEMA was the first organisation in the English-speaking world to use social media for information dissemination (Musacchio, 2014). The analysis of FEMA Facebook, Twitter and blog communication showed that Facebook messages were short signposts to further information and often contained imperatives (e.g. 'Be prepared!'), Twitter tweets were shorter and often used hashtags, blogs were longer and similar in content to newspaper articles. On Twitter, FEMA was found to utilise consolidated terminology, with a focus on creating connections, and devising educational slogan-like messages. Although FEMA is an institute based in US, it can be used by critical infrastructure operators as an example of best practices for providing real-time updates which can be developed in EU countries.

Critical infrastructure operators should also use functions such as the 'retweet' on Twitter to share messages from official sources. Official sources include emergency services, incident managers and local authorities, whereas unofficial sources are most likely to consist of content posted by citizens. Studies have shown that such repetition of official crisis information is more likely to convince people to take appropriate action to protect themselves and their communities from harm (Tierney, 2009; New Zealand, the Ministry of Civil Defense & Emergency Management, 2010; Stephens et al., 2013; Reilly et al., 2016). For example, research has shown that music festivals in Belgium repost and retweet content originally posted by local Police and other blue light organisations in the case of an incident (Reilly et al., 2016) thus improving resilience.

During crises, critical infrastructure operators should provide real-time updates to customers about when services will be fully restored. During Hurricane Sandy, for instance, customers became increasingly frustrated when power companies refused or were unwilling to give them an accurate timeline for restoration of electricity and other key utilities in affected areas (Pramaggiore, 2014). The frustration over not having access to power was compounded by the feelings of uncertainty due to a lack of communication from the power companies. Our interviewees (representatives of VISOV and COGIC), for instance, reported that during emergencies, they used their Twitter accounts to direct the general public toward the source of information that could better provide responses to the questions

³⁶ <https://training.fema.gov/>

raised. Critical infrastructure operators should do the same through the use of their social media accounts.

Recommendations:

- Critical infrastructure operators should use social media to provide real-time updates to citizen about when services will be fully restored;
- Critical infrastructure operators should share content produced by emergency management organisations during crisis situations;
- Critical infrastructure operators should respond to queries via social media in a timely fashion (but not necessarily immediately) in order to build relationships with local communities;
- Critical infrastructure operators should redirect the communication toward emergency management organisations in the case of questions beyond their scope.

6.3 Observe and adhere to context-specific regulatory frameworks for emergency management and resilience

Critical infrastructure operators should ensure that their communication strategies are compliant with relevant national regulatory frameworks. Reducing the vulnerabilities of critical infrastructure and increasing their resilience are two of the major objectives within the European Programme for Critical Infrastructure protection³⁷ (EPCIP). This document sets the overall frameworks for practices that aims to improve the protection of critical infrastructure in Europe. Critical infrastructure operators should consult this regulatory framework in order to put their organisation in line with EU regulations. A fundamental document of this programme is the Directive on European Critical Infrastructure³⁸ (DECI) dated 2008. This document illustrates a common approach for assessing the need for critical infrastructure improvement (energy and transport sectors only). According to these studies, an adequate level of protection must be ensured and the detrimental effects of disruptions on society and citizens must be limited. As discussed in IMPROVER project D1.1, in the EU there are regulatory frameworks for critical infrastructure operators that differ among countries (Melkunaite et al., 2016).

This regulatory framework is helpful for emergency managers and other actors during crises because it illustrates chains of command, degrees of collaboration between actors, and different national regulations. An example of these methodologies can be observed in the UK JESIP (Joint Emergency Services Interoperability Practices). These guidelines can be used to implement most of the processes that regulate emergency management. The aim of this programme was primarily to improve how emergency services collaborate when responding to crisis situations. To do so, JESIP produced a guideline the 'joint doctrine called interoperability framework' based on the following principles: working together, situational awareness, joint-decision making, risk assessment and multi-agency communication. As can be seen, JESIP's focus on improving responses during crises was largely based on communication, collaboration and interoperability. Critical infrastructure operators should consider employing JESIP's principles and models because they can be applied to a multitude of situations where organisations need to work together.

As discussed in IMPROVER project D1.1, in Europe, there is not a well-established concept of resilience in relation to critical infrastructure operators (Melkunaite et al., 2016). It emerges that critical infrastructure operators have different plans for different emergencies without presenting a uniform strategy. For example, Swedish critical infrastructure operators have regulatory frameworks with different indicators to measure their performance: "in the power sector the regulator in Sweden

³⁷ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2006:0786:FIN:EN:PDF>

³⁸ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:345:0075:0082:EN:PDF>

has a number of metrics of performance included in the legislation” (Melkunaite et al., 2016: 65). It follows that differences in regulatory frameworks raise challenges in relation to interdependencies of critical infrastructure operators working in different countries. IMPROVER project D1.1 reported that ‘in case of an accident, for example, different organisations are in charge on the two sides of the strait. In Denmark, it is the police, in Sweden, it is the fire department. There is an agreement that all four (both police and fire on both sides) departments are notified if something happens. This collaboration works quite well’³⁹ (Melkunaite et al., 2016:66). As it can be observed, communication among different organisations seems to be a crucial element that helps to solve the challenges experienced during incidents when services and infrastructures depend on each other. Furthermore, attention to resilience seems to be missing from objectives identified in many risk assessment methodologies for critical infrastructure operators (Giannopoulos et al., 2012). Considering these existing differences, to be effective critical infrastructure operators should refer to and adhere to their own national-level regulatory frameworks.

For example, Canada presents a National Strategy for Critical Infrastructure. This action plan aims to enhance resilience for critical infrastructures promoting a collaborative approach among all levels of government and critical infrastructure operators. The strategy is mainly formed by three points: building partnerships, implementing an all-hazards risk management approach, and sharing and protecting information. As discussed in this report, information sharing during crises between critical infrastructure operators and emergency management organisations is an important way to enhance resilience. Therefore, improving the information sharing in full respect of existing policies will also increase the effectiveness of emergency management operations. Together with this strategic objective, information protection in critical infrastructure sectors is another important aspect regulated by the Canadian Government called Government of Canada’s Emergency Management Act⁴⁰. This document provides protection to sensitive information. This National Strategy for Critical Infrastructure shows that building partnerships between emergency management organisations and critical infrastructure operators strengthens resilience. This is the reason why this report recommends collaboration as it promotes a more effective use of resources and practices.

On the other hand, the Australian Government takes a non-regulatory approach to critical infrastructure. Based on this approach, as also discussed in IMPROVER project D1.1, the owners and operators of critical infrastructures are best placed to manage risks to their operations and determine the most effective mitigation strategies (Melkunaite et al., 2016). Yet, even in Australia, information sharing is considered to be one of the key elements to achieve critical infrastructure resilience. Regarding this aspect, the Australian Government established in 2003 the Trusted Information Sharing Network⁴¹ (TISN) to provide a secure environment in which critical infrastructure owners and operators could meet regularly to share information and cooperate within and across sectors to address security and business continuity challenges. To enhance resilience, the Australian Government promotes a number of activities to raise awareness (in particular in relation to cross-sector dependencies), including exercises and workshops with industry and the Critical Infrastructure Program for Modelling and Analysis⁴² (CIPMA). This is similar to what is happening in Europe where

³⁹ Personal interview, former employee of an organisation operating Öresund Bridge and tunnel, Sweden, 17 May 2016.

⁴⁰ <http://laws-lois.justice.gc.ca/eng/acts/E-4.56/>

⁴¹ <http://www.tisn.gov.au/Pages/default.aspx>

⁴²

<https://www.ag.gov.au/NationalSecurity/InfrastructureResilience/Pages/CriticalInfrastructureProgramforModellingandAnalysisCIPMA.aspx>

A Communication Strategy to build Critical Infrastructure Resilience

ERNICIP⁴³ and many of the FP7 and H2020 projects organize training activities for critical infrastructure operators. The CIPRNet⁴⁴ master classes and the ERNCIP annual workshops are examples of the interest in educating and improving critical infrastructure operators' resilience. Critical infrastructure operators should identify similar workshops to train their staff.

Another important element of interest in contemporary regulations and protection of critical infrastructure is cybersecurity. In 2013, the US National Institute of Standards and Technology⁴⁵ (NIST) developed a regulatory framework to improve critical infrastructure cybersecurity. The aim of this framework is to enhance the security and resilience of US critical infrastructure. The Cybersecurity Framework⁴⁶ consists of three parts: The Framework Core, the Framework Profile, and the Framework Implementation Tiers. The Framework Core is a set of cybersecurity activities, outcomes, and informative references that are common across critical infrastructure sectors, providing detailed guidance for developing individual organisational 'profiles'. Through the use of profiles, the Framework will help organisations to align their cybersecurity activities with their business requirements, risk tolerances, and resources. The Tiers provide a mechanism for organisations to view and understand the characteristics of their approach to managing cybersecurity risk. Critical infrastructure operators can use the Framework as a key part of their process to identify, assess, and manage cybersecurity risk in order to improve resilience. Critical infrastructure operators should have a process in place to support compliance of cybersecurity activities with applicable privacy laws, regulations, and constitutional requirements. For instance, a representative of a French transport company reports the use of social media monitoring tools through which they collect information that is internally verified and reworked by the crisis communication team in collaboration (when necessary) with the legal department.

Another official initiative on critical infrastructure resilience by the EU can be observed in work carried out by the Institute for the Protection and the Security of Citizens of the Joint Research Centre (JRC) of the European Commission. It set up the European Reference Network for Critical Infrastructure Protection⁴⁷ (ERNICIP). The main objective of this project was to improve the protection of critical infrastructure in Europe focusing in particular on the harmonisation of test methodologies and test protocols regarding the technical protective security solutions. One of the main issues explored by this project was the need to anticipate serious operational problems, particularly the testing requirements associated with solutions that support crisis management and operational recovery. It also highlighted the need for communication among relevant parties, both in terms of terminology and connectivity. Regarding these issues ERNCIP responded by creating a trusted forum for critical infrastructure operators to efficiently provide more guidance through operator workshops. However, as IMPROVER project D1.1 discusses, the EU has funded several projects related to critical infrastructure and others are still in progress. Tangible results will be available in the next few years (Melkunaite et al., 2016).

⁴³ <https://erncip-project.jrc.ec.europa.eu/>

⁴⁴ <https://www.ciprnet.eu/home.html>

⁴⁵ <https://www.nist.gov/>

⁴⁶ <https://www.nist.gov/programs-projects/cybersecurity-framework>

⁴⁷ <https://erncip-project.jrc.ec.europa.eu/news/european-reference-network-critical-infrastructure-protection-project-first-phase-2011-2014>

In addition, the European Commission sets out the principles and instruments needed to implement the European Programme for Critical Infrastructure Protection⁴⁸ (EPCIP), aimed at both European and national infrastructure. This plan discusses the information sharing on Critical Infrastructure Protection (CIP). It reports that “stakeholders must share information, in particularly on measures concerning the security of critical infrastructure and protected systems, interdependency studies and CIP related vulnerability, threat and risk assessments. At the same time, there must be assurance that shared information of a proprietary, sensitive or personal nature is not publicly disclosed and that any personnel handling of classified information will have an appropriate level of security vetting by their EU country”⁴⁹. When planning their communication strategies, critical infrastructure operators should consult EU regulations available online which are regularly updated.

Recommendations:

- Critical infrastructure operators should ensure that information provided during crisis situations is compliant with national frameworks governing emergency management organisations;
- Critical infrastructure operators should ensure that information provided adheres to cybersecurity regulations.

6.4 Post-disaster learning should be employed in order to enhance and develop future communication strategies

There was a consensus among our interviewees that the communication strategies for future incidents will be formed by the increased use of social media, apps and digital information sharing with the public together with the use of traditional media. This approach has been developed considering the advantages and disadvantages of social media observed in past events. Learning from past incidents is fundamental to improve critical infrastructure operators’ communication strategies. For example, a representative from Barreiro City Council reported that lessons learnt from past events (floods in 2000) helped to improve the way they currently communicate with the public. Our interviewees (representatives from Barreiro City Council and a French public transport company) reported also that they have a communication strategy in place, which is elaborated and developed by crisis teams and emergency managers. Moreover, a representative of a French public transportation company reported that they reviewed their communication strategies regularly in order to adapt their techniques to technological and societal changes. Regarding the introduction of new platforms and apps, critical infrastructure operators aim to regularly share information whilst engaging with other service providers (e.g. weather forecast) in order to make the public familiar with new platforms and apps they use. In this way, when an emergency occurs, citizens are already familiar with the channels used and able to reach information effectively.

To improve their practices, critical infrastructure operators should rely on feedback and comments provided by citizens in relation to the services they offer and how they dealt with past crises. For instance, through social media platforms, they should collect comments and feedback on how they performed. However, as a representative of a French public transportation company reported, the majority of comments that critical infrastructure operators receive are about train delays or disruptions. It is important that key lessons are acknowledged in order to address gaps and/or weaknesses in communication strategies. We suggest that a systematic review should focus on what elements of communication strategy enhance resilience during crisis situations. This should include communication with emergency management organisations and the general public. In doing this,

⁴⁸ <http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=LEGISSUM:l33260&from=EN>

⁴⁹ <http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=LEGISSUM:l33260&from=EN>

A Communication Strategy to build Critical Infrastructure Resilience

critical infrastructure operators should reconsider also the criteria used to evaluate the communication strategy.

Recommendations:

- Critical infrastructure operators should create platforms and/or channels of communication where the public can provide feedback about their services before, during and after a major incident;
- Critical infrastructure operators' communication team should meet regularly to review existing protocols;
- Critical infrastructure operators should review lessons learned from major incidents in conjunction with other operators and emergency management organisations.

7 Communication strategy flowchart for critical infrastructure operators

This section of the report presents a flowchart for effective communication between critical infrastructure operators, emergency management organisations and members of the public during crisis situations. At each stage of a crisis, critical infrastructure operators should pay attention to consistency and frequency of information sharing between traditional media and social media in order to maximise the effectiveness of communication. They should also pay attention to the language used in communications. Critical infrastructure operators should avoid jargon and/or complex and technical terminologies. Regarding this, it emerges the need for emergency management organisations to agree on what key terms mean to minimise the potential for misunderstandings between different stakeholders (Reilly & Atanasova, 2016). One way to do this is by consulting a terminology database, such as Firebrary. For more information on interoperable communications, see IMPROVER project D2.2 (Pursiainen et al., 2016).

All our interviewees recognised the importance of using social media in crisis communication, engaging with emergency management operators and news media organisations. This data shows the importance of developing new communication strategies that exploit the potential of social media. Together with the interest in technological advancements, our interviewees (both critical infrastructure operators and emergency management organisations) noted the importance of maintaining effective communication on traditional media.

This list of communication tactics is based on ‘AESOP’ guidelines that critical infrastructure operators should follow. Emergency management is usually divided into four phases: mitigation, preparedness, response and recovery. The following sections outline communication strategies for each of these four phases by building on the case studies, literature reviewed and data analysis discussed throughout the report.

7.1 Mitigation

Inform the public about risk mitigation measures: Critical infrastructure operators and emergency management organisations should communicate with the general public about risk mitigation measures using both traditional media and social media, especially in areas where there are specific risks. Critical infrastructure operators could provide the public with contact details of emergency management organisations in advance.

Consistency of information sharing on traditional media and social media: Information about risk mitigation measures should be shared by critical infrastructure operators and emergency management organisations through all available channels in order to reach different target populations. As discussed earlier, a combination of traditional media and social media is the most effective way to reach citizens. In particular, they should ensure consistency between their uses of social media accounts versus press releases and broadcasts media.

Increase public engagement: On traditional and social media channels, critical infrastructure operators should make the public aware of the impact of disruptions and the efforts being made (and timeline) to restore these services. Critical infrastructure operators should engage with local communities at every stage of the disaster cycle (mitigation, preparedness, response, recovery). In this way, the public would have an increased awareness of how best to prepare for emergencies. The public should be aware of the strain on critical infrastructure services and be briefed on how to minimise the impact upon them and their families. This convention helps build trust between critical infrastructure operators, emergency management organisations and members of the public, and helps improve mitigation and preparedness.

Make use of relationships with key stakeholders and local communities: Engaging with key stakeholders and local communities can help critical infrastructure operators to foster trust and reliability. It can also help critical infrastructure operators to share information through the visibility afforded by the collaboration with professional journalists and emergency management organisations.

Keep active use of popular communication channels: Citizens tend to reach information through different channels during crises. They also seek information from sources they trust. As discussed above, critical infrastructure operators should use different channels to share information and engage with local communities on a regular basis. Therefore, maintaining a regular presence on communication channels would help citizens to familiarise and build trust with the information sources before crises occur.

7.2 Preparedness

Train staff to deal with crisis communication: Critical infrastructure operators, during non-emergency periods, should set a communication department that is trained to deal with crisis and disaster communication. Critical infrastructure operators should follow appropriate regulatory frameworks in order to define who is responsible for the authorisation of sharing information with the public. Members of communication teams should receive training regularly on how to deal with information sharing legally.

Develop and test communication practices: Critical infrastructure operators should work and update their communication strategies on an annual basis considering advancements in information and communication technologies and social changes in order to provide information and advice in advance. To do so, critical infrastructure operators should define communication practices that can be tested before being deployed during disasters.

Improve and promote social media presence: Critical infrastructure operators should build trust with members of the general public through an active and appropriate use of social media. They should share information about risk mitigation and preparedness keeping their online presence engaging and updated. In this way, the general public are more likely to search for information on these platforms during emergencies. For instance, critical infrastructure operators could link their social media platforms to community representatives and politicians of their local area as a way to increase visibility and number of followers (on Twitter). The promotion of institutional social media accounts is fundamental to build trust with members of local population. In this, critical infrastructure operators should identify the most used platforms for their target audience (e.g. Facebook, Twitter, YouTube, Instagram, and Snapchat) and employ pre-existing hashtags on Twitter, promotional events on Facebook, and informational videos on YouTube to increase their following.

Prepare contingency plans and meet the information expectation of the public: Members of the general public inevitably increase their demand for information and communication during emergency situations. When implementing their communication strategies, critical infrastructure operators should make sure that emergency services work in parallel with crisis communication departments. In this case, institutional social media accounts can also be used to redirect the public towards other traditional media channels and vice versa.

Disseminate prevention messages: A combination of traditional and social media should inform the general public about preparedness and potential emergency situations. Critical infrastructure operators should warn members of the general public about the potential spread of false information and suggest to find information from institutional platforms and channels. This could include the various ways in which the public can communicate with blue light organisations or key agencies during incidents. This

tactic aims to reassure the public that adequate emergency measures are in place if a crisis occurs. Critical infrastructure operators should also consider the employment of automated messaging services as a valid tool to simplify the information sharing. For example, the EMSC⁵⁰ (European-Mediterranean Seismological centre), although it is not a critical infrastructure operator, makes a wide use of Twitter messages in the case of an earthquake.

Use social media to manage relationships with traditional media: The cultivation of good relationships with news media organisations and professional journalists can help critical infrastructure operators in their effort to inform the citizens about their services during crises. News media organisations can help to enhance crisis information shared on social media (Twitter and Facebook, for instance), radio, television, and newspapers. As discussed above, the visibility afforded by traditional media can help mobilise volunteers and inform about emergency management operations.

Establish information verification procedures: Critical infrastructure operators should accelerate their internal information verification procedures. As discussed above, this was a barrier to produce real-time information. Increasing the speed of information verification procedures can improve communication between critical infrastructure operators, emergency management organisations and the general public, promoting official interventions, service restoration and rescue procedures.

Increase the use of social media apps: Although most of the general public relies on traditional media to find information during emergency situations, critical infrastructure operators should also promote the use of apps. They should inform the general public about the advantages of using apps in emergencies (e.g. floods apps). Using apps compared to phone calls and text messages are more resilient platforms for communication because they rely on Wi-Fi and Internet connections, which are more resistant to network failures due to increased traffic experienced in emergencies. Therefore, apps promoted by the police, fire and rescue services could also be promoted by critical infrastructure operators who should make use of these tools as an alternate to routine activities (e.g. for asking people about satisfaction with their services or to provide warning messages).

7.3 Response

Redirecting citizens towards appropriate information sources: To enhance resilience during emergency situations critical infrastructure operators should employ all their communication channels to redirect the general public toward appropriate information sources during crises. This technique could help information seekers and their ability to find appropriate information and updates about services restoration. Critical infrastructure operators should share information from other stakeholders in emergency management in order to provide accurate information to citizens, possibly to reduce the number of queries that they receive and that they cannot answer (e.g. about damage to other infrastructures), and/or queries that the police and fire and rescue services are best placed to answer.

Responding on social media in a timely manner: During crises, critical infrastructure operators should show their active presence on social media to respond to queries. Although, emergency situations are usually chaotic, critical infrastructure operators should provide real-time information about the event, providing warnings, updates (even about the wait) and advice.

Crossroads between broadcast and social media platforms: During emergency situations, information should be shared across all channels. In this, social media should be used by critical infrastructure operators to interact with professional journalists, news media organisations, and vice

⁵⁰ <http://www.emsc-csem.org/#2>

A Communication Strategy to build Critical Infrastructure Resilience

versa. The messages shared should be consistent across all the different channels. This collaboration can provide more accurate information to the general public because of the visibility offered by official television, radio and newspapers in combination with the use of social media, such as Twitter and Facebook.

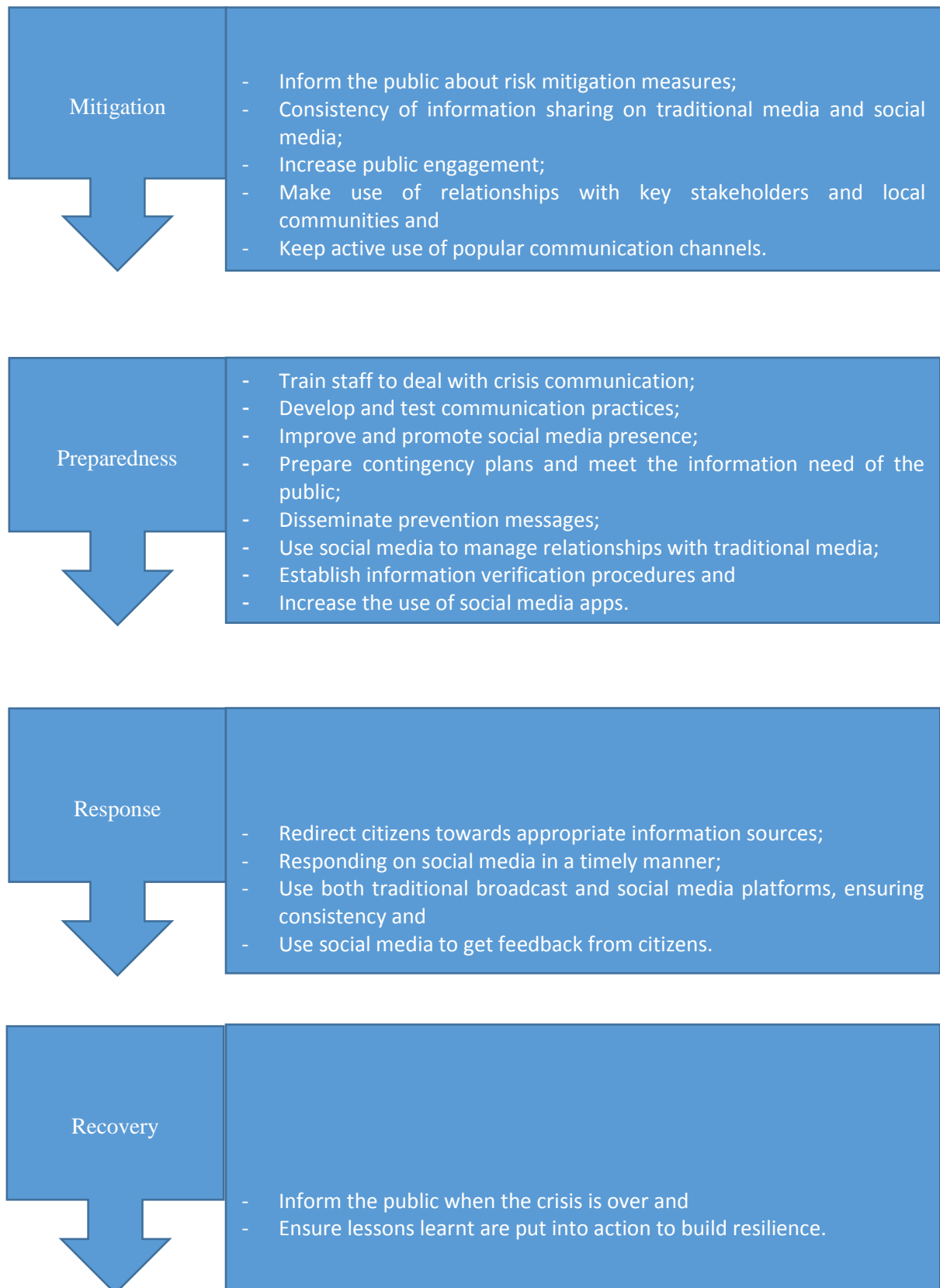
Use social media to get feedback from citizens: Critical infrastructure operators should listen and then determine what people need to know about crises. Social media can provide opportunities for critical infrastructure operators to receive people's feedback about how their service was restored. Their comments can help to anticipate further gaps in information sharing. This information could also be shared with emergency managers in order to coordinate their collaboration.

7.4 Recovery

Inform the public when the crisis is over: Crises cause devastating economic effects upon affected areas. Critical infrastructure operators should keep the public informed about efforts to fully restore key services in order to reduce the anxiety and distress experienced by those living in affected areas. In this phase, members of the public can use social media to organise recovery operations, and critical infrastructure operators should facilitate these initiatives redirecting useful information and engaging with emergency management organisations. They should also be sure to inform the public when services have been fully restored and future plans to help reduce recovery time.

Ensure lessons learnt are put into action to build resilience: Critical infrastructure operators should build on past experience to improve their communication strategy. Key lessons should be recorded and used for future incidents. Feedback and comments from other organisations and the general public should be sought and acted upon.

The above tactics can be summarised in the communication strategy flow chart presented below.



8 Conclusion

This report has presented a list of best practices in emergency management and crisis communication in order to develop guidelines for effective communication between critical infrastructure operators, emergency management organisations, and members of the public during emergency situations. Lessons learnt from two case studies (Floods in Portugal, Paris Terrorist attacks) were also incorporated into the AESOP guidelines together with the consultations. These are:

- 1- Analyse the information-seeking behaviours of local populations before deciding which media channels to deploy during disasters;
- 2- Engage key stakeholders in order to ensure message consistency across traditional and social media platforms;
- 3- Social media should be used to provide real-time updates to citizens about ongoing efforts to restore services;
- 4- Observe and adhere to context-specific regulatory frameworks for emergency management and resilience;
- 5- Post-disaster learning should be employed in order to enhance and develop future communication strategies.

Key findings also included:

1- Critical infrastructure operators should engage with emergency management organisations and news media organisations in order to maximise the information sharing. Thanks to this collaboration, information should be shared with the general public at all stages of crisis (mitigation, preparedness, response, and recovery) to enrich visibility and effectiveness of communication plans.

2- A strategic communication mix of traditional media and social media was identified as the most effective approach that critical infrastructure operators should employ at all stages of crisis. Considering that a single, effective mean of communication has not been identified, this report suggests taking into account the potentials of social media to correct rumours, spread accurate information, and create interaction between critical infrastructure operators and the public, alongside the traditional means of communication (e.g. television, radio and newspapers). This would develop the capability to support emergency services and the general public during crises. This approach contributes also to improve critical infrastructure operators' resilience.

3- Traditional media still remains the main source of information for those groups of people unable or unwilling to access social media. For many, indeed, traditional media are recognised as more stable and trustworthy sources of information. Crisis communication departments should take traditional media into account when planning and reviewing their communication strategies.

4- Critical infrastructure operators, collaborating with emergency services and news media organisations, should ensure that the information they share is clear, consistent and accurate. Such information is more likely to be understood by/ effectively reach members of the public.

5- Lessons learned from previous incidents should be used to improve future communication plans. Citizens' feedback and comments on critical infrastructure operators' services should also be considered a useful component for reviewing current strategies.

9 References

- Adger W. N. (2000): Social and ecological resilience: are they related? *Progress in Human Geography*, 24(3) 347–364.
- Alexander D. E. (2014): Communicating earthquake risk to the public: the trial of the “L’ Aquila seven”. *Natural Hazards*, 71(2), 1159-1173.
- Alexander D. E. (2013): Social media in disaster risk reduction and crisis management. *Science and Engineering Ethics*, 20(3): 717-733.
- Allen, S. (2007). Citizen journalism and the rise of “Mass Self-Communication”: Reporting the London bombings, *Global Media Journal* 1 (1): 1–20.
- Artman H., Brynielsson J., Johansson B. J. E., & Trnka, J. (2011): Dialogical emergency management and strategic awareness in emergency communication. In *Proceedings of the 8th International ISCRAM Conference* (pp. 1–9). Lisbon, Portugal. Retrieved from <http://kth.diva-portal.org/smash/get/diva2:479686/FULLTEXT01.pdf> (Accessed 12 February 2017).
- Andersson W. A. (2006): Disaster warning and communication processes in two communities, *Journal of Communication*, 19 (2): 92–104.
- Austin L., Liu B. F., & Jin Y. (2012): How audiences seek out crisis information: Exploring the social-mediated crisis communication model, *Journal of Applied Communication Research*, 40(2): 188-207.
- Banahene O. K., Anvuur A. M., & Dainty A. R. J. (2014): Conceptualising organisational resilience: an investigation into project organising. Leicestershire, UK. In Raiden A. B. & Aboagye-Nimo E. (ed.) *Proceeding of the 30th Annual ARCOM Conference*, 1-3 September 2014, Portsmouth, UK, 2, 795-804.
- BBC News (2016): *Brussels blasts: Crisis information*. 22 March 2016. Available at: <http://www.bbc.co.uk/news/world-europe-35870096> (Accessed 10 March 2017). (Accessed 30 March 2017).
- BBC World Service Trust (2008): *Left in the dark: The unmet need for information in humanitarian responses*, Policy Briefing #2. Available at: http://downloads.bbc.co.uk/worldservice/trust/pdf/humanitarian_response_briefing.pdf (Accessed 30 March 2017).
- Berkes F. (2004): Knowledge, Learning and the Resilience of Social-Ecological Systems. Paper prepared for the Panel “Knowledge for the Development of Adaptive Co-Management” Nancy J. Turner and Fikret Berkes, session organizers IACSP ’04, Oaxaca, Mexico, August 2004. Available online at: http://dlc.dlib.indiana.edu/dlc/bitstream/handle/10535/2385/berkes_knowledge_040511_paper299a.pdf?sequence=1 (Accessed 3 October 16).
- Bird D., Ling M., & Haynes K. (2012): Flooding Facebook-the use of social media during the Queensland and Victorian floods, *Australian Journal of Emergency Management*, 27(1): 27–33.
- Bohensky, E.L. & Leitch, A.M. (2014): Framing the flood: a media analysis of themes of resilience in the 2011 Brisbane flood, *Regional Environmental Change*, 14 (2): 475-488.
- Boon H. J., Cottrell A., King D., Stevenson R. B., & Millar J. (2012): Bronfenbrenner’s bioecological theory for modelling community resilience to natural disasters, *Natural Hazards*, 60(2): 381-408.

A Communication Strategy to build Critical Infrastructure Resilience

- boyd d. (2009): 'Social media is here to stay... now what?' *Microsoft Research Tech Fest*. Redmond, Washington, February 26.
- Braun V. & Clarke V. (2006): Using thematic analysis in psychology, *Qualitative Research in Psychology*, 3 (2): 77-101.
- Burger J., Gochfeld M., Jeitner C., Pittfield T., & Donio M. (2013): Trusted information sources used during and after superstorm Sandy: TV and radio were used more often than social media, *Journal of Toxicology and Environmental Health, Part A: Current Issue*, 76(20): 1138-1150.
- Burnard K., & Bhamra R. (2011): Organisational resilience: development of a conceptual framework for organisational responses, *International Journal of Production Research*, 49(18), 5581–5599.
- Caragea C., Mcneese N., Jaiswal, A., Traylor G., Kim H., Mitra P., & Yen J. (2011): Classifying Text Messages for the Haiti Earthquake, *Proceedings of the 8th International ISCRAM Conference*, 1–10.
- Carey J. (2003): 'The functions and uses of media during the September 11 crisis and its aftermath'. In *Crisis Communications. Lessons from September 11*, A. M. Noll (eds.), New York: Rowman & Littlefield Publishers.
- CARMA (2006): *The CARMA report on Western media coverage of humanitarian disasters*. Retrieved 20 February 2011. Available at: http://www.imaging-famine.org/images/pdfs/carma_%20report.pdf (Accessed 22 May 2017).
- Carpenter A. (2013): Social Ties, Space, and Resilience: Literature Review of Community Resilience to Disasters and Constituent Social and Built Environment Factors. *Community and Economic Development Discussion Paper*, 2(13). Available online at: <https://www.frbatlanta.org/-/media/Documents/community-development/publications/discussion-papers/2013/02-literature-review-of-community-resilience-to-disasters-2013-09-25.pdf> (Accessed 20 September 2016).
- Cassa C. A., Chunara R., Mandl K., & Brownstein J. S. (2013): Twitter as a Sentinel in Emergency Situations: Lessons from the Boston Marathon Explosions. *PLoS Currents*, 1–12.
- Chambers S. (1995): Discourse and Democratic Practices. In White S. K. Ed. *The Cambridge Companion to Habermas*. Cambridge: Cambridge University Press, 233-254.
- Chen M., Shiwen M., & Liu Y. (2014): Big Data: A Survey. *Mobile Netw Appl*, 19, 171-209.
- Cheng J. W., Mitomo H., Otsuka T., & Jeon S. Y. (2015): The effects of ICT and mass media in post-disaster recovery - A two model case study of the Great East Japan Earthquake. *Telecommunications Policy*, 39(6), 515–532.
- Chouliaraki L. (2013): *The Ironic Spectator: Solidarity in the age of post-humanitarianism*, Cambridge: Polity.
- Chouliaraki L. (2008): The mediation of suffering and the vision of a cosmopolitan public, *Television and New Media*, 9(5): 371-391.
- Chouliaraki L. (2006): *The Spectatorship of Suffering*, London: Sage.
- Christoplos I. (2006): *Links between relief, rehabilitation and development in the tsunami response*. London: Tsunami Evaluation Coalition.
- Colten C. E. & Sumpter A. R. (2009): Social memory and resilience in New Orleans. *Natural Hazards*, 48, 355-364.

- Combs W. T. (2010): 'Parameters of Crisis Communication'. In *The Handbook of Crisis Communication*. Coombs W. T. and Holladay S. J. (eds.), Malden, MA: Blackwell Publishing Ltd, pp. 17-53.
- Cooper G. (2011): From their own correspondent? New media and the changes in disaster coverage: lessons to be learnt. *Report, Reuters Institute for the Study of Journalism*, University of Oxford, 1–48. Available online at: http://reutersinstitute.politics.ox.ac.uk/fileadmin/documents/Publications/Working_Papers/From_Their_Own_Correspondent.pdf (Accessed 22 November 2016).
- Corbin K. (2012): Tapping Social Media in Disasters, *CIO*, 25: 28.
- Correa T., Scherman A., & Arriagada A. (2016): Audiences and Disasters: Analyses of Media Diaries Before and After an Earthquake and a Massive Fire. *Journal of Communication*, 66(4), 519-541.
- Cottle S. (2014): Rethinking media and disasters in a global age: What's changed and why it matters. *Media, War & Conflict*, 7(1): 3–22.
- Cottle S. (2006): 'Mediatized rituals: Beyond manufacturing consent', *Media, Culture & Society*, 28(3): 411-32.
- Crawford K, Faleiros G, Luers A, et al. (2013): Big data, communities and ethical resilience: a framework for action. *White Paper for PopTech and Rockefeller Foundation*. Available at: http://poptech.org/system/uploaded_files/66/original/BellagioFramework.pdf (Accessed 02 September 2016).
- Cutter S. L., Barnes L., Berry M., Burton C., Evans E., Tate E., & Webb J. (2008b): A place-based model for understanding community resilience to natural disasters, *Global Environmental Change*, 18(4): 598-606.
- Dailey D. & Starbird K. (2014): Visible Skepticism: Community Vetting after Hurricane Irene, *Short Paper. 2014 Information Systems for Crisis Response and Management Conference (ISCRAM 2014)*, Penn State University.
- David C. C., Ong J. C., & Legara E. F. T. (2016): Tweeting Supertyphoon Haiyan: Evolving Functions of Twitter during and after a Disaster Event. *Plos One*, 11(3), e0150190.
- Dayan D. & Katz E. (1992): *Media events: The live broadcasting of history*. Cambridge, MA: Harvard University Press.
- De Albuquerque J. P., Herfort B., Brenning A., & Zipf A. (2015): A geographic approach for combining social media and authoritative data towards identifying useful information for disaster management. *International Journal of Geographical Information Science*, 8816, 1–23.
- Dillard J. P., Shen L. & Vail R. G. (2007): Does perceived message effectiveness cause persuasion or vice versa? 17 consistent answers. *Human Communication Research*, 33, 467–488.
- DiMaggio P. & Hargittai E. (2001): *From the 'Digital Divide' to 'Digital Inequality': Studying Internet Use As Penetration Increases*. Princeton University Center for Arts and Cultural Policy Studies, Working Paper #15, Summer 2001.
- Drabek T. E. (1999): Understanding disaster warning responses. *The Social Science Journal*, 36(3), 515–523.

A Communication Strategy to build Critical Infrastructure Resilience

Drache D., Feldman S., & Clifton D. (2003): *Media Coverage of the 2003 Toronto SARS Outbreak*. Robarts Centre Research Papers. Toronto. Available online at: http://www.yorku.ca/drache/academic/papers/gcf_sars.pdf (Accessed 13 November 2016).

Dufty N. (2011): Engagement or Education. *Australian Journal of Emergency Management*, 26(3), 34-39.

European Council (2008): Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection. 23.12.2008 Official Journal of the European Union, L345, 75–82.

Flanagin A. J. & Metzger M. J. (2000): Perceptions of Internet Information Credibility, *Journalism & Mass Communication Quarterly*, 77(3): 515-540.

Gao H., Barbier G. & Goolsby R. (2011): Harnessing the crowdsourcing power of social media for disaster relief, *IEEE Intelligent Society*, 26(3): 10-14.

Giannopoulos G., Filippini R., & Schimmer M. (2012): Risk assessment methodologies for Critical Infrastructure Protection. Part I: A state of the art. Publications Office of the European Union, *JRC Scientific and Policy Reports*.

Gortner E. & Pennebaker J.W. (2003): The Archival Anatomy Of A Disaster: Media Coverage and Community-Wide Health Effects of The Texas A&M Bonfire Tragedy, *Journal of Social and Clinical Psychology*, 22 (5): 580-603.

Gupta A., Lamba H., Kumaraguru P., & Joshi A. (2013): Faking Sandy: characterizing and identifying fake images on Twitter during Hurricane Sandy. *WWW 2013 Companion Proceedings of the 22nd International Conference on World Wide Web*, Rio de Janeiro, Brazil - May 13-17, 2013, 729-736.

Haddow G. & Haddow H. (2008): *Disaster Communications in a Changing Media World*. Burlington, MA: Butterworth Heinemann.

Hannides T. (2015): *Humanitarian Broadcasting in Emergencies - A Synthesis of Evaluation Findings*, Research report Issue 7. BBC Media Action, London.

Hjorth L. & Kim K. H. Y. (2011): The mourning after: A case study of social media in the 3.11 earthquake disaster in Japan. *Television and New Media*, 12(6), 552-559.

Hoijer B. (2004): The discourse of global compassion: the audience and media reporting of human suffering. *Media, Culture & Society*, 26(4), 513-531.

Houston J. B., Spialek M. L., Cox J., Greenwood M. M., & First J. (2015): The Centrality of Communication and Media in Fostering Community Resilience: A Framework for Assessment and Intervention, *Community Resilience Theory*, 59(2): 270-283.

Houston J.B. (2012): Public disaster mental/behavioral health communication: intervention across disaster phases, *Journal of Emergency Management*, 10 (4): 283–292.

Houston J. B., Pfefferbaum B., & Rozenholtz E. (2012): Disaster news: Framing and frame changing in coverage of major U.S. natural disasters, 2000–2010, *Journalism and Mass Communication Quarterly*, 89(4): 606–623.

Hughes A. L., & Palen L. (2012): The Evolving Role of the Public Information Officer: An Examination of Social Media in Emergency Management, *Journal of Homeland Security and Emergency Management*, 9(1).

- Hughes A. L., Palen L., Sutton J., Liu S. B., & Vieweg S. (2008): "Site-Seeing" in Disaster: An Examination of On-Line Social Convergence. *5th International ISCRAM Conference*, (May), 44–54. Available online at: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.157.3104&rep=rep1&type=pdf> (Accessed 23 November 2016).
- Imran M., Castillo C., Diaz F., & Vieweg S. (2015): A Processing Social Media Messages in Mass Emergency: A Survey. *ACM Computing Surveys, Journal ACM Computing Surveys*, 47(4).
- Jackson D., Aldrovandi C., & Hayes P. (2015): Ethical Framework for a Disaster Management Decision Support System Which Harvests Social Media Data on a Large Scale. In N. B. BenSaoud, C. Adam, & C. Hanachi ed. *Information Systems for Crisis Response and Management in Mediterranean Countries, ISCRAM-MED 2015*. Berlin: Springer-Verlag, 167–180.
- Jenkins H., Ford S., Green J. (2013): *Spreadable Media: Creating Value and meaning in a Networked Culture*. NY; London: New York University Press.
- Joye S. (2010): News discourses on distant suffering: A critical discourse analysis of the 2003 SARS outbreak, *Discourse & Society*, 21(5): 586-601.
- Joy S. (2009): The Hierarchy of global suffering. A critical discourse analysis of television news reporting on foreign natural disasters, *The Journal of International Communication*, 15(2): 45-61.
- Jung K. & Song M. (2015): Linking emergency management networks to disaster resilience: bonding and bridging strategy in hierarchical or horizontal collaboration networks, *Quality & Quantity*, 49(4), 1465–83.
- Kaufman M. (2015): Resilience 2.0: social media use and (self-)care during the Norway attacks, *Media, Culture & Society*, 37(7): 972-987.
- Kaufman, S., Qing, C., Levenson, N., & Hanson, M. (2012): Transportation During and After Hurricane Sandy. *Rudin Center for Transportation NYU Wagner Graduate School of Public Service*, (November), 1–36.
- Kaufhold M. & Reuter C. (2016): The self-organisation of digital volunteers across social media: the case of the 2013 European floods in Germany, *Homeland Security & Emergency Management*, 13(1): 137-166.
- Keck M. & Sakdapolrak P. (2013): What is social resilience? Lessons learned and ways forward. *Erdkunde*, 67(1): 5-19.
- Keim M.E, & Noji E. (2011): Emergent use of social media: a new age of opportunity for disaster resilience. *American Journal of Disaster Medicine*, 6 (1): 47-54.
- Kiouis S. (2001): Public Trust or Mistrust? Perceptions of Media Credibility in the Information Age, *Mass Communication and Society*, 4 (4): 381-403.
- Kongthon A., Haruechaiyasak C., Pailai J., & Kongyoung S. (2012): The Role of Twitter during a Natural Disaster: Case Study of 2011 Thai Flood. *International Journal of Innovation and Technology Management*, 11(3).
- Kryvasheyev Y., Chen H., Obradovich N., Moro E., Hentenryck P. Van, Fowler J., & Cebrian M. (2016): Rapid assessment of disaster damage using social media activity, *Science Advances*, 2(3): 1–12.

A Communication Strategy to build Critical Infrastructure Resilience

Kuttschreuter M., Gutteling J. M., & de Hond M. (2011): Framing and tone-of-voice of disaster media coverage: The aftermath of the Enschede fireworks disaster in the Netherlands, *Health, Risk & Society*, 13(3): 201–220.

Lacey S. (2014): Resiliency: How Superstorm Sandy Changed America's Grid, *Greentech media*.

Available at: <https://www.greentechmedia.com/articles/featured/resiliency-how-superstorm-sandy-changed-americas-grid> (Accessed 18 May 2017).

Lachlan K.A, Westerman D.K., & Spence P.R. (2010): Disaster News and Subsequent Information Seeking: Exploring the Role of Spatial Presence and Perceptual Realism, *Electronic News*, 4 (4): 203-217.

Laituri M. & Kodrich K. (2008): On line disaster response community: People as sensors of high magnitude disasters using internet GIS, *Sensors*, 8 (5): 3037–3055.

Latonero M. & Shklovski I. (2010): Respectfully yours in safety and service: Emergency management & social media evangelism, in *Proceedings of the 7th international ISCRAM conference*, Seattle, USA (2010).

Lerman K., & Ghosh R. (2010): Information contagion: An empirical study of the spread of news on Digg and Twitter social networks. In *Fourth International AAAI Conference on Weblogs and Social Media*, 90–97. Available online at: <http://arxiv.org/abs/1003.2664> (Accessed 23 November 2016).

Lindell M. & Perry R. (1987): Warning mechanisms in emergency response systems, *International Journal of Mass Emergencies and Disasters*, 5(2): 137–153.

Lindsay B.R. (2011): *Social Media and Disasters: Current Uses, Future Options, and Policy Considerations*. Report for Congressional Research Service, 1–10. Available at: https://ofti.org/wp-content/uploads/2012/07/42245_gri-04-11-2011.pdf (Accessed 12 April 2017).

Liu B. F., Fraustino J. D., & Jin Y. (2014): How Disaster Information Form, Source, Type, and Prior Disaster Exposure Affect Public Outcomes: Jumping on the Social Media Bandwagon?, *Journal of Applied Communication Research*, 43(1): 44–65.

Liu, B. F., Jin, Y., & Austin, L. L. (2013). The tendency to tell: Understanding publics' communicative responses to crisis information form and source. *Journal of Public Relations Research*, 25(1): 51–67.

Liu B.F; Austin L; & Jin Y. (2011): How publics respond to crisis communication strategies: The interplay of information form and source, *Public Relations Review*, 37, 345–353.

Losada C., Scaparra M. P., & O'Hanley J. R. (2012): Optimizing system resilience: A facility protection model with recovery time, *European Journal of Operational Research*, 217, 519–530.

Low R., Burdon, M., Christensen S., Duncan W., Barne, P., & Foo E. (2010): Protecting the protectors: Legal liabilities from the use of Web 2.0 for Australian disaster response. In Michael, Katina (eds.) *Proceedings of the 2010 IEEE International Symposium on Technology and Society : Social Implications of Emerging Technologies*, ISTAS 2010 Program Committee, University of Wollongong, New South Wales, pp. 411-418.

Lundgren R.E. & McMakin, A.H. (2009) *Risk Communication: A Handbook for Communicating Environmental, Safety, and Health Risks*, Wiley-IEEE Press, 4th Edition.

MacLean K., Cuthill M., & Ross H. (2014): Six attributes of social resilience, *Environmental Planning and Management*, 57(1): 143-156.

- Madianou M., Longboan L. & Ong J. (2015): Finding a voice through humanitarian Technologies?, *International Journal of Communication*, 9, 3020–3038.
- Magis K. (2010): Community Resilience: An Indicator of Social Sustainability, *Society & Natural Resources*, 23(5), 401-416.
- Mallak L. (1998): Putting Organisational Resilience to Work. *Industrial Management*, 40(6), 8–13.
- Manyena S. B., O'Brien G., O'Keefe P., & Rose J. (2011): Disaster resilience: a bounce back or bounce forward ability? *Local Environment*, 16(5): 417–424.
- Melkunaite L. et al (2016): International Survey. IMPROVER Project, Deliverable 1.1.
- McKinnon S., Gorman-Murray A., & Dominey-Howes D. (2016): Disasters, Queer Narratives and the News: How are LGBTI Disaster Experiences Reported by the Mainstream and LGBTI Media?, *Journal of Homosexuality*, 4, 1-23.
- Mendoza M., Poblete B., & Castillo C. (2010): Twitter Under Crisis: Can we trust what we RT?. In *Proceedings of the first workshop on social media analytics*, 71-79.
- Miles B., & Morse S. (2007): The role of news media in natural disaster risk and recovery, *Ecological Economics*, 63(2–3): 365–373.
- Mitchell J.T., Thomas D.S.K., Hill A.A., Cutter S.L. (2000): Catastrophe in reel life versus real life: perpetuating disaster myth through Hollywood films, *International Journal of Mass Emergencies and Disasters*, 18 (3): 383–402.
- Moeller S. (1999): *Compassion Fatigue. How the Media sell Disease, Famine, War and Death*. London: Routledge.
- Montjoye Y., Hidalgo C. A., Verleysen M., & Blondel V. D. (2013): Unique in the Crowd: The Privacy Bounds of Human Mobility, *Scientific Report*, 3:1376, available online at: [file:///C:/Users/Elisa/Downloads/srep01376%20\(1\).pdf](file:///C:/Users/Elisa/Downloads/srep01376%20(1).pdf) (Accessed 10 December 2016).
- Montjoye Y., Hidalgo C. A., Verleysen M. & Blondel V. D. (2012): Unique in the Crowd: The privacy bounds of human mobility. *Scientific Reports*, 3. Available online at: <file:///C:/Users/Elisa/Downloads/srep01376.pdf> (Accessed 1 November 2016).
- Morris J. T., Mueller J. L., & Jones M. L. (2014): Use of social media during public emergencies by people with disabilities, *The Western Journal of Emergency Medicine*, 15(5): 567–74.
- Moynihan D. P. (2009): The network governance of crisis response: case studies of incidents command systems, *Journal of Public Administration Research and Theory*, 19(4): 895-915.
- Murthy D. & Longwell S. A. (2013): TWITTER AND DISASTERS The uses of Twitter during the 2010 Pakistan floods, *Information, Communication & Society*, 16(6): 837-855.
- Murray-Johnson L., Witte K., Liu W.Y., Hubbell A.P., Sampson J., & Morrison K. (2001): Addressing cultural orientations in fear appeals: promoting AIDS-protective behaviors among Mexican immigrant and African American adolescents and American and Taiwanese college students, *Journal of Health Communication*, 6 (4): 335-58.
- Musacchio M. T. (2014): Social media and disaster management: US FEMA as a benchmark for its European counterparts? In K. Ahmad & C. Vogel (eds.) *9th International Conference on Language Resources and Evaluation (LREC)*. Paris: European Language Resources Assoc-Elra, 10-14. Available online at: <http://slandail.eu/wp->

A Communication Strategy to build Critical Infrastructure Resilience

[content/uploads/2014/06/LREC_2014_Musacchio_Dimple_presentation_310514_for_Slandail_partners.pdf](#) (Accessed 23 November 2016).

Nahon K. & Hemsley J. (2013): *Going Viral*. Cambridge: Polity Press.

Neuhaus C. (2010): Integrated crisis communication as new approach in crisis management, *Proceedings of the 7th International ISCRAM Conference - Seattle, USA*.

Norris F. H., Stevens S. P., Pfefferbaum B., Wyche K. F., Pfefferbaum R. L. (2008): Community Resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness, *American Journal of Community Psychology*, 41(1-2): 127-150.

Oh O., Agrawal M., & Raghav Rao H. (2013): Community intelligence and social media services: A rumor theoretic analysis of tweets during social crises, *MIS Quarterly*, 37(2): 407-426.

Palen L., Vieweg S., Liu S. B., & Hughes A. L. (2009): Crisis in a Networked World Features of Computer-Mediated Communication in the April 16, 2007, Virginia Tech Event," *Social Science Computer Review*, 27(5), 1-14.

Palen L., & Liu S. B. (2007): Citizen Communications in crisis: anticipating a future of ICT-supported public participation. *CHI 2007 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, San Jose, California, USA — April 28 - May 03, 2007, 727-736.

Palen L., Vieweg S., & Sutton J. (2007): Crisis informatics: Studying crisis in a networked world. *3rd international Conference on e-Social Sciences*, Ann Arbor, Michigan, October 7-9, 2007.

Pennington-Gray L., Kaplanidou K. & Schroeder A. (2013): Drivers of social media use among African Americans in the event of a crisis, *Natural Hazards*, 66(1): 77-95.

Pantti M., & Sumiala J. (2009): Till death do us join: media, mourning rituals and the sacred centre of the society, *Media, Culture & Society*, 31(1): 119–135.

Perez-Lugo M. (2004): Media uses in disaster situations: A new focus on the impact phase, *Sociological Inquiry*, 74(2): 210–225.

Perko T. (2011): Importance of risk communication during and after a nuclear accident, *Integrated Environmental Assessment and Management*, 7(3): 388–392.

Petersen L., Fallou L., Reilly P., Serafinelli E., Carreira E., & Utkin A. (2016): Social resilience for critical infrastructures during crises. IMPROVER Project. Deliverable 1.1.

Pohl D., Bouchachia A., & Hellwagner H. (2016): Online indexing and clustering of social media data for emergency management, *Neurocomputing*, 172, 168–179.

Procter R., Crump J., Karstedt S., Voss A. & Cantijoch M. (2013): Reading the riots: what were the police doing on Twitter?, *Policing and Society: An International Journal of Research and Policy*, 23(4): 413-436.

Pfefferbaum R. L., Pfefferbaum B., Nitiéma P., Houston J. B., & Van Horn R. L. (2015): Assessing Community Resilience: An Application of the Expanded CART Survey Instrument With Affiliated Volunteer Responders, *American Behavioral Scientist*, 59(2): 181–199.

Pfefferbaum B., Van Horn R.L. & Pfefferbaum R.L. (2015): A Conceptual Framework to Enhance Community Resilience Using Social Capital. *Clinical Social Work Journal*, 1-9.

Pfefferbaum R. L., & Klomp R. W. (2013): Community resilience, disasters, and the public's health. In F. G. Murphy (Ed.), *Community engagement, organization, and development for public health practice*. New York, NY: Springer, 275-298.

Potts L. (2014): *Social Media in Disaster Response: How Experience Architects Can Build for Participation*. London: Routledge.

Pursiainen C. & Rod B. (2016): Report on criteria for evaluating resilience. IMPROVER Project. Deliverable 2.2.

Raikes J. & Mc Bean G. (2016): Responsibility and liability in emergency management to natural disasters: A Canadian example, *International Journal of Disaster Risk Reduction*, 16, 12-18.

Raine L. & Wellman B. (2012): *Networked: The New Social Operating System*. Cambridge MA; London: MIT Press.

Ransohoff D. F. & Ransohoff R. M. (2001): Sensationalism in the media: When scientists and journalists may be complicit collaborators. *Effective Clinic Practice*, 4, 185-188.

Reilly P. & Atanasova D. (2016a): *A report on the role of the media in the information flows that emerge during crisis situations*, EC FP7 CasEff Project Deliverable 3.4, European Commission FP7.

Reilly P. (2016): Tweeting for peace? Twitter and the Ardoyne parade dispute in Belfast, July 2014, *First Monday*, 21(11).

Resilient Organisations, A collaboration between research & industry. *Resilience of Organisations*. Available at: <http://www.resorgs.org.nz/Current-Research/resilience-of-organisations.html>. (Accessed 11 October 2016).

Reuter C. & Spielhofer T. (2016): Towards social resilience: A quantitative and qualitative survey on citizens' perception of social media in emergencies in Europe. *Technological Forecasting & Social Change*. In Press.

Reynolds B, & Seeger M. W. (2005): Crisis and Emergency Risk Communication as an Integrative Model, *Journal of Health Communication*, 10, 43-55.

Rheingold H. (2012): *Net Smart. How to Thrive Online*. Cambridge MA; London: MIT Press.

Riccadi M.T. (2016): The power of crowdsourcing in disaster response operations, *International Journal of Disaster Risk Reduction*, 20 (12): 123–128.

Rogstadius J., Vuko M., Teixeira C. A., Kostakos V., Karapanos V., Laredo J. A. (2013): CrisisTracker: crowdsourced social media curation for disaster awareness, *IBM Journal of Research and Development*, 57(5), 4:1-4:13.

Rubin J. H. & Rubin I. S. (2005): *Qualitative Interviewing. The Art of Hearing Data*. 2nd Ed. London: Sage.

Sampson T. D. (2012): *Virality. Contagion Theory in the Age of Networks*. Minneapolis: University of Minnesota Press.

Sahebjamnia N., Torabi S.A., & Mansouri S.A. (2015): Integrated business continuity and disaster recovery planning: towards organizational resilience, *European Journal of Operational Research* 242(1): 261–273.

A Communication Strategy to build Critical Infrastructure Resilience

Schimak G., Havlik D., & Pielorz J. (2015): Crowdsourcing in Crisis and Disaster Management - Challenges and Considerations. In Denzer R., Argent R.M., Schimak G., Hřebíček J. (eds.) *Environmental Software Systems. Infrastructures, Services and Applications*. ISESS 2015. IFIP Advances in Information and Communication Technology, 448. Springer, Cham.

Scifo S. & Salman Y. (2015): Citizens' involvement in emergency preparedness and response: A comparative analysis of media strategies and online presence in Turkey, Italy and Germany, *Interactions: Studies in Communication & Culture*, 6 (2): 179-198.

Seeger M.W. (2006): Best Practices in Crisis Communication: An Expert Panel Process, *Journal of Applied Communication Research*, 34(3): 232-244.

Seeger M.W., Sellnow T., & Ulmer R.R. (2003): *Communication and Organizational Crisis*. Westport, CT: Praeger.

Shaw R., & Goda K. (2004): From disaster to sustainable civil society: the Kobe experience, *Disasters*, 28(1): 16-40.

Shklovski I., Burke M., Kiesler S., & Kraut R. (2010): Technology adoption and use in the aftermath of Hurricane Katrina in New Orleans. *American Behavioral Scientist*, 53(8): 1228-1246.

Simon T., Goldberg A., & Adini B. (2016): Are ethical norms and current policies still relevant in face of the recent mass terror events?, *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, 24:118.

Simon T., Goldberg A., & Adini B. (2015): Socializing in emergencies—A review of the use of social media in emergency situations. *International Journal of Information Management*, 35(5), 609-619.

Simon T., Adini B., El-Hadid M., & Aharonson-Daniel L. (2013): Competing to rescue-leveraging social media for cross border collaboration in life-saving rescue operations, *The American Journal of Emergency Medicine*, 13(11): 1618.

Smith B.G. (2010): Socially distributing public relations: Twitter, Haiti, and interactivity in social media, *Public Relations Review*, 36 (4): 329-335.

Singer E. & Endreny P. (1994): *Reporting on Risk*. NY: Russell Sage Foundation.

Spialek L. M., Czapinski H. M., & Houston J. B. (2016): Disaster communication ecology and community resilience perceptions following the 2013 central Illinois tornadoes, *International Journal of Disaster Risk Reduction*, 17, 154-160.

Starbird K., Maddock J., Orand M., Achterman P., & Mason R. M.(2014): Rumors, false flags, and digital vigilantes: misinformation on Twitter after the 2013 Boston Marathon bombing. In *Proceedings of the iConference 2014*, 654-662.

Starbird K. (2011): Digital Volunteerism During Disaster: Crowdsourcing Information Processing. *CHI2011*, May 7-12, 2011, Vancouver, BC, Canada.

Stephens K. K., Barrett A., & Mahometa M. L. (2013): Organizational communication in emergencies: Using multiple channels and sources to combat noise and capture attention, *Human Communication Research*, 39, 230-251.

Stiegler R., Tilley S., & Parveen T. (2011): Finding family and friends in the aftermath of a disaster using federated queries on social networks and websites. *Web System Evolution, Proceedings - 13th IEEE International Symposium*, Melbourne, Australia, 21-26.

Su Y. S., Wardell C., & Thorkildsen Z. (2013). Social media in the emergency management field: 2012 survey results. CNA. Available at: <https://pdfs.semanticscholar.org/c632/16cb2174a5472bda221b5ef36fa8e94b81f4.pdf> (Accessed 2 May 2017).

Subasic I., & Berendt B. (2011): Peddling or creating? Investigating the role of twitter in news reporting, *Advances in Information Retrieval*, 661: 207–213.

Sutton J., Skiba U. M., van Grinsven H. J. M., Oenema O., Watson C. J., Williams J., Hellums D. T., Maas R., Gydenkaerne S., Pathak H., & Winiwater W. (2014): Green economy thinking and the control of nitrous oxide emissions, *Environmental Development*, 9, 76-85.

Sutton J. N. (2010): Twittering Tennessee: Distributed networks and collaboration following a technological disaster. *Proceedings of the 7th International ISCRAM Conference*, Seattle, USA - May 2010.

Tapia A. H., & Moore K. (2014): Good enough is good enough: Overcoming Disaster Response Organizations Slow Social Media Data Adoption. *Computer Supported Cooperative Work: CSCW: An International Journal*, 23(4–6): 483–512.

Tester K. (2001): *Compassion, Morality and the Media*. Buckingham: Open University Press.

Thelwall M. & Stuart D. (2007): RUOK? Blogging communication technologies during crises, *Journal of Computer Mediated Communication*, 12: 523–548.

Tierney K. (2009). Disaster Response: Research Findings and Their Implications for Resilience Measures. Available at: <http://www.resilientus.org/wp-content/uploads/2013/06/Tierney-20092.pdf> (Accessed 9 February 2016).

Tierney K., Becv C., & Kuligowski E. (2006): Metaphors Matter: Disaster Myths, Media Frames, and Their Consequences in Hurricane Katrina. *The ANNALS of the American Academy of Political and Social Science*, 604(1): 57–81.

Tierney K. & Trainor J. (2004): Networks and resilience in the world trade centre disaster, *Research Progress and Accomplishments*, 6, Buffalo, NY: Multidisciplinary Centre for Earthquake Engineering Research, pp. 158-72.

Tierney T. (2014): Crowdsourcing Disaster Response: Mobilizing Social Media for Urban Resilience. *The European Business Review*. Available at: <http://www.europeanbusinessreview.com/?p=4911> (Accessed 10 May 2016).

Unger E. (2015): Planning for Disaster- Ensuring Utility Communication System Resilience. *Energycentral*. Available at: <http://www.energycentral.com/gridtandd/communicationsandsecurity/articles/3167/Planning-for-Disaster-Ensuring-UtilityCommunication-System-Resilience/> (Accessed 6 April 2016).

UNISDR (2009): UNISDR Terminology on Disaster Risk Reduction. International Strategy for Disaster Reduction (ISDR). Available at: www.unisdr.org/publications (Accessed 23 April 2016).

Veil S., Buehner T., & Palenchar M. J. (2011): A work-in-process literature review: Incorporating social media in risk and crisis communication. *Journal of Contingencies and Crisis Management*, 19(2): 110–122.

Verderber K. S., Sellnow D. D. & Verderber R. F. (2015): *COMM*. Stamford, CT: Cengage Learning.

A Communication Strategy to build Critical Infrastructure Resilience

Vieweg S., Castillo C., & Imran M. (2014): Integrating Social Media Communications into the Rapid Assessment of Sudden Onset Disasters. *Social Informatics*, 444–461.

Vieweg S., Hughes A. L., Starbird K., & Palen L. (2010): Mivroblogging during two natural hazards events: What twitter may contribute to situational awareness, *28th Annual CHI Conference on Human Factors in Computing Systems CHI 2010*, Atlanta, GA; United States, 10 April 2010, 2, 1079-1088.

Vieweg, S., Palen, L., Liu, S. B., Hughes, A. L., & Sutton, J. (2008). Collective Intelligence in Disaster: Examination of the Phenomenon in the Aftermath of the 2007 Virginia Tech Shooting. *In Proceedings of the Information Systems for Crisis Response and Management Conference (ISCRAM 2008)*. Washington D.C.

Watson H. & Rodrigues R. (2017): Bringing Privacy into the Fold: Considerations for the Use of Social Media in Crisis Management. *Journal of Contingencies and Crisis Management*.

Wang X., & Kapucu N. (2008): Public complacency under repeated emergency threats: Some empirical evidence, *Journal of Public Administration Research and Theory*, 18(1): 57–78.

Wendling C., J. Radisch & S. Jacobzone (2013): The Use of Social Media in Risk and Crisis Communication. *OECD Working Papers on Public Governance*, No. 24, OECD Publishing.

Wilson G. A. (2012): *Community resilience and environmental transitions*. London, England: Earthscan from Routledge Press.

Yates D. & Paquette S. (2011): Emergency knowledge management and social media technologies: A case study of the 2010 Haitian earthquake, *International Journal of Information Management*, 31(1): 6–13.

Yin J., Karimi S., Lampert A., Cameron M., Robinson B., & Power R. (2012): Using social media to enhance emergency situation awareness: extended abstract, *Intelligent Systems*, IEEE 27(6): 52-59.

Younger P. (2010): Internet-based information-seeking behaviour amongst doctors and nurses: a short review of the literature, *Health Information and Libraries Journal*, 27(1): 2–10.

Zebrowski C. (2009): Governing the network society: a biopolitical critique of resilience, *Political Perspectives*, 3(1): 1–41.

Zook M., Graham M., Shelton T., & Gorman S. (2010): Volunteered Geographic Information and Crowdsourcing Disaster Relief: A Case Study of the Haitian Earthquake, *World Medical Health Policy*, 2(2): 7-33.

10 Appendices

10.1 Appendix 1: Background on case studies

Floods in Porto and Coimbra, Portugal (January 2015 - February 2016)

Between January and February 2016, as reported by Portugal's National Civil Protection Authority⁵¹ (ANPC) the Douro, Mondego and Tâmega rivers overflowed affecting areas of Porto and Coimbra districts. ANPC had issued warnings following a period of heavy rain and strong winds that affected the North and Central regions of the country over a few days. ANPC also recorded over 300 weather-related incidents, with around 200 of them a resulting in flooding. Porto and Coimbra districts have been reported as the areas worst affected by the flooding. Although no fatalities were reported, the natural environment impacted the district of Porto around residential areas, which included fallen trees and landslides. The severe weather conditions also caused the derailment of two trains, injuring three people.

Social media were not reported as a main means of communication for emergency managers. However, officials' prefectures websites reported warning messages and updates of the crisis. Instagram images and YouTube videos from the general public were collected and used by official news channels to report the damages caused by the flood. Emergency notifications were posted only on official websites. Local television channels and radio played an important role in informing the general public about the circumstances of the floods.

Terrorist attack in Paris, France (13 November 2015)

On the night of Friday 13th November 2015, a gunman and suicide bombers hit a concert hall, a major stadium, restaurants and bars, almost simultaneously and left 130 people dead and hundreds wounded. The first of three explosions occurred outside the Stade de France stadium on the northern fringe of Paris where France were playing Germany in an international football friendly. A man wearing a suicide belt was reportedly prevented from entering the stadium after a routine security check detected the explosives. The man backed away from security guards and detonated the explosives. The game, attended by President Francois Hollande, was being broadcast on television. After a second man detonated his suicide vest outside a different stadium entrance at 21:30, the president was rushed to safety. A third suicide bomber blew himself at a fast-food outlet near the stadium at 21:53. The attackers all wore identical explosive vests. Meanwhile, other attacks were unfolding nearer to the centre of town around popular nightlife spots. The first took place at about 21:25 in the 10th district (arrondissement), not far from the Place de la Republique. The gunmen arrived at the scene in a black seat car, later found abandoned, about three miles (nearly 5km) away in the eastern suburb of Montreuil. Witnesses at Le Carillon bar, 18 rue Alibert, said they initially thought a firecracker had gone off before realising that they were under fire from semi-automatic rifles. "People dropped to the ground. We put a table over our heads to protect us", said Ben Grant, who was with his wife at the back of the bar. Then, three heavily armed gunmen broke into the Bataclan during a rock group performance at 21:40. They killed 90 people at the venue and critically injured many others.

After those events, social media have been widely used to share messages of support, fear, hope and pride. #Prayers4Paris was one of the most used hashtag to show support. #PorteOuverte was another hashtag widely used during and after the disaster to connect people in need of shelter and safety with those offering help. Images and texts on Twitter, Facebook and Instagram represented the story

⁵¹ <http://www.preventionweb.net/organizations/34>

A Communication Strategy to build Critical Infrastructure Resilience

through people's emotional personal perspectives. Traditional media reacted to the event broadcasting news of the attack on their front pages.

10.2 Appendix 2: Interviews and Focus Groups: Explore the role of social media in building community resilience

General Information

Project:

IMPROVER: Improved risk evaluation and implementation of resilience concepts to critical infrastructure. EC Horizon 2020.

Principal Investigators:

Dr Paul Reilly

Senior Lecturer in Social Media & Digital Society, E: p.j.reilly@sheffield.ac.uk

Dr Elisa Serafinelli

Research Associate, E: e.serafinelli@sheffield.ac.uk

Information School, University of Sheffield

235 Regent Court

211 Portobello

Sheffield

S1 4DP

Date: 31 May 2016

Background information

The title of this research is IMPROVER: Improved risk evaluation and implementation of resilience concepts to critical infrastructure. The principal investigators of the Sheffield work package in this project is *Dr Paul Reilly*, Senior Lecturer in Media and Communication and *Dr Elisa Serafinelli*, Research Associate, University of Sheffield. This study explores how information shared via social media can help reduce response and recovery times and raise awareness about the risk of future disasters. The Sheffield team will look specifically at how community representatives, professional journalists, critical infrastructure operators and those involved in emergency management can use social media to create early-warning systems that can be activated during such events.

The Sheffield team hopes to identify examples of good practice for information dissemination to the public during crises. These will be used to develop a communication strategy for emergency services and incident managers that will raise public awareness about the risks associated with these events.

Procedures and Protection

The study involves the use of focus groups and interviews to explore perspectives on how key stakeholders (e.g. community representatives, critical infrastructure operators, professional journalists, and agencies involved in emergency management) employed social media during several recent man-

made and natural disasters in Europe. This study aims to identify best practice in the use of social media as a tool to increase disaster preparedness in these areas.

Participants will be drawn from a range of institutions with relevant experience in this area. Interviews will be recorded and transcribed by an independent transcriber who has signed a confidentiality agreement with the Principal Investigator. The session should take *about 45 minutes*.

Your participation in the project is entirely voluntary and you are free to withdraw from the project at any point. If you are uncertain or uncomfortable about any aspect of your participation please contact the Principal Investigators listed at the top of this letter to discuss your concerns or request clarification on any aspect of the study.

Any information you supply to use will be treated confidentially in accordance with the 1998 Data Protection Act: your name and identifying affiliations will be anonymised in any resulting publications, unless you give us your explicit consent to identify you as a subject.

If you have any questions about the ethical conduct of this research please contact Dr Elisa Serafinelli, using the contact details at the top of this letter.

Thank you very much for participating,
Dr Elisa Serafinelli

Interview Consent Form

If you consent to being interviewed and to any data gathered being processed as outlined below, please print and sign your name, and date the form, in the spaces provided.

Title of Project: IMPROVER: Improved risk evaluation and implementation of resilience concepts to critical infrastructure.

Principal Investigators:

Dr Paul Reilly, Senior Lecturer in Social Media & Digital Society, E: p.j.reilly@sheffield.ac.uk

Dr Elisa Serafinelli, Research Associate, E: e.serafinelli@sheffield.ac.uk

Information School, University of Sheffield

235 Regent Court

211 Portobello

Sheffield

S1 4DP

In signing this form I confirm that I have freely agreed to participate in the above project and have been briefed on what this involves.

Interviews will be recorded and transcribed by an independent transcriber who has signed a confidentiality agreement with the Principal Investigators.

All data will be treated as personal under the 1998 Data Protection Act, and will be stored securely.

A Communication Strategy to build Critical Infrastructure Resilience

A copy of the interview transcript will be provided, free of charge, on request.

Data collected may be processed manually and with the aid of computer software.

Please indicate, by ticking ONE of the boxes below, whether you are willing to be identified, and whether I may quote your words directly, in reports and publications arising from this research.

I/my employer (delete which is not applicable) may be identified in publications.	
Neither I, nor my employer, may be identified in any publications. My words may be quoted provided that they are anonymised.	
Neither I, nor my employer, may be identified in any publications. My words may not be quoted.	

Please print your name: _____

Signature: _____

Date: _____

10.3 Appendix 3: List of questions

IMPROVER Focus Group Interview: Community representatives and community leaders (the research question focuses on their perception of what appeared to work (and not work) in relation to building disaster resilience)

- How do local residents tend to get information about breaking news stories? Probe for examples
- What factors influence their choice of platform? (Reliability? Credibility? Trustworthiness? Ease of access? Recommendation from family member/friend?)
- Do they tend to use social media during major emergencies and disasters? If so, how? Probe for examples
- To what extent do local residents interact with key stakeholders (local police authority/fire & rescue service) on social media during such incidents? Probe for examples.

- Turning to the incident (floods in Cumbria; Portugal flood; Paris terrorist attack; Brussels bombing; floods in Norway – use as appropriate), how did you first become aware of this incident? How did local residents first hear about it?
- Why do you think these platforms were most commonly used by residents in the aftermath of the incident?
- Can you tell me a little about how you (and local residents) used social media and other sources to get information during this incident – how did your information-seeking change, if at all, as events unfolded?
- Were there any examples of rumour, disinformation or misinformation being spread as the incident unfolded? Probe for examples
- If so, to what extent did local residents/eyewitnesses assist with the verification of such information? What role, if any, did social media play in this process?
- What feedback did you get from members of the public via traditional media during and after the incident e.g. telephone, social media channels, comment sections of news articles? How did you respond to this?
- How did you engage with incident managers and other emergency services during this incident? Face-to-face? Telephone? Press conference? Social media?
- Which communication platform e.g. tv, radio through to social media site was the most effective in reassuring the public and mitigating the effects from this incident?
- What lessons, if any, did your organisation learn from this incident in terms of how best to communicate with the public? Has your approach changed as a result of this incident?
- Turning to disaster preparedness, how do you and other key stakeholders share information with members of disaster-vulnerable/prone communities? (probe for examples)
- What factors have influenced this approach? (probe for examples)
- Which communication platform do you think has been the most effective in building disaster resilience in your community? (probe for examples) Why do you think that is the case?

A Communication Strategy to build Critical Infrastructure Resilience

- What feedback have you had from members of the public in relation to these initiatives (use of traditional and/or social media to build disaster resilience/preparedness)?
- How often do you review these initiatives?
- How would you like to see these initiatives develop in the future? Probe for examples of using traditional and social media to build resilience)
- Is there anything else that you would like to add?

IMPROVER Focus Group Interview: Critical infrastructure providers, members of the emergency services and agencies involved in emergency management

- Could you tell me a bit about your media/communication strategy and where the Internet (social media) fits into that?
- What social networking websites or smart phone apps has your organisation joined, if any? List of names for prompting – Facebook, Twitter, YouTube
- What factors have influenced your use of social media for communicating with the public? Institutional? Examples of good practice from other organisations? (Probe for examples)
- What sort of feedback have you received so far about your use of social media for communicating with the public? (Provide examples)
- What sorts of groups are accessing your social media sites? Who are you speaking to on social media? What kind of data analysis do you make on that communication (traffic analysis, feedback etc)?
- Do you collect data on who is accessing your sites? How? How is this data used?
- How often do you evaluate and update your communication strategies? How long does such an evaluation process take? Who is responsible for this?

- Are there any forms of media that you think are particularly effective during crisis situations? Probe for examples

- To what extent does your organisation monitor social media sites or smart phone apps such as Facebook and Twitter to gather information about potential incidents and to plan operations to prevent their escalation?

- Turning to the (floods in Cumbria; Portugal flood; Paris terrorist attack; Brussels bombing; Floods in Norway– use as appropriate), how did you (or your organisation) first become aware of this incident?

- Can you tell me a little about how your communication strategy evolved during the incident – at what stage did you talk to the media, issue statements on social media e.g. Twitter

- Did you use social media content e.g. comments/pictures/videos posted by eyewitnesses to coordinate the emergency response? If so, how did you collect and verify this content? Were there any ethical challenges?

- What feedback did you get from members of the public via traditional e.g. telephone and social media channels? Did you have guidelines as to how best to respond to these queries?

- Which communication platform e.g. tv, radio through to social media site was most effective in reassuring the public and mitigating the effects from this incident?

- What lessons, if any, did your organisation learn from this incident in terms of how best to communicate with the public? Has your approach changed as a result of this incident?

- Turning to disaster preparedness, how do you share information with disaster-vulnerable/prone communities? (probe for examples)

- What factors have influenced this approach? (probe for examples)

- Which communication platform do you think has been the most effective in building disaster resilience? (probe for examples)

- What feedback have you had from members of the public in relation to these (traditional and social media) initiatives? How often do you review these initiatives?

- How do you see that your communication strategies developing over the next few years?

A Communication Strategy to build Critical Infrastructure Resilience

- How would you like to see them develop?
- Is there anything else that you would like to say?

IMPROVER Focus Group Interview: Professional Journalists

- Can you give me a quick overview of your role and the organisation you work for? Probe for information on how long they have been a journalist.
- Tell me a little about how you use social media as a tool for journalism. Probe for information on what sites they use, whether they blog, etc.
- What factors influence your use of social media in your job? Example of good practice, training, etc.
- How would you describe your interactions with members of the public on social media? Probe for positive and negative, any site-specific examples e.g. how does Facebook compare to YouTube.
- How would you describe your interactions with relevant organisations (local police authority/fire & rescue service) on social media? Probe for positive and negative, site-specific examples/comparisons.
- Do you use social media to detect incidents e.g. disasters and events that may be of interest to your organisation and/or audience? How do you do this?
- How do you verify information posted online by eyewitnesses during crisis/emergency situations? Probing questions: How do you determine that a social media account is reliable/not fake, etc.? What's your source of expertise when it comes to verifying social media content? Are there tools or other resources that you use/plan to use/are aware of that help you or can help you with verification? How do you understand verification – what does it encompass? Are there circumstances where you might distribute social media content without being sure that it is reliable/without first verifying it? How do you decide when enough verification has been done/enough has been done to establish accuracy? Ask about the verification of both textual info and images.
- What ethical challenges do you face when using social media as a source of information during crisis situations? How have you addressed these? How do you go about contacting

people that you found on a social media site who are caught up in a crisis situation? How do you ensure their safety? Their privacy? Does your organisation have procedures in place on these issues?

- What legal challenges do you face when using social media as a source of information during crisis situations? How well informed about these do you feel? How do you credit social media content in your work? How do you check about copyright? How do you inform social media users about the way in which their content has been used? What guidelines does your organisation have on these issues?

- Turning to the (floods in Cumbria; Portugal flood; Paris terrorist attack; Brussels bombing; floods in Norway– use as appropriate), how did you first become aware of this incident?

- Can you tell me a little about how you used social media and other sources to get information during this incident – how did your information-seeking change, if at all, as events unfolded?

- How did you verify the information posted online by eyewitnesses and members of the public during this incident? Probe about both text and visuals.

- What feedback did you get from members of the public via traditional e.g. telephone, social media channels, comment sections of news articles? How did you respond to this?

- How did you engage with incident managers and other emergency services during this incident? Face-to-face? Telephone? Press conference? Social media?

- Is there anything else that you would like to add?