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Informing crisis alerts using social media: Best practices and proof of concept

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Social media has become an integrated part of human communication, both as a means to establish and maintain social relationships, and as a means of sharing and co-creating information. Social media comes with an array of possibilities for individuals as well as organizations, corporations, and authorities. Within the field of crisis communication, social media possibilities such as online sharing and social networking have had an impact on the way crisis information is disseminated and updated. This paper addresses the issues related to using social media for communicating crisis information and broadcasting alert messages to the general population, discusses the role of social media in future pan-European crisis alerting, and presents a prototype system demonstrating the possibilities. An extensive systematic literature review was carried out to identify factors that affect the use of social media for alerting and warning. These factors were mirrored in experiences, collected through interviews, obtained by emergency management organizations in three European countries (Sweden, Czech Republic, and Spain). The factors finally form the basis for suggestions and recommendations regarding the design of technological tools for both communication and information collection to serve as an integral part of a future pan-European crisis alerting system.

1 | INTRODUCTION

With the emergence of new media tools such as online social networks and blogging services, communication patterns have changed, in terms of both available information sources and active participation. Social media allows collaborative generation and dissemination of several types of content such as text, images, videos, applications. The most distinctive features of social media are that they are user-generated, interactive, and mobile. Users are creators, editors, as well as consumers of the media content. Traditional editorial media has also become more interactive with the advent of social media, now allowing both sharing and commenting online. Thus, information and communication flows are now more integrated into people's online as well as offline realities than ever.

The most widespread and discussed social media tools today are the social networking site Facebook (with 1.94 billion monthly active users as of 31 March 2017[1]) and the micro-blogging application Twitter (with 313 million monthly active users as of 30 June 2016[2]). These two channels have played an important role during many world events such as the revolutions in northern Africa, the riots in London, and the tsunami and nuclear accident in Japan. In these events, the focus of social media use has been on citizen use for organizing and spreading information, but social media should also be considered to be a communication link and a significant source of information for emergency managers (Artman, Brynielsson, Johansson, & Trnka, 2011; Gibson, Akhgar, & Domdouzis, 2015). However, despite the acknowledged importance of social media as a communication channel and despite the vast and sometimes lifesaving

information that is out there, it is not clear how emergency management should use social media and its content in case of an emergency or a crisis. So, what are the most important factors for designing a social media communication tool? And, what bearing will those factors have for the design of a social media screening tool?

The aim of this paper was to go through relevant literature and practitioner experience to extract key factors of importance for the design of future pan-European social media communication and screening tools within emergency management. The design approach presented in the paper aims at shedding light on the factors' impact on the design. In Section 2, the paper provides background information regarding crisis communication strategies, variables to take into account according to current knowledge, and the research context. Section 3 presents details regarding the two undertaken data collection methods in the form of a systematic literature review and an interview study. The main findings are then presented in Section 4 followed by a synthesis in Section 5 where the relevant factors to be considered for designing a social media screening tool for emergency management are discussed. The design of the social media screening tool is presented in Section 6, and finally, some general conclusions wrap up the paper in Section 7.

2 | ALERTING THE POPULATION IN TIME OF CRISIS

The main motive of communication and alerting of the population during emergency and crisis situations is to save lives and prevent or limit the dangers and risks of damage caused by the ongoing event/s. There are several different technical systems for emergency management in Europe, such as satellite-based warning systems as well as sirens and automated emergency messages and high-level strategic and organizational systems (Hill, 2010). This section describes the most commonly used ways of alerting and communicating crisis information to the European population, the use of social media for crisis communication, and what influences reactions to the communicated information. Also, a final subsection puts this study in context by presenting the long-term research effort which the study has contributed to.

2.1 | Using social media for crisis communication

The social media world has been a factor in shaping what Goolsby (2010) calls *socio-technical behaviour*, a term that describes new patterns of behaviour that emerge through the use of advanced communication technologies. For instance, rather than purchasing one newspaper, people now instead read news online from many different sources. This is true also in crisis communication; rather than waiting for public announcements regarding ongoing scenarios, people actively find information and participate in conversations online. A similar change happened when mobile phones first became popular: Emergency call centres were suddenly overwhelmed with phone calls as everyone now had the possibility of reporting an incident or calling for help (Artman, 1999).

