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European Expectations of Disaster Information provided by Critical Infrastructure Operators:

Lessons from Portugal, France, Norway and Sweden

Laura Petersen, Euro-Mediterranean Seismological Centre (EMSC), Essonne, France
Laure Fallou, Euro-Mediterranean Seismological Centre (EMSC), Essonne, France
Paul Reilly, University of Sheffield, Sheffield, UK
Elisa Serafinelli, University of Sheffield, Sheffield, UK

ABSTRACT

Previous research into social media crisis communication has tended to focus on use by emergency managers rather than other key stakeholder, critical infrastructure (CI) operators. This article adds to the field by empirically investigating public expectations of information provided by CI operators during crisis situations and if CI operators currently meet such expectations. It draws on key themes that emerged from a review of the literature on public expectations of disaster related information shared via social media. Then, it presents the results of an online questionnaire and interview-based study of disaster-vulnerable communities in France, Norway, Portugal and Sweden. Results indicate that members of the public expect CI operators to provide disaster related information via traditional and social media, but not necessarily respond to their queries on social media. Operators appear to meet public expectations of traditional media use, but should expand their current practices to include digital media. Recommendations for CI operators on how to do use social media follow.

KEYWORDS

Crisis Communication, Digital Divides, IMPROVER, Interview, Living Labs, Public Expectations, Questionnaire, Social Media, Traditional Media

INTRODUCTION

Effective crisis communication can be defined as "the provision of effective and efficient messages to relevant audiences during the course of a crisis process" (Freberg et al., 2013:186). Since the Mumbai terrorist attacks in November 2008 social media has been used in crisis times for sharing disaster information and build situational awareness (Latonero & Shvlovski, 2010; Potts, 2014). This has led to the development of a series of guidelines for blue light organisations, such as police, firefighters,

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rescue services, etc. who use blue light sirens, as well as emergency managers on how best to use social media as a tool for crisis communication. For example, EU projects DRIVER, CascEff, COSMIC and EMERGENT have all produced guidelines. Various national governments also have guides. Previous research in this emergent area has tended to focus solely upon how these actors or the public use social media in crisis times (The American Red Cross, 2009; Bruns, Burgess, Crawford, & Shaw, 2012; Imran, Castillo, Diaz, & Vieweg, 2015; Reuter & Kaufhold, 2018; Reuter, Kaufhold, Spielhofer, & Hahne, 2017; Reuter, Ludwig, Kaufhold, & Spielhofer, 2016), often overlooking the role played by another key stakeholder, critical infrastructure (CI) operators. Thus, there have been few empirical studies exploring public expectations of information shared by CI operators during crisis situations. This paper attempts to address this gap by answering the following four research questions:

RQ1: What do European citizens expect of CI operators in regard to information provision during crisis situations?
RQ2: Are there any noticeable similarities/differences between public expectations based on nationality or other demographic factors?
RQ3: How do these declared expectations compare to the current communication efforts of CI operators?
RQ4: How can CI operators meet these expectations?

It does so by drawing on key themes that emerged from a review of the literature on public expectations of disaster related information shared via social media (Section 2). Then the methodology (Section 3) and the results (Section 4) of an online questionnaire and interview-based study of disaster-vulnerable communities in France, Norway, Portugal and Sweden are described. Afterwards, the findings are discussed with regard to social media use by CI operators during disasters (Section 5). Our findings show that the public have high expectations to be provided information, but less high in regard to answering comments on social media. CI operators appear to meet expectations concerning traditional media use, but not necessarily when it comes to digital media use. The paper concludes by proposing recommendations for how CI operators can use social media to communicate with the public during crisis situations (Section 6).

PUBLIC EXPECTATIONS OF DISASTER RELATED INFORMATION ON SOCIAL MEDIA

Characteristics of Information

Members of the public expect to be kept informed about the threat to their lives and properties at each stage of the disaster cycle (Perko, van Gorp, Turcanu, Thijssen, & Carle, 2013; Tierney, 2009). They expect to be able to find out what has happened, what is expected to happen, and what steps they should take to mitigate the risk to themselves and their homes (Ryan, 2012). For example, after the Nepal earthquake in 2015, a survey of LastQuake app users conducted by the European Mediterranean Seismological Centre (EMSC) found that 44% of respondents wanted to be provided with "Dos and Don'ts", in order for them to understand how to act after an earthquake (Bossu et al., 2015). 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, Sellnow, & Ulmer, 2003). Indeed, providing timely information can reduce anxiety and contribute to global risk reduction (Bossu et al., 2018). People also expect to receive information written in a language that is jargon-free and easy to understand (Kaufman, Qing, Levenson, & Hanson, 2012). This should also account for the different languages spoken by disaster affected communities. Indeed, during Hurricane Sandy in 2012, CI operators in New York City were criticised for providing information about evacuation using public transport

exclusively in English (Kaufman et al., 2012). Crisis communication should therefore be not only timely and accurate, but also tailored to the specific characteristics of the target population.

Social Media and Crisis Situations

Social media has been identified as an increasingly important source of information during crisis situations. While there can be a considerable lag between the occurrence of a crisis situation and news reports about it, social media has been recognised for its potential to provide complementary and relevant information for crisis management in near real-time (Imran et al., 2015; Meier, 2013). The Reuter and Kaufhold (2018) review of 15 years of crisis informatics research demonstrated that studies of social media use cover both natural hazards and human-induced disasters; cover use by both the general public and authorities; and show that social media is used for both crisis communication and situation awareness. That said, the public expect to receive crisis information from key stakeholders via both social and traditional media channels (The American Red Cross, 2009). Research has consistently shown that citizens seek information from whatever media channels are available to them during disasters, as was the case during large-scale incidents such as Hurricane Sandy and the 2011 Great East Japan Earthquake (Burger, Gochfeld, Jeitner, Pittfield, & Donio, 2013; Mitomo, Otsuka, Jeon, & Cheng, 2013). Expectations about the availability of crisis information on social media continue to rise. A study commissioned by the American Red Cross (2012) found that 12% of the general public have used social media to share or obtain information during crises. Subsequent surveys conducted in the European Union found that 43% of respondents used social media to look for information during a past emergency, with 58% stating that they would do so in the case of a future disaster (Reuter et al., 2016). During the 2011 Great East Japan Earthquake and Tsunami, more than half of Japanese citizens used sites such as Twitter to search for disaster-related information (Takeuchi, Peary, & Shaw, 2012). As per the Reuter and Spielhofer (2016) survey, which found that 77% of respondents felt that crisis information was shared much more quickly online than via traditional media channels, social media appeared popular due to the ease with which these populations could search for and obtain information about the earthquake. Furthermore, both Facebook and Twitter were heavily used to find out information in Germany during the 2013 European Floods, with 157 Facebook pages and groups being created (Kaufhold et al., 2016).

Nationality and Expectations of Social Media Use in Crisis

Crisis are interpreted through culture, which influences risk perception, disaster preparedness and response (Furedi, 2007; Hewitt, 2008; The Johns Hopkins and the International Federation of Red Cross and Red Crescent Societies, n.d.; Mayhorn & McLaughlin, 2012). That said, the exact roles nationality and culture play in public expectations for crisis communication have yet to be explored in depth. Majority of research on how nationality and culture affect public perception of crisis communication have been done in regard to public relations (see for example, Yi-Hui, Wu, & Cheng, 2016; Zhu, Anagondahallib, & Zhang, 2017) and few have examined disasters as defined by this study. To the best of our knowledge, only one representative study on citizens' perceptions of social media in emergencies has been conducted in Germany (Reuter et al., 2017), making comparisons between nationalities difficult. However, the same study indicated that preliminary findings from a survey of UK citizens showed that differences do exist (Reuter et al., 2017). Expectations of social media use in crisis most likely also depend on risk culture and social media culture, which are impacted by nationality. Indeed, the European project "Opti-Alert" studied risk cultures across seven European countries and concluded that there are three main risk cultures: individual-oriented, where citizens perceive themselves as actors in crisis management and trust in authorities is medium to high; state-oriented, where citizens perceive themselves as dependent on the state to take care of their safety and trust in authorities is high to very high; and fatalistic, where citizens perceive that both authorities and citizens are powerless in the face of crisis and trust in authorities is low (Dressel, 2015). While risk culture is not only determined by nationality, Dressel (2015) found that certain nationalities held

certain types of risk cultures. The Dutch were individual-oriented, German, Austrians and Swedes were state-oriented, and Italians and Hungarians were fatalistic. Concerning social media culture, a recent Pew study showed that there are differences between nationalities when it comes to use. While around 70% of people in Sweden, the Netherlands and Austria use social media, only 48% do so in France and 37% in Germany (Poushter, 2017). Beyond differences in adoption, what is mostly shared on social media sites varies also by country. For example, while 64% of Italian respondents share information about community issues, only 14% of French respondents state they do (Pew, 2012). Thus, it seems likely that differences would also exist when it comes to social media use in crisis times.

Social Media use by Authorities

There is already significant evidence to suggest that citizens are turning to the social media channels of emergency services to obtain information during crisis situations (Lindsay, 2011). Authorities use social media to communicate about both natural and malicious crises. The Queensland Police Service Media Unit used its Twitter account (@QPSMedia) to provide real-time information about the 2010-11 Queensland floods. Local, State and Federal agencies in the USA used Twitter to share information with the public during the 2013 Boston Marathon Bombing (Sutton et al., 2014). Authorities also amplify each other's official messages. For example, during the 2013 Westgate Mall Terror Attack in Kenya, officials retweeted one another, with speeds of almost immediately to days later (Simon, Goldberg, & Adini, 2014). While authorities generally recognize social media as an important channel for crisis communication, few have actually used it for this purpose (Reuter et al., 2018). The public also expect a quick response if they contact blue light organisations via social media. A Canadian Red Cross survey (2012) found that 63% of respondents believe that emergency services should monitor social media, with one third expecting emergency services to respond to requests for help posted on social media. This resonated with the findings of the Reuter and Spielhofer (2016) survey, which suggested that 42% of European citizens expect emergency services to respond within one hour of them posting for help on their social media sites. A 2017 representative study of German citizens found that 67% of respondents expected emergency services to monitor social media and 47% expected a response within one hour of posting (Reuter et al., 2017).

Social Media Use by CI Operators

In contrast to emergency management organisations, there remains relatively little empirical research exploring public expectations of information provided by CI operators during crisis situations. A study investigating Twitter data corresponding to 26 crises between 2012 and 2013 found that while on average 7% of tweets contained information related to infrastructure and utilities, these tweets were among the most retweeted during such incidents (Olteanu, Vieweg, & Castillo, 2015). Therefore, it appears that information related to CI is of great interest to the public in crisis times. Self-evidently, citizens are likely to expect regular updates on progress towards the restoration of services provided by these operators. Reuter (2015) examined public information needs from energy operators during a blackout and found that both the duration and cause were of key interest. Some CI operators have already used social media to address the information needs of disaster-affected populations, as was seen during Hurricane Sandy. Both New York's Metropolitan Transportation Authority (MTA) and Energy company Public Service Enterprise Group (PSE&G) used social media to post regular updates on service availability to customers (Fine, 2013; Kaufman et al., 2012). During the July 2016 Munich shooting, the metro operator MGV tweeted updates regarding their service level (Personal observation). However, other operators are still allowing an "expectation gap" to exist. For example, also during Hurricane Sandy, although power was restored to customers faster than on average, there was public outcry about how long it took. This was because the energy providers did not effectively communicate how they were dealing with the disruption (Lacey, 2014). Some customers who were not receiving information took to social media to crowdsource restoration information (Pramaggiore, 2014). This is especially troublesome for CI operators because when expectations of communication are not met

this can lead to further discontent and frustration within the affected communities, leading to a poor brand image even following the crisis (Christoplos, 2006). Further, going beyond basic needs and meeting expectations helps to maintain a good reputation in and after times of crisis (Barker, 2013).

METHODOLOGY

In order to investigate these questions, the EU Horizon 2020 project IMPROVER (Improved risk evaluation and implementation of resilience concepts to critical infrastructure) designed an online questionnaire and interview-based study. Ethics approval was sought and obtained from the respective authorities prior to data being collected.

Background on the Living Labs

The IMPROVER project uses Living Labs in order to study various aspects of critical infrastructure resilience. Living Labs are a research concept that create an open-innovation ecosystem and use a systematic user co-creation processes. This means the actors of a Living Lab are not simply subjects but also active participants in the research process. For this project, the Living Labs include different types of infrastructure which provide specific services to a city or region. These Living Labs have been the focal point of the scientific work carried out within the project.

Barreiro Municipal Water Network

Barreiro municipality is situated in the Lisbon Metropolitan area, located 40 km from Lisbon city, on the south bank of the Tagus River estuary (Ioannou et al., 2016). Barreiro has a population of 78,764 people with an area of 36.41 km2 according to the 2011 Census (INE, n.d.). The Barreiro Municipal Water Network (BMWN) delivers potable water to the municipality of Barreiro and serves 42,400 customers (Ioannou et al., 2016). The Barreiro Municipal Water Network is an IMPROVER associate partner.

French A31 Highway

The section of the French A31 Highway (A31) studied in IMPROVER is Nancy-Metz-Luxemburg. The section has a high traffic volume with 100,000 vehicles per day, is frequently used for intercity travel by the approximately 1,500,000 inhabitants of the Moselle valley and is also heavily used for holiday traffic (Ioannou et al., 2016). DIR Est (Direction Interdépartementale des Routes de l'Est – Eastern Interdepartmental Road Office) and DDT57 (Direction départementales des Territoires de Moselle – Departmental Office of the Moselle Territories) are IMPROVER associate partners.

The Oslo Harbour

The Oslo Harbour is an economically independent and partially self-governed municipal company, which combines harbour and industrial areas. It is a multifaceted infrastructure, providing recreation, transportation, business and tourism opportunities to the public. It is the largest container port in Norway. The harbour is located in the southeast of the city of Oslo (population 619,000) (Ioannou et al., 2016). The Oslo Harbour Authority (OHA) and the Directorate for Civil Protectorate of Norway (DBS) are IMPROVER associate partners.

The Oresund Region

The Oresund Region is made up of the Swedish region Skåne, including the city of Malmö, and the Danish region Zealand, including the Danish capital city Copenhagen. It has a total population of 3.2 million people. This combined region is made possible by the Oresund Crossing, which is a combined railway and roadway bridge across the Oresund strait. (Ioannou et al., 2016). The Danish Red Cross, Danske Olieberedskabslagre (FDO) and the Oresund Crossing are IMPROVER associate partners.

Questionnaire

The target population for the questionnaire was adults aged 18 years and over who were familiar with one of the IMPROVER Living Labs. Convenience sampling was used. The questionnaire was translated into the six languages spoken around the Living Labs (English, French, Danish, Swedish, Norwegian, and Portuguese). It was structured as follows: first, a brief description of the IMPROVER project was provided and participants were informed of their right to withdraw from the project at any time, as well as how all data would be handled during the project. Respondents were presented with the following definition of a disaster: "an event which has catastrophic consequences and significantly affects the quality, quantity, or availability of the service provided by the critical infrastructure." A Likert scale was used to measure participants' expectations. Participants were asked the following two questions regarding information provision:

1. During and immediately after a disaster, I expect critical infrastructure operators to provide me with information:
   a. Via calling their telephone number;
   b. On their website;
   c. On their social media sites (Facebook, Twitter);
   d. Through traditional media e.g. interviews with television networks or the radio, press releases;
2. During and immediately after a disaster, I expect critical infrastructure operators to respond to my questions and comments on their social media sites e.g. Twitter.

The questionnaire also asked about the participants' demographics. Data from the questionnaire was collected between 28 March 2016 and 30 April 2016. The questionnaires were translated back into English at the data entry stage. The questionnaire was disseminated through the IMPROVER consortium partners' contacts as well as through the Living Labs. The questionnaire was promoted on the IMPROVER Twitter, LinkedIn, website and email list. The Barreiro Municipality highly promoted the questionnaire via their Facebook page (Figure 1) and thus was able to recruit a high number of respondents. The other Living Labs were less active in publicising the questionnaire.

Microsoft Excel was used to perform chi-squared tests to explore any significant differences across different types of respondents (age, nationality, sex, education level, and social media use) in relation to the questions. For some chi-squared tests, the responses for strongly disagree and disagree were grouped together in order to have enough responses.

Sample Characteristics

The sample consisted of 403 respondents. Due to the dissemination method, this self-selected sample was not broadly representative of the European population nor the Living Labs. Sample characteristics showed that 57% of participants were male, 41% female and 2% not answering. Most were highly educated, with 77% reporting that they have a university degree or higher qualification. Both young and old people appeared to be underrepresented in the study. Respondents aged 18-24 accounted for only 8% of the total sample, with only 16% identifying themselves as aged 55 years and above. While 26 nationalities responded, 88 percent of the questionnaire sample consisted of French, Norwegian, Portuguese or Swedish respondents (Figure 2).

Indeed, they are the only countries with a sufficient critical mass of respondents with more than 50 answers each. One respondent out of three is Portuguese so this has a real impact on the questionnaire results. While not representative of the Portuguese population, the questionnaire sample follows closely the age distribution of the Barreiro Facebook[1] page's active users (Figure 3). Facebook defines an active user as a Facebook user who liked, commented or shared the page publication or interacted with the page in the last 28 days. This shows the impact of the dissemination method on our sample.

Figure 1. Barreiro Municipality's Facebook page with post about the IMPROVER questionnaire

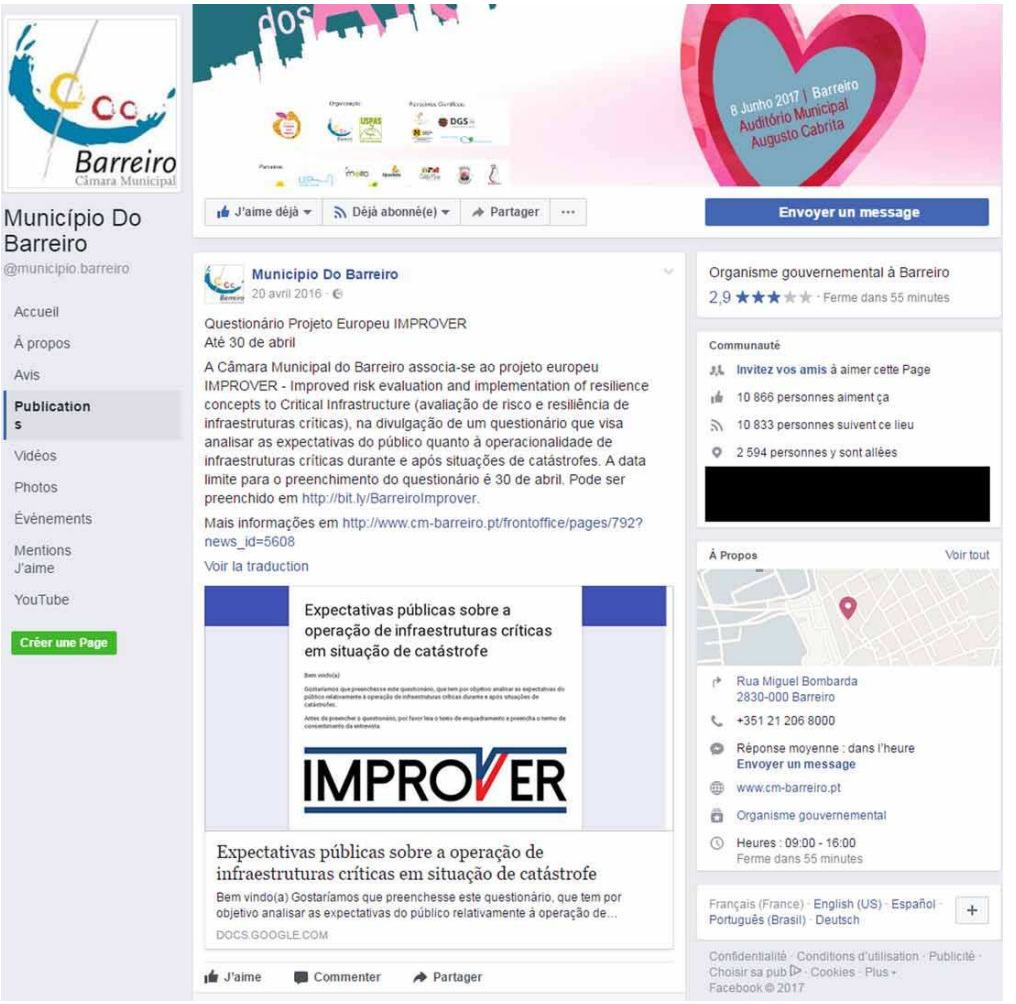


Figure 2. Distribution of the respondents' nationality in the sample

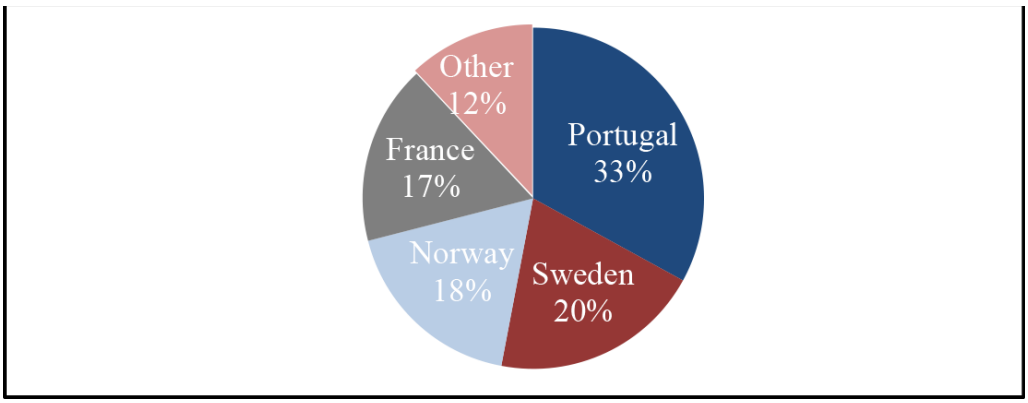
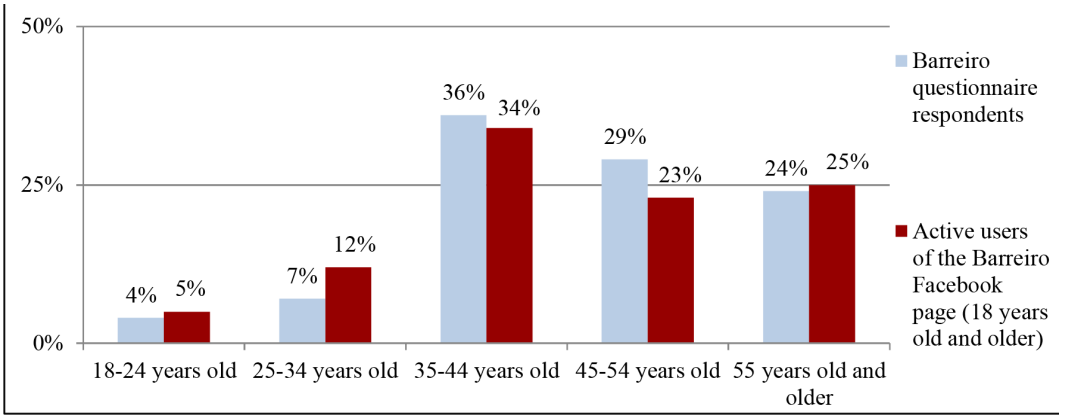


Figure 3. Age of Barreiro respondents compared to the age of the active users of the Facebook page



While the Oresund Region Living Lab includes both Swedish and Danish residents, recruiting Danish respondents was difficult and in fact only 2 Danish people responded to the questionnaire. This is most likely due to the fact that certain associate partners of the Oresund Region were on sick leave during the study period and thus unable to actively publicise the questionnaire. As such, only the Swedish responses are examined here. Details of the sample characteristics by nationality can be seen in Table 1.

Given the nature of the questionnaire, it was no surprise that 90% of the participants stated that they used social media sites on a regular basis. 86% of Portuguese respondents, 91% of French respondents, 99.6% of Norwegian respondents and 92.5% of Swedish respondents report to use social

Table 1. Sample description distributed by nationality of the respondents

	France	Portugal	Norway	Sweden
Sex				
Male	59%	55%	62%	52%
Female	41%	45%	38%	48%
Age				
18 – 24	25%	4%	6%	4%
25 – 34	40%	8%	49%	28%
35 – 44	20%	33%	23%	28%
45 – 54	11%	32%	9%	23%
55 +	5%	23%	13%	16%
Education level				
University or college or equivalent	89%	72%	79%	74%
Social Media use				
Yes	91%	86%	96%	93%
No	9%	14%	4%	8%

media. Finally, respondents who used social media were asked to list a maximum of three sites that they used most frequently (Figure 4).

Interviews

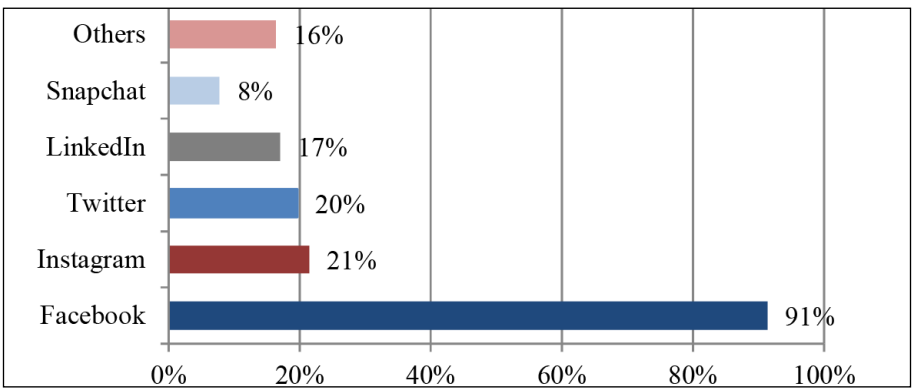
The findings were then compared to the current practices of the operators in three out of the four Living Labs due to the Oresund Region being on sick leave. For the remaining Living Labs, an in-person, semi-structured, group interview took place with relevant actors. The general interview guide approach was used, and the guide can be seen here:

1. How do you communicate with public stakeholders? How often?
2. Which of these communication channels do you think is most effective? Why?
3. Do you have a communication strategy in place to communicate with the public during disasters?
4. Do you have a plan/strategy to increase disaster preparedness amongst members of the public?

However, this approach allows for flexibility and thus depending on the conversation with the interviewee, the questions might not have been asked in the presented order or even asked at all (meaning the interviewee provided the desired information without being prompted).

For the Oslo Harbour operators, interviewees included actors from an energy company that is based at the harbour, the OHA and DBS. The interview was conducted in English. Data was collected on 28 January 2016. For the BMWN the interviewees included an actor from the wastewater and water supply management, an environmental engineer for water quality, and the manager of the new technologies and Water Security Plan. The interview was conducted in English. Data was collected on 18-19 February 2016. For the A31, actors from both DIR Est and DDT57 were interviewed. These included representatives from the office dealing with the intersection of the A31 between Nancy and Luxembourg, the office in charge of real time management for crisis interventions, the crisis management and alternative route designation office, and the urbanism and risk prevention office. Interviews were held in French and then data was translated into English by a certified bilingual speaker for analysis. Data was collected on 25-26 May 2016.

Figure 4. Respondents' most frequently used social media sites



RESULTS

Questionnaires

Crisis Communication Channel Expectations

Every respondent expected CI operators to provide information during and immediately after a disaster via at least one media channel. CI operators were overwhelmingly expected to use traditional media and the majority of respondents also had high expectations in relation to the availability of crisis information on the website and social media accounts of operators (Figure 5).

The study also found that expectations varied according to different age groups, previous experience of social media use, and nationality. Social media was more popular among the youngest respondents, with 70% of 18-24-year-olds strongly agreeing that they should be kept informed through sites such as Facebook and Twitter, compared to just 37% of those aged 55 years old and older. This equates to a significant relationship between age and social media expectations, ($X^2 = 691.83$, df = 12, $p < 0.001$). A similar finding emerged in relation to expectations that such information should be available on the website of CI operators and equates to a significant relationship between age and website expectations, ($X^2 = 939.17$, df = 12, $p < 0.001$). Those who declared that they were regular social media users were the most likely to expect to receive information from CI operators on these platforms. Indeed, 78% agreed or strongly agreed with this proposition, in comparison to only 29% of those who did not use social media sites. Social media non-users mostly (47%) declared that they were unsure or neutral. This equates to a significant relationship between social media use and social media expectations, ($X^2 = 1085.45$, df = 4, $p < 0.001$). However, there appeared to be no significant differences between social media users and non-users in terms of their expectations of the other media channels.

Channels by Nationality

Traditional media use appeared to create a consensus among the nationalities studied, having little to no disagreement for all four nationalities (Figure 6). The majority of respondents also had high expectations in relation to the availability of crisis information on the website of operators and on operator run social media accounts (Figure 7; Figure 8). Calling the CI operator led to higher levels of uncertainty in respondents (Figure 9). Differences between nationalities appear statistically significant for traditional media ($X^2 = 577.49$, df = 6, $p < 0.001$), website ($X^2 = 817.52$, df = 9, $p < 0.001$), social media ($X^2 = 771.89$, df = 9, $p < 0.001$), and telephone ($X^2 = 1060.35$, df = 12, $p < 0.001$).

Figure 5. I expect CI operators to provide me with information… [Q1a – 1d]

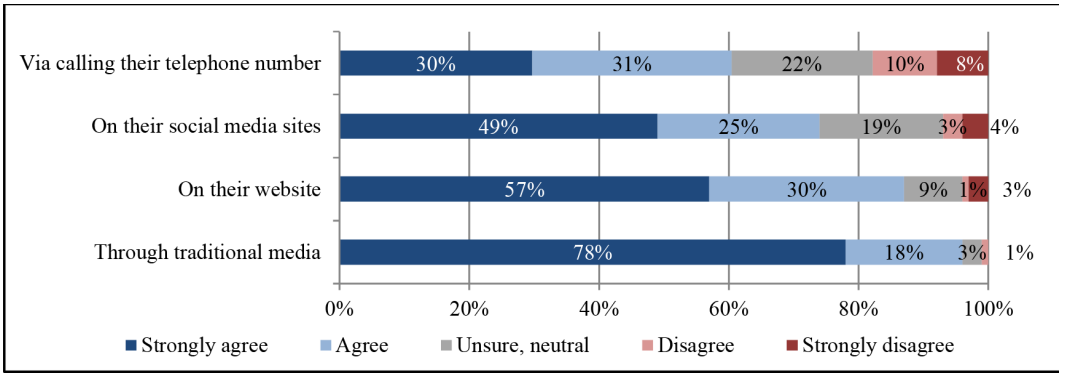


Figure 6. I expect CI operators to provide me with information through traditional media [Q1d]

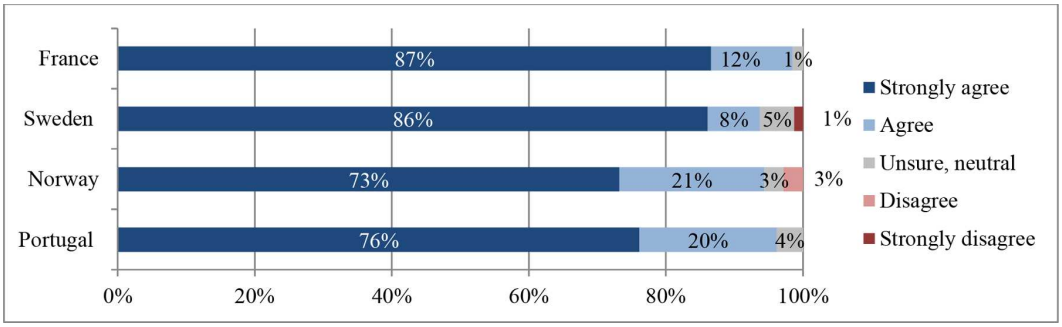


Figure 7. I expect CI operators to provide me with information on their website [Q1b]

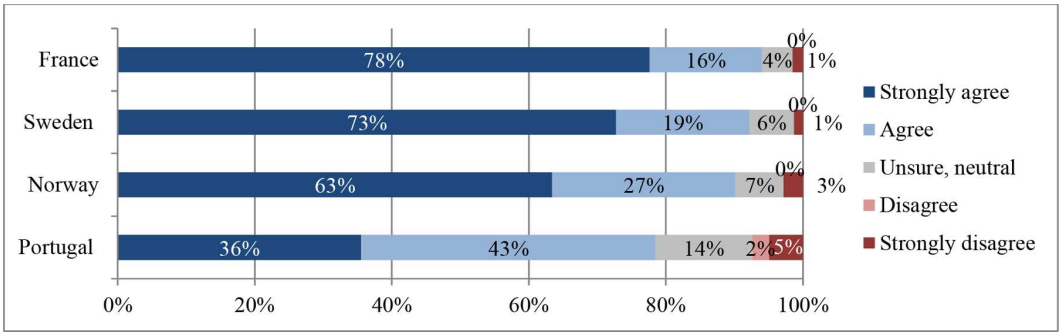
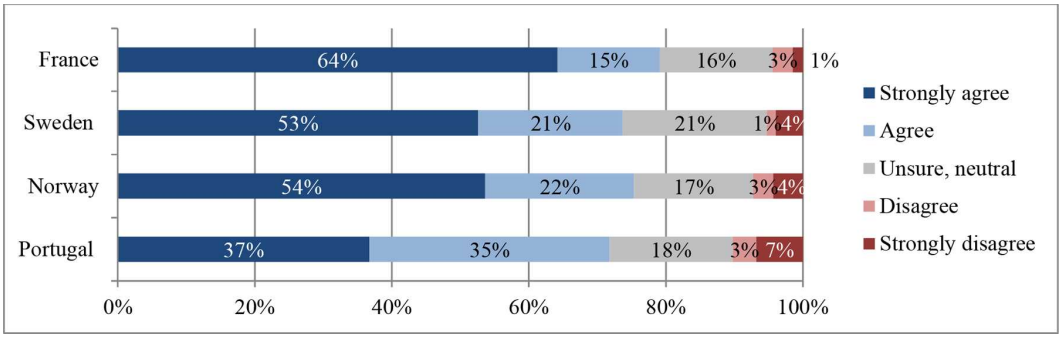


Figure 8. I expect CI operators to provide me with information on their social media sites [Q1c]



CI Operators' Responsiveness to Comments Posted on Their Social Media Accounts

When asked if they expect CI operators to respond to questions and comments sent by members of the public to their social media accounts, there appeared to be greater uncertainty (Figure 10). No significant differences linked to sex, age, or education level were found in the responses to this particular question. Those who used social media (56% agreed or strongly agreed) were more likely to agree that CI operators should respond to these social media queries than non-users (32% agreed or strongly agreed), ($X^2 = 1162.39$, df = 4, $p < 0.001$).

Figure 9. I expect CI operators to provide me with information via calling their telephone number [Q1a]

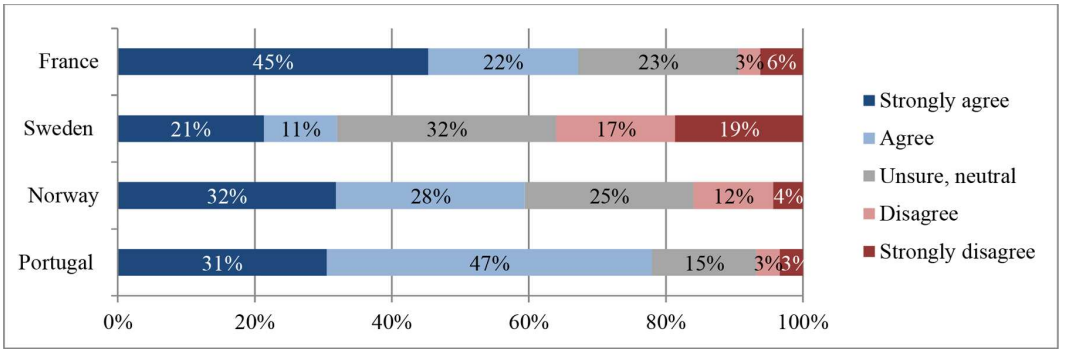
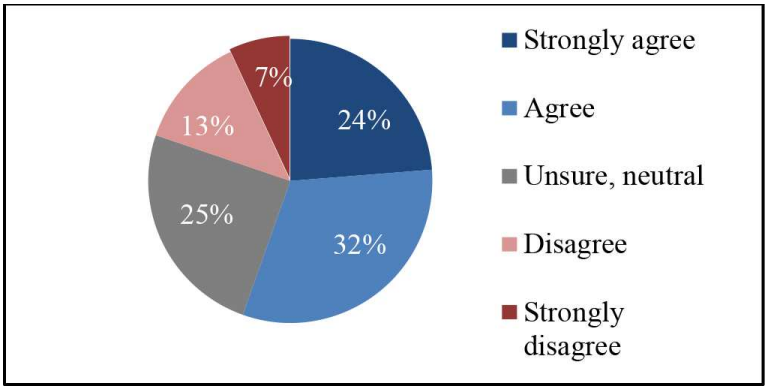


Figure 10. I expect critical infrastructure operators to respond to my questions and comments on their social media sites [Q2]



Responsiveness by Nationality

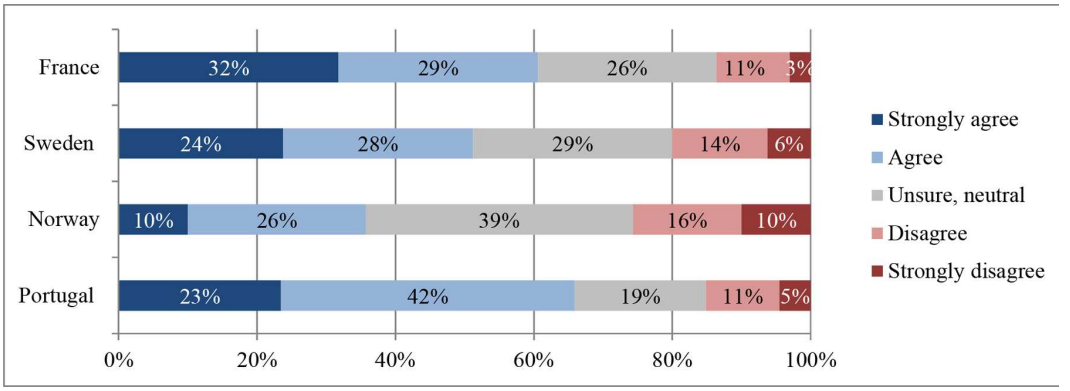
Differences emerged between nationalities ($X^2 = 1130.27$, df = 12, $p < 0.001$) (Figure 11). At least over half of French, Swedish and Portuguese respondents agreed or strongly agreed, whereas only 36% of Norwegian respondents agreed or strongly agreed. There was high uncertainty/neutrality in regard to responding to queries for all nationalities, but Norwegian respondents are most unsure (39%). There were also high levels of disagreement with this statement across nationalities.

Interviews

Existing Procedures

Procedures ranged from non-existent to very well established depending on the operator. The BMWN does not currently have their own crisis communication strategy, but a general communications plan does exist within the municipal emergency plan, which includes using traditional media. They are currently working on developing their Water Safety Plan, which will include a communication strategy and mandate stakeholder meetings. Currently, they provide a call centre for the public to report damages. The operators do not have their own website or social media accounts. The operators only actively inform the population of the interruptions that are scheduled and that are more time consuming and involve a higher level of complexity in terms of implementation. Indeed, and although not always, but in many cases, when it comes to service disruptions, it has been the citizens who report by calling their telephone line. BMWN does provide information via traditional media. It appears that

Figure 11. I expect critical infrastructure operators to respond to my questions and comments on their social media sites…by nationality [Q2]



most of the communication with the public comes from the municipality in general, and not from the infrastructure operators themselves. The municipality's media department works closely with the operators and provides a website, an FAQ page, social media sites and has close ties to the press.

For the A31, DIR Est is charged with communicating with the public. Since they are a public institution, they "must guarantee the reliability, usefulness, and credibility of information" before they share it with the public (Interviewee F1). DDT57 gather and synthesize data to be shared with the crisis cell and with the Préfet in times of crisis and do not communicate with the public. The emergency response structure in France is such that the Préfet is the one who makes all the crisis management decisions, including those related to communication. As such, the DIR Est follows the guidelines and regulations in regard to crisis communication, waiting for approval from the appropriate persons before sharing information with the public. A strategy focusing on communication with their users exists and is applicable in both normal times and crisis times. Crisis communication involves more frequent communication and requires a greater mobilization of actors than day-to-day communication. In general, they distinguish between two types of crisis communication. "Programmed" is when the event can be anticipated, such as certain weather-related events or foreseen traffic peaks. "Real time" is when the event cannot be anticipated. Programmed communication uses three main channels: traditional media via the press, the DIR Est website and collaboration with Bison Futé, the official French government website relating to traffic conditions. They may also implement warning levels when appropriate. For real time communication, they have a partnership with the radio station France Bleu, which allows them to not only disseminate traffic information at scheduled times, but also in the form of "flash" information, whereby the regular programming is interrupted in order to warn the listeners/highway users. "These information 'flashes' are sometimes picked up by other radio stations," said one operator (Interviewee F3), "but we do not have partnerships with other stations." Lastly, they communicate via VMS (variable messaging signs – electric traffic signs used on road ways to convey relevant information), which "allow us to communicate as closely as possible to 'in real time' when an incident occurs" (Interviewee F3). During crisis times, the press takes on an even greater role in information sharing. The DIR Est informs not only the radio but also television news channels and online news sites about sudden onset crisis events. They do not send out SMS warnings, nor do they use social media. They are aware that users may communicate information via social media, but they see this kind of information as being the subjective opinion of a given user and as such don't view social media as a reliable information source. They did mention that Loractu and ITLF (Info Traffic Lorraine et Frontière), two local news sources, are active on social media and discuss traffic conditions. However, there is no official partnership with them. They see their job as

provider of critical, crisis-related information to the press, and the job of the press as messenger of said information to the public.

At the Oslo Harbour, all interviewees stated that they have a communication department that deals with public communication in both normal and crisis times. In normal times, the Oslo Harbour Authority's responsible department communicates via website, email, social media (Facebook and Twitter) and neighbour meetings. The energy company also communicates with the public via website and newsletters (which are also accessible on their website). DSB also has a yearly safety forum and website. For crisis times, all interviewees said that they have a strategy in place, including the use of crisis teams and communication managers. However, there was a bigger focus on informing the government authorities and/or traditional media during crises, who then inform the public, than on directly communicating with the public. The energy company actor stated that first the information passes internally, followed by the activation of the crisis team, who communicate with government authorities and the media. They use emails and press releases to communicate about any incidents. The energy company actor also mentioned the internal communication that happens amongst the businesses located at the harbour and with the OHA in crisis times. DSB mentioned that emergency management professionals use social media to communicate with the public during crisis times as well as normal times.

Characteristics of Shared Information

As BMWN operators do not currently have a crisis communication strategy for public communication in place, they could not discuss what kind of information they share with the public, beyond notices for planned works.

The A31 operators, however, declared that when it comes to their crisis communication, two elements are absolutely necessary to convey to the public: 1) delays associated with the crisis and 2) the cause of the crisis. Furthermore, the information must be updated regularly in accordance with which crisis management stage they are in and the ever-evolving traffic conditions. According to our interviewees, "users demand to be informed of the situation" (Interviewee F1). They have learned from past mistakes where they did not inform the public, such as the example shared in this anecdote.

"In 2013, part of the highway was stuck in a standstill traffic jam. Some people began to turn around and go the wrong way on the motorway! This was happening around the same time that the highway was starting to circulate again, and so going the wrong way was risking a major accident. If the users had been provided the information related to the traffic jam, this crisis could have been prevented" (Interviewee F2).

While the Oslo Harbour operators did not share specifics about the characteristics of information they share, interviewees did mention that oftentimes it is the media who comes to them for information instead of the other way around. For this reason, interviewees discussed having had media training.

Perceived Effectiveness of Strategies

The BMWN considers communication with their stakeholders as not very efficient, stating that they do not communicate with the general public enough. Face-to-face stakeholder meetings are seen by the operators to be the most effective means of communicating with the public. However, the most used means of communication is the telephone. The operators believe that most people in the city would use the telephone to contact the emergency response authorities if there was a disaster. Despite a close relationship with the municipality's communication department, the operators said that they feel that "communication tends to fail during incidents" (Interviewee B2).

A31 operators believe their current strategy has "already proved its effectiveness" (Interviewee F1). They view the radio and the VMS as the most effective means of communicating with the public. According to the operators from DIR Est, the radio station France Bleu is listened to by many of the highway users. However, DDT57 brought up a limitation. "The problem with the A31 is that there

is no dedicated radio station and the promotion of the partnership with France Bleu does not have as great an impact as a dedicated radio station would" (Interviewee F4).

For the Oslo Harbour, all interviewees agreed that it is important to employ a combination of communication techniques and were hesitant to state which was the most effective. However, they also said that they feel that they never have enough time to communicate directly with the public during crises.

Awareness of Public Expectations of Information

The BMWN is aware that people expect disaster-related information. "People are searching for information," said one operator (Interviewee B1), "and we recognize the need to become more proactive." As such, they are working on a smartphone application and automatic communication via SMS to reach residents without Internet access. They would like for in the future to have a clear strategy in terms of communication, which would provide a collaborative platform for all stakeholders. The operators also mentioned that Portuguese people are known for their resilience and adaptability, which means that current communication expectations are probably not as high as they could be. A31 operators appear to be very aware of the public expectation that they share disaster related information. As was previously stated, they meet these information needs by sharing the delays associated with the crisis and the cause of the crisis. For the Oslo Harbour, OHA stated that there is a public expectation for information and answers in crisis times, and that the public expect them to handle the situation fast and return to normal as quickly as possible. Table 2 summarizes the findings from the interview.

DISCUSSION

Crisis Information Should be Provided on Social Media but CI Operators are not Necessarily Expected to Engage With the Public on These Sites

Regarding RQ1, results indicate that members of the public expect CI operators to provide disaster related information via both traditional and social media. There was almost no disagreement among respondents when it came to traditional media, reinforcing the idea that even to the public, digital media such as websites or social media platforms is meant to complement more traditional crisis communication methods and not replace them. Social media should be considered a main channel for information dissemination. There appears to be a greater expectation for information to be pushed via social media than for queries to be answered. Indeed, one fourth of respondents were unsure about whether CI operators should respond to questions and comments on social media. Since individuals turn to the media platforms that they are already familiar with during crisis (Fire Services Commissioner Victoria, 2013; Steelman, McCaffrey, Velez, & Briefel, 2014), it seems natural that respondents who use social media have higher expectations for social media use by CI operators than social media non-users.

Some Evidence of a 'Digital Divide' in Relation to Expectations of CI Operators' Use of Internet and Social Media During Crises

In answer to RQ2, expectations were indeed found to be influenced by age. It seems that the use of social media and websites by CI operators is slightly more of a young person's expectation. A 'digital divide' based on age has been widely acknowledged and researched, demonstrating that young people not only have a higher access rate and use technology more regularly, but also show a wider range of different uses (Bingham, Valentine, & Holloway, 1999; Ólafsson, Livingstone, & Haddon, 2013; Horrigan 2016). Thus, social media could be used in such a way as to target and better reach young people during disasters. Indeed, more effective crisis communication uses targeted messages (Medford-Davis, 2014). However, as young people are not the only ones using social media, it remains a useful way to reach even more people in times of crisis. Other types of 'digital divides' should be further researched.

Table 2. Summary of interview findings

	BMWN	A31	Oslo Harbour
Current practices			
Has a crisis communication strategy		X	X
Top-down, hierarchical structure		X	X
Channels used for crisis communication			
Traditional media	X	X	X
Operator website		X	
Operator social media sites			
Operator telephone hotline	X		
Dedicated collaboration radio		X	
Dedicated collaboration website		X	
Ad hoc collaboration with local government	X		
VMS (Variable Messaging Signs)*		X	
Perceived effectiveness			
Believe they don't have enough time to communicate with the public in crisis	X		X
Believe current practices are effective		X	
Aware of public expectations for disaster related information	X	X	X
Operators' perception of most effective communication means			
Neighbor meetings	X		
Radio & VMS		X	
Need a combination			X

*Only applicable to roadways

Expectations Appear Affected by Nationality

Continuing to examine RQ2, with the exception of traditional media use, which appears to have made a consensus with all respondents, differences in nationality appear to affect expectations for crisis communication channels. This is not surprising, as the fact that culture influences expectations was well established in the literature review. The cultural differences found in this study may be due to differences in how crisis management is organised in the different countries and should be studied in more depth. Risk cultures could also be influencing the expectations. Looking at trust, which was found to be linked to which risk culture a country belonged to, a 2015 Eurostat poll asked respondents to declare their level of trust in police on a scale of 0 to 10 (where 0 corresponds to the lowest and 10 to the highest level of trust), and the mean trust in police for Portugal was 5.4, France 5.7, Sweden 7.1 and Norway 7.5. The similar high levels of trust in authorities between Sweden and Norway could indicate that Norway also has a state-oriented risk culture. However, the high uncertainty and high levels of disagreement for CI operators to respond on social media could indicate that Norwegian respondents view themselves as capable of responding to a crisis and not as in need of state assistance. This would then mean that they have an individual-oriented risk culture. For France and Portugal, the lack of trust in police indicates that they most likely have a fatalistic risk culture. However, their high expectations for responses on social media from operators may imply that they

would want authorities to help take care of their safety, which would then imply a more state-oriented risk culture. More research on these countries should be conducted to see if expectations are closely tied to risk cultures as the questionnaire did not examine levels of trust nor views on active/passive actors in crisis management.

While differences exist between nation states regarding Internet access and social media use, the link to expectations is not clear. The fact that Portuguese respondents seem to have lower expectations for website (with an eleven point or more difference) could be because Portugal has a lower Internet access by household rate and a less frequent Internet use than the other studied countries[2] (Eurostat, 2015). This could also explain why Portuguese respondents agreed less strongly than the other nationalities when it comes to social media use. However, Norwegian respondents were the most uncertain/neutral when it comes to CI operators responding to questions and comments on social media (ranging from a 9 point to 20-point difference) and also had the highest level of disagreement. This difference in opinion compared to the other countries does not appear to be influenced by Internet access, as Norway has high Internet access rates as well as high social media use rates (Eurostat, 2015; Mediefakta, 2010). Furthermore, despite having lower social media use rates compared to Sweden (48% FR vs. 71% SW), more French respondents agreed that CI operators should respond on social media than did Swedish respondents (Poushter, 2017). Further research should then examine these differences.

The current channels used by the operators to provide information may also have affected responses. Indeed, one reason that Portuguese respondents have a higher expectation to get information via calling the CI telephone number than the other nationalities studied could be because the BMWN currently uses almost exclusively this method to provide information to the public. French respondents' expectations for website use were the highest and currently the A31 is the only operator to provide disaster-related information on their website. High expectations for traditional media use by all nationalities then could be explained by the fact that all operators use this channel. However, all nationalities had high expectations for social media use (72% or higher) and this channel is not currently used by the operators interviewed. Thus more research is needed.

CI Operators Meet Certain Expectations, but Underuse Digital Communication Tools

Answering RQ3, despite awareness of the public expectation for operators to provide disaster-related information, few operators use all available crisis communication channels to communicate with the public and thus do not meet all public expectations on this matter. All three Living Labs appear to meet traditional media expectations. Furthermore, the importance in using traditional media as a means for crisis communication is acknowledged by the operators. The A31 also appears to meet expectations in regard to websites as they publish crisis related information on their website. The BMWN appears to meet the high expectations from respondents that they provide information via a telephone hotline.

However, expectations in regard to websites are not currently met by either the Oslo Harbour or the BMWN. Indeed, as the BMWN does not have a website, they are unable to meet this expectation. The fact that expectations of Portuguese respondents for information to be available on a website were higher than those for a telephone hotline clearly indicates that this is an area where the operators can improve the effectiveness of their crisis communication. This is similar to the findings from Norway, where expectations for information to be available on operator run websites were only 4 points lower than expectations for traditional media. It appears that none of the interviewed operators are currently meeting public expectations in regard to social media use. Neither the A31 nor the BMWN have social media accounts. While some operators in the Oslo Harbour have social media, they do not currently use it to share disaster-related information during crisis. The fact that respondents of all nationalities have high expectations for operators to use social media clearly indicates that this is an area where the operators can improve the effectiveness of their crisis communication. That said, it

is also important to note that limitations with the use of social media include those laid out by the operators of the A31, namely reliability of information and the need to verify it.

As an institution of the French government, the A31 operators must follow a hierarchical communication strategy, which is indeed the opposite of the information flows on social media. Both the A31 and the Oslo Harbour appear to still be in a top-down, hierarchical crisis communication structure, insisting on controlling information. While social media use encourages a Bottom Up communication style, respondents of both nationalities were mostly unsure if operators should respond to questions or comments. This shows that it is more important for operators to push information to the public than to respond to queries.

The BMWN, while not currently meeting digital media expectations, was the only operator to be aware of this and to acknowledgement the need to be more proactive in informing the public in times of crisis. Their ideas to develop smart phone applications or SMS alerts are innovative, but as these two channels were not presented as options to respondents, further work should study public expectations for these two channels. The A31 operators stated that they felt their crisis communication to already be efficient. However, French respondents clearly demonstrate a desire for information to be shared on social media, indicating either that participants didn't understand the implications of using social media for crisis communication or a gap in perception of the crisis communication plan.

Since crisis communication that uses multiple channels to reach audiences has been found more effective (Tierney, 2009; Stephens, Barrett, & Mahometa, 2013), including websites and social media platforms in these operators' crisis communication strategies would not only help to meet public expectations, but also improve the efficacy. Furthermore, the operators themselves have stated that using multiple communication channels is important for public communication. Thus, it is recommended that the operators include digital media in their crisis communication strategy. Suggestions for how the IMPROVER Living Labs could include digital media are laid out in section 5.5. Ways in which to use social media for crisis communication are then presented in the following section (6).

Suggestions for How the Living Lab Operators Could Better Meet Public Expectations

To answer RQ4, some potential solutions to better meet public expectations are laid out hereafter. One way to easily increase communication on digital media is to simply repeat the information shared with traditional media on operator owned websites and social media accounts. For example, the Oslo Harbour operators could also publish press releases that are written and distributed to traditional media on their websites. The A31, while hesitant to use social media due to the fact that information needs to be verified, already provide verified, official messages in "near real time" on their VMS system. Indeed, once verified, other institutions in the French government do communicate crisis information via social media. For example, the French Ministry of Interior, the Prefecture of Police and the city of Paris all used Twitter to share crisis information with the public during the 13 November 2015 terrorist attacks (Petersen et al., 2018). While the information in this case is indeed published less rapidly than that coming from ordinary users, it is still important to be able to find official information sources on social media. While these are easy-to-implement solutions, it is important to also take into account Internet culture and communication styles when using digital media for crisis communication.

Another way operators could potentially meet the expectations of the public in regard to social media use could be partnerships. As the BMWN already works alongside the municipality more generally when it comes to public communication, it may be interesting to see if the municipality's social media sites and websites would be considered by the public as an appropriate source to find CI related disaster information. For the A31 already perhaps an official partnership with either Loractu or ITLF could be envisioned, similar to the current partnership with Radio Bleu. As such, this approach could be another dimension of their existing relationships with news media. However, the comment on the limitations of using a partner radio station instead of a dedicated radio station during the

interview also merits further investigation before putting into place more such partnerships. For the Oslo Harbour, DSB stated that emergency responders are already active on social media, providing information to the public during crisis times. Thus, it would be interesting to see if they would also be seen as a valid, trustworthy source for information pertaining to CI. If that were the case, then the Oslo Harbour could state that crisis information is available on social media at a partner's account in an official capacity. This may even help to avoid information overload. However, as the expectations studied here were for the operators to provide the information directly to the public, further research is needed to examine if the CI operators need to use social media, or if they just need to make their information available via social media via other official sources. Lastly, in keeping with their Top Down crisis communication styles, both the A31 and the Oslo Harbour could still use social media to provide needed, disaster-related information to citizens by having a transparent, no response policy on social media platforms.

Limitations

The limitations of the study should be acknowledged in the interpretation of the results presented above. As discussed earlier, the questionnaire had a self-selecting sample that was not representative of the demographics in the four respective Living Labs. It should also be noted that the use of the website to distribute the questionnaire was likely to have skewed the sample in favour of those who used the Internet and social media on a regular basis. The international aspect of the survey may also cause an inaccurate generalisation of the findings, as social and cultural backgrounds may create different meanings for the Likert scale (Boulan, 2015). Furthermore, people often respond to online surveys by providing snap judgments based on available information and may be influenced by emotional or contextual factors (Schwarz & Strack, 1999). Lastly, as the IMPROVER questionnaire did not establish what the participants understood as crisis-related information, the stated expectations may be uninformed. Another limitation is the low number of interviewees from the Living Labs. Moreover, the Living Labs also do not span all sectors considered as CI. While the findings may be relevant for these Living Labs, the results may be difficult to generalize to all CI operators. However, our study helps to fill in the knowledge gap regarding public expectations of and CI operators' current crisis communication activities.

RECOMMENDATIONS FOR SOCIAL MEDIA USE BY CRITICAL INFRASTRUCTURE OPERATORS DURING AND IMMEDIATELY AFTER A DISASTER

While a number of guidelines for how blue light organisations can use social media during disasters have been published over the past decade, few seem to focus on how CI operators could use these platforms to contribute to disaster information flows. Here, in order to further answer RQ4, we present a brief look at our ongoing work to develop a social media communication guide for CI operators to deploy during crisis situations, mainly based thus far on literature. However, the questionnaire clearly demonstrates that differences among disaster vulnerable populations exist. As such, knowing your audience seems like a particularly important step in order to have effective crisis communications. The following sections then describe how CI operators should attempt to meet the information needs of disaster vulnerable and affected communities. They should provide information on 1) what has happened, 2) what is expected to happen, and 3) what citizens should do to mitigate the effects of such incidents.

Know Your Audience

Critical infrastructure operators should collect and analyse data about traditional and social media use as a starting point to engage with the public. 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, Brynielsson, Johansson, & Trnka, 2011). Thus, CI operators should identify the platforms that their target audience uses on a regular basis in order to use those same platforms to share crisis information, especially as people continue to use media they are already familiar with during disasters. Based on our survey, it is highly recommended that CI operators be present on Facebook.

What Information to Share

What Has Happened

It is vital that CI operators publicly acknowledge the disruption to their service(s), even if no further information on their cause and likely resolution is known. It is also important for operators to inform members of the public that they are working to restore these services even if no new information is available at that time (Petersen et al., 2016). CI operators should also use functionalities 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 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 & Atanasova, 2016).

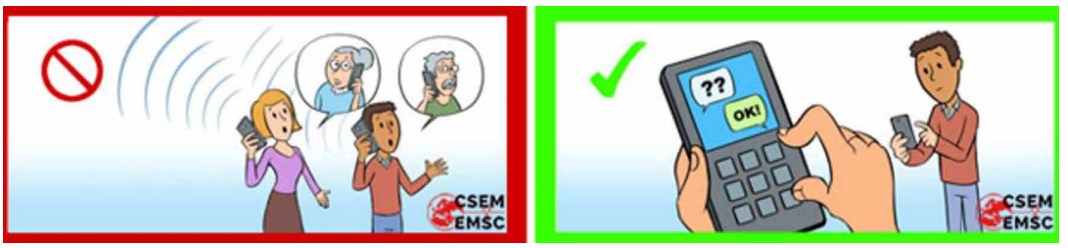
What is Expected to Happen

As soon as is possible, CI operators should provide an estimate of when services will be fully restored. While it is beyond the scope of this paper to explore these strategies in full, Reilly and Atanasova (2016) suggest that social media can help key stakeholders such as CI operators prevent a communication vacuum from developing while simultaneously preventing cascading effects that might occur from citizen speculation about the causes and effects of crisis situations. This information should be updated regularly, as when the public receive regular updates, they are more likely to have realistic expectations of disaster response and service restoration (Bylund & Lille, 1999; Christoplos, 2006; Buller, 2015).

What Citizens Should do to Mitigate the Effects of Incidents

As previously stated, when a disaster strikes, people begin a search for information about how they should act. As such, it is a good opportunity to provide the public with appropriate, CI specific advice, such as to, if conditions are safe, turn off the gas before leaving the house after an earthquake. An example that could be replicated by CI operators could be the EMSC Safety Tips. Following their survey, the EMSC created cartoon images of the main messages of the behaviour to adopt and avoid after a violent shaking no matter the country of residence, which is pushed to users of their app in a given location when violent shaking has occurred near them (Figure 12).

Figure 12. An example of one of the safety tips from the EMSC LastQuake app



CONCLUSION

Our findings suggest that CI operators should continue to use traditional media during crisis situations, as almost all respondents expect to be able to find information through this means and all operators interviewed currently use this channel. This should be supplemented through the provision of disaster related information on website and social media platforms maintained by CI operators. Young people and social media users appear to have higher expectations in regard to the use of social media by CI operators in times of crises. As social media is meant to compliment more traditional crisis communication methods and not replace them, it remains a useful way to reach even more people in times of crisis. The expectation to be on social media did not necessarily mean that these sites should be used to encourage dialogue and interaction between these companies and members of the public. Indeed, there appeared to be a greater demand for information to be pushed via social media than for queries to be answered during such incidents. Despite this, high expectations for information to be pushed via social media demonstrate the importance in including it in a multichannel crisis communication strategy. Expectations were also found to be influenced by nationality. These demographic differences point to the importance in knowing the audience before engaging in crisis communication. Currently, the operators interviewed do not use social media for crisis communication. Thus, it is recommended that the interviewees from the Living Labs expand their crisis communication efforts to include Internet communication via social media and websites in order to meet public expectations. For certain operators, this may be difficult to put into place due to the current organisational culture which views social media poorly. Lastly, the found expectations of CI operators seem similar to the expectations of authorities that were discussed in the literature review, and many efforts are being made to help authorities use social media for crisis communication. Thus, the same should be done for CI operators. Nevertheless, it should be acknowledged that this was a self-selecting sample that was not representative of the demographics in the populations studied, and as it was an online questionnaire it most likely attracted people who generally use the Internet and social media. Further work is needed to explore how the perspectives of citizens who are unable or unwilling to use digital media.

Based on these findings, recommendations for social media use by CI operators during and immediately after a disaster were presented. CI operators should identify the communication channels that their target audience uses on a regular basis in order to meet their expectations. CI operators should communicate on social media about 1) what has happened, 2) what is expected to happen, and 3) what to do. Future work includes the development of a communication strategy, encompassing both digital and traditional media platforms. A future questionnaire is being developed within the IMPROVER project that will be disseminated by telephone in Barreiro in order to try to also reach citizens who do not use digital media. It will address media habits of citizens and issues of trust alongside expectations of crisis communication.

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ENDNOTES

1 The data about Barreiro Facebook was provided by Elisabete Carreira, Advisor to the Board of Directors at INOV, Portugal on 13/05/2016.

2 Percent of households with Internet access: Norway 97%, Sweden 91%, France 83%, Portugal 70%. Percent of individuals who used Internet in the last three months: Norway 97%, Sweden 91%, France 85%, Portugal 69%. Eurostat. (2015).

Laura Petersen received her MS in Engineering and Management of the Environment and Sustainable Development from the University of Technology in Troyes (UTT) in 2014. Currently she is an Environment, Resilience and Risk Engineer at the European-Mediterranean Seismological Centre (EMSC) where she focuses on social resilience and the use of new technologies in crisis communication. Currently in charge of managing the EU IMPROVER project for EMSC, she also has previous experience working on European projects related to sustainable development.

Laure Fallou graduated in sociology from ENS Cachan and EHESS Paris in 2014. After two years working as a research assistant for l'ObSoCo, a sociological consulting company, she joined the European-Mediterranean Seismological Centre (EMSC). She worked on EU H2020 projects CARISMAND and IMPROVER. Her research focuses mainly on technology use related to disasters and on its cultural aspects.

Paul Reilly is Senior Lecturer in Social Media & Digital Society in the Information School at the University of Sheffield. He specialises in the study of online political communication, with a specific interest in how social media is used to promote better community relations in divided societies. He has written one book on the role of the internet in conflict transformation in Northern Ireland (Framing the Troubles Online: Northern Irish Groups and Website Strategy, Manchester University Press 2011) and is currently writing his second on the role of social media in promoting positive intercommunity relations in the region (due 2018). His work has been published in a number of journals including Information, Communication & Society, New Media & Society, Policy and Internet and Urban Studies. His current research projects include a Horizon 2020 funded study of how social media can be used to build community resilience against disasters.

Elisa Serafinelli received her PhD in Media, Communication and Society from the University of Hull (UK) in 2015. In 2016 she was hired as Research Associate by the University of Sheffield and is currently working for the Digital Society Network. She writes and presents widely on issues on online data privacy protection, new media literacy and smart mobile technologies. She is author of the upcoming manuscript Digital Life on Instagram.