Crisis communication strategies are relevant for any organization, governmental or private, and best practices for using social media during crisis ought to be aligned with the overall crisis communication strategy (Lin, Spence, Sellnow, & Lachlan, 2016). In this context, Houston et al. (2015) identified a disaster social media framework incorporating users and practices to be utilized to facilitate the development of social media tools and processes, whilst Veil, Buehner, and Palenchar (2011) reported on a work-in-progress literature review in the field of social media in crisis communication with an analysis based on ten guidelines for emergency managers. The ten guidelines include the following: Establish risk and emergency management policies and process approaches; plan pre-event logistics; partner with the public; listen to the public's concerns and understand the audience; communicate with honesty; collaborate and coordinate with credible sources; meet the needs of the media and remain accessible; communicate with compassion, concern, and empathy; accept uncertainty and ambiguity; and provide messages of self-efficacy. The guidelines are aimed at crisis communication in general, regardless of what tools and channels are used. Veil et al. (2011) used the guidelines as a basis for a literature review and analysis which showed that "social media can be used to assist organizations in following best practices in risk and crisis communication" (Veil et al., 2011, p. 118). Abedin, Babar, and Abbasi (2014), conducting a literature review on social media for disaster relief, found that social media generally is considered an effective platform to create situational awareness among communities. Emergency responders can use social media to understand the sentiments of communities, and thus tailor crisis information to address the information needs and mitigate rumours. One of the main arguments for emergency managers to use social media is that stakeholders in emergencies and crises already use social media. Regardless of the responsible authorities' presence in social online media, the public will still keep up the conversation about the emergency or crisis. Thus, if an organization wants to be heard in the ongoing conversation, their presence is needed.

Social media can also be used to filter information. According to White (2011), it can be used to reduce information overload due to the sorting and recommendations done by people and organizations. Goolsby (2010) mentions crowdsourcing for information as a practical use of social media and Artman et al. (2011) present a concept for a screening tool which would aid crisis communication officials to come into dialogue with the public by following, structuring, and responding to online communication.

2.2 | Responses and reactions to crisis information

In general, there are four main interrelated variables that influence people's responses to emergency warnings. These four variables are environmental cues, social context, warning components (source, channel, and message), and receiver characteristics (Perry & Lindell, 2006, p. 303).

Environmental cues are described as information from the five human senses that tell us danger is present. Sounds, sights, and

smells are physical cues that can give evidence that there is a threat, for example, the sound of a roaring wind or the smell of smoke. Observing how other people respond in a given situation has strong impact on our own actions and behaviour: "The behavioral cues facilitate protective action search, protective action assessment, and protective action implementation" (Earle et al., 2010; Gregg et al., 2007; Perry & Lindell, 2006, p. 304; Samarajiva, 2005).

The *social context* includes people's kinship networks, community involvement, and family life. It includes the groupings or social clusters that could be long term, such as church community or family relations, or short term, such as engaging in a discussion about a traffic jam with fellow passengers on a bus (Elliott & Pais, 2006; Jalarajan Raj, Ullah, & Akhter, 2010; Merchant, Elmer, & Lurie, 2011; Perry & Lindell, 2006; Samarajiva, 2005; Tekeli-Yeşil, Dedeoğlu, Tanner, Braun-Fahrlaender, & Obrist, 2010; Yates & Paquette, 2011).

Warning *source*, *channel*, and *message* are the three characteristics of *warning components*. The *channel* through which a warning message is disseminated affects how people respond to it (Schultz, Utz, & Göritz, 2011), and the response is also affected by the *source* and *content* of the message and how the message is constructed (Liu, Austin, & Jin, 2011; Liu, Fraustino, & Jin, 2015). Warning sources include authorities, media, and peers, and people have different levels of trust in the sources based on previous experiences, general social context, etc. Perceptions of source credibility have impact on the protective action decision process. A warning from a credible source will have greater impact. If a source is not considered as reliable, people tend to find confirmation through other multiple sources. When message content addresses factors such as location, time, and magnitude of impact of an event, people are more likely to believe the message and more motivated to take protective action. Message style is also important. Official messages need to be specific, consistent, clear, and accurate and should also include explicit conclusions about the threat. Several studies have also indicated that information is regarded more trustworthy if the source is located in the same social network, for instance neighbours, family, and friends, especially when compared to information coming through media (Crowe, 2010; Earle et al., 2010; Elliott & Pais, 2006; Friese, 2009; Gregg et al., 2007; Jalarajan Raj et al., 2010; Landau, 2011; League et al., 2010; Merchant et al., 2011; Mersham, 2010; Molinari & Handmer, 2011; Nakatani, Suzuki, Sakata, & Nishida, 2009; Samarajiva, 2005; Saylor, Cowart, Lipovsky, Jackson, & Finch, Jr., 2003; Sutton, 2009; Tekeli-Yeşil et al., 2010; Veil et al., 2011; Voorhees, Vick, & Perkins, 2007; Wang & Li, 2008; Wei, Zhao, Yang, Du, & Marinova, 2010; Yates & Paquette, 2011).

There are mainly four categories of *receiver characteristics* relevant for response to warnings: previous experience, pre-existing beliefs, personal traits, and demographic traits. Previous experience is assumed important when it comes to take protective action. Research has illustrated that, for instance, perceived risk is a significant and independent factor that influences human behaviour when it comes to response to warning messages concerning evacuation, see, for example, Stein, Dueñas-Osorio, and Subramanian (2010) and several in there referenced papers. Relevant personal traits are, for example, fatalism, where the belief that external forces beyond the individual's control determine what will happen, self-efficacy, which refers to the confidence that one can determine one's personal outcome, and finally responsive efficacy which refers to the individual's belief that implementing a given protective action recommendation will give protection. Demographic characteristics also influence response behaviour. For example, income, education, age, gender, ethnicity, and religion will affect the decisional stages of disaster response. These factors are important in relation to human behaviour in emergencies and crises, but research has not shown clear results illustrating their interrelated impact. Demographics are believed to put constraints on human behaviour, but these factors cannot be used to predict human behaviour during, for instance, an evacuation (Elliott & Pais, 2006; Gregg et al., 2007; Horbury & Hughes, 2010; Jalarajan Raj et al., 2010; Merchant et al., 2011; Stein et al., 2010; Tekeli-Yeşil et al., 2010; Yamamura, 2010).

2.3 | Research context

The work presented in this paper is part of a long-term research effort with the aim of informing design of pan-European support systems for emergency management organizations. A conceptual paper (Artman et al., 2011) presented how social media monitoring could be used by emergency management organizations to come into dialogue with the population in accordance with the applicable crisis communication strategies. Then, Nilsson et al. (2012) presented a preliminary study investigating the possibility to use social media analysis for informing crisis communication, where promising and important design aspects to take into account were highlighted. A detailed design concept for how a screening tool would potentially be used for increasing situational awareness during emergencies and crises, where data acquisition and data analysis were identified as two important parts of such a tool, was outlined by Johansson, Brynielsson, and Narganes Quijano (2012). Studies on tweet classification (Brynielsson, Johansson, Jonsson, & Westling, 2014; Brynielsson, Johansson, & Westling, 2013b) and a series of user-centred activities, involving emergency management personnel, aiming at understanding user needs, and informing the design of a social media screening tool (Brynielsson, Johansson, & Lindquist, 2013a) were conducted.

3 | METHODOLOGY

The study presented in this paper has been conducted to identify issues necessary for the design and development of a web screening tool that can help emergency management personnel to understand public opinions and citizen alertness with regard to an ongoing emergency or crisis. The study includes two separate data collection methods: a systematic literature review, and an interview study that investigates practitioner experience. The results from the literature review were mirrored in experiences collected through interviews, with the aim to validate the literature review findings.

3.1 | Systematic literature review

In order to identify, evaluate, and interpret available research regarding the use of social media in crisis communication, a literature review was conducted. The method was based on a systematic literature review process (Biolchini, Mian, Natali, & Travassos, 2005; Kitchenham, 2004; Kitchenham & Charters, 2007). The general features of a predefined strategy include a review protocol, a defined search strategy in order to detect relevant literature, documentation of the strategy, and description of criteria for inclusion and exclusion of results.

3.1.1 | Review protocol, search strategy, and criteria for inclusion and exclusion

The review protocol for the literature review included fields for metadata, such as paper title, authors, origin, as well as more specific research questions including questions related to the use of social media for crisis communication and information dissemination according to the following:

1. Does the paper contain any descriptions/reflections on human behaviour in response to alerting in emergency situations?
2. Does the paper discuss or mention trust in relation to authorities during an emergency response, and especially the trust in the messages being sent to the population? (Regional/national/international differences or similarities?)
3. Does the paper discuss/mention the effects of clubs, communities, and social groups in relation to alerting in emergency situations?
4. Does the paper discuss/mention the impact of family and friends in relation to alerting?
5. Does the paper address the issue of differences in crisis behaviour between rural and urban regions?
6. Does the paper discuss/mention the issue of civil preparedness in relation to emergency situations and crisis alerts?
7. Does the paper discuss/mention the issue of religion and nationality in relation to emergency situations and crisis alerts?
8. Does the paper describe/mention experiences with native and non-native citizens in the region regarding their reaction to crisis alerts?
9. Does the paper describe/mention communication plans or other official strategies for dealing with alerting or warning of the general public?
10. If the paper describes an emergency or a crisis, which media channels are used in emergency situations and for crisis alerting?
11. Does the paper mention or discuss the issue of culture/social groups/demographics in relation to crisis behaviour?
12. If the paper describes an emergency or a crisis, how does the population communicate with each other?
13. Does the paper mention/discuss the "critical mass" effect, and whether it is important for disseminating alerting messages?
14. Is social media used for information dissemination and, if so, how?

These questions were considered for each of the investigated 62 articles. In addition to the research questions, the protocol also included fields relating to a subjective assessment of the paper and its relevance to the theme of this paper.

The literature search was conducted through digital literature databases and search platforms such as ProQuest according to Table 1, for scientific articles from journals and conferences. In order to find studies of scientific quality, the search was limited to peer-reviewed papers. The search was also given a time constraint between 2003 and 2011 in order to limit the results to recent and relevant research on social media as of 2012. Additionally, the reference lists in the found articles were also scanned and studies deemed relevant for the literature review were included. For the purpose of this literature study, both primary and secondary studies were included in the synthesis as a basis for the extraction of factors influencing individuals' behaviour.

The criteria used to decide whether an article should be included in the review are that the article is published either in a journal or peer-reviewed conference, that it addresses social media in relation to crisis information and public warnings, and that it was published between 2003 and 2011. Articles and papers that address the same study/results were limited to the most extensive version of the paper and articles that only mention social media, emergency/crisis, or warning, but do not discuss it in relation to the mentioned review protocol research questions were excluded.

3.1.2 | Databases, search strings, and review process

The databases used for the search, as well as the number of hits they generated, are listed in Table 1. The databases were searched using several different search strings according to Table 2. In total, 22 strings of the type "emergenc*" *AND* "warning*" *AND* "social media" *AND* ("communication*" *OR* "information*") were used. Between each

TABLE 1 Databases, number of hits, and search strings according to Table 2

Databases	Hits	Search strings
Web of Knowledge/Web of Science	145	8–19
Science Direct	277	1–11
ISCTRIC International Security & Counter Terrorism Reference Center	180	8, 11–18
CSA: ASSIA, IBSS, PAI and World Wide Political Science	161	8–19
PsycArticles/PsycINFO	11	20–21
Wiley Online Library	34	22
ProQuest	120	n/a
	928	

TABLE 2 Search strings and their corresponding number of hits

#	Search string	Hits
1	("human behavior" *OR* "human behaviour") *AND* "disaster*" *AND* ("communication*" *OR* "crisis information*")	7
2	"warning*" *AND* "disaster*" *AND* "behave*" *AND* ("communication*" *OR* "information*")	35
3	"emergenc*" *AND* "alert*" *AND* "warning*" *AND* ("communication*" *OR* "information*")	40
4	"emergenc*" *AND* "alert*" *AND* "warning*" *AND* "behav*" *AND* ("communication*" *OR* "information*")	17
5	"disaster*" *AND* "warning" *AND* "media" *AND* ("communication*" *OR* "information")	26
6	"emergenc*" *AND* "warning*" *AND* "media" *AND* ("communication*" *OR* "information*")	41
7	"emergenc*" *AND* "warning*" *AND* "culture" *AND* ("communication*" *OR* "information*")	20
8	"disaster*" *AND* "warning*" *AND* "new media"	41
9	"disaster*" *AND* "warning*" *AND* "media"	79
10	"emergency" *AND* "warning*" *AND* "new media"	35
11	"emergency" *AND* "warning*" *AND* "media"	121
12	"human behav*" *AND* "disaster*" *AND* ("communication*" *OR* "information*")	75
13	"warning*" *AND* "disaster*" *AND* "behave*" *AND* ("communication*" *OR* "information*")	33
14	"emergenc*" *AND* "alert*" *AND* "warning*" *AND* ("communication*" *OR* "information*")	91
15	"emergenc*" *AND* "alert*" *AND* "warning*" *AND* "behav*" *AND* ("communication*" *OR* "information*")	34
16	"disaster*" *AND* "warning" *AND* "social media" *AND* ("communication*" *OR* "information*")	13
17	"emergenc*" *AND* "warning*" *AND* "social media" *AND* ("communication*" *OR* "information*")	12
18	"disaster*" *AND* "warning*" *AND* "social media" *AND* ("communication*" *OR* "information*")	28
19	"emergenc*" *AND* "warning*" *AND* "culture" *AND* ("communication*" *OR* "information*")	15
20	"disaster*" *AND* "warning" *AND* ("social media" *OR* "new media")	6
21	"emergency" *AND* "warning*" *AND* ("social media" *OR* "new media")	5
22	"disaster*" *AND* "warning*" *AND* "social media"	34

research issue, an *AND* relationship was assumed, and between each term within each research issue, *OR* was used for the search.

The first selection of 928 articles was purged through criteria for inclusion and exclusion (as described earlier) to remove obviously irrelevant studies; 128 articles were selected. The second selection was based on reading of title and abstract and was the base for a more in-depth review process. Articles deemed relevant based on initial reading, in total 62, were read in full text by reviewers, which assessed their relevance through filling out a literature protocol. The papers were then categorized according to the earlier-mentioned Perry and Lindell variables (Perry & Lindell, 2006, p. 303) and sorted based on content. There is an overlap between the categories as each paper can address more than one variable.

3.2 | Interview study

In order to validate the analysis empirically, information about the technologies used for alerting and communicating with the public during a crisis event was collected through interviews. Due to the size and variation of countries and languages in Europe, emergency management organizations from three diverse EU member states were interviewed. Interviews were conducted with 12 officials from regional and local councils and fire and rescue services as well as 112 SOS centres in three different regions: the Basque Country in Spain, the Kalmar County in Sweden, and the Vysočina Region in the Czech Republic. In the Basque Country in Spain, four interviews were carried out with personnel involved at different organizational levels regarding communication to the population, planning, and strategies for managing emergencies and crises. In Sweden, interviews were conducted with four respondents who are all involved in crisis communication in the region: one from the municipal council, one from the regional council, one from the local fire and rescue services, and one from the regional 112 SOS centre. In the Czech Republic, interviews were also conducted with four respondents: one from the national command and control centre of the fire and rescue service in Prague, one from the regional 112 SOS centre in Jihlava, and two from the Vysočina Region fire and rescue service. The interviews, which were semi-structured making use of a preprepared interview guide, were conducted by the authors using the respective native languages (Spanish, Swedish, and Czech), and then translated and summarized according to the research aim as outlined in Section 1.

4 | RESULTS

The following section describes the main findings from the literature review and the interview study. The analysis of both the literature review and the interviews was mainly qualitative, and the literature review results are the foundation for the discussion of the findings in the interviews as well as the general conclusions of the paper. The

main focus of the literature review and interviews was on crisis information and the warning components' variable, that is, how crisis alerts, emergency warnings, and other crisis information are disseminated.

4.1 | Literature review—issues and practices concerning social media use in crisis communication

The analysis of the literature review results revealed a number of variables that were re-occurring: aspects of trust, media coverage, media outreach, social media use, media channel, timely response, connectivity, message content, and warning repetitiveness. The content was given an including name listed below for each variable.

4.1.1 | Warning components

Warning message content is perhaps the most noticeable factor influencing an individual's behaviour. The content of the message includes factors such as location, time, and magnitude of the impact of an event. The message does not necessarily have to be in text or words—messages based on sirens have content too. A sounding siren should, however, not be used for multiple purposes, unless it is very easy to distinguish the difference between the sounds. Message style is important. Official messages need to be specific, consistent, clear, and accurate, and should also include explicit conclusions about the threat (Gregg et al., 2007; League et al., 2010; Mersham, 2010).

The *timing* of a message is also of importance: An appropriate release time can lead to effective transmission of crisis information. Warning timeliness is related to timely response. With warnings and information broadcasted on TV and/or an increase in the frequency of broadcasting, a higher percentage of people will be watching repeatedly which according to tested models results in a gradually decreasing marginal utility of information release (Wei et al., 2010). Different warnings have to be sent out according to people's expected response to the specific warning content and the specific warning channel. How a warning is perceived, responded to and the *timeliness of the response*, is dependent on those two parameters. Timely response is also an important evaluation factor when planning for using social media within emergency management organizations (Earle et al., 2010; Landau, 2011; League et al., 2010; Samarajiva, 2005; Wei et al., 2010).

Trust has got to do with both the sender of a warning and the receiver of that warning in relation to the three components source, channel, and message (Elliott & Pais, 2006; Friese, 2009; League et al., 2010; Mersham, 2010; Molinari & Handmer, 2011; Samarajiva, 2005; Stein et al., 2010; Tekeli-Yeşil et al., 2010; Veil et al., 2011; Voorhees et al., 2007; Wei et al., 2010). This means that people's trust in a warning message is a result of both their prior experience with the source of the message, the channel used, and its content. For instance, if the message is received through a friend or family member who is considered trustworthy, the information is more likely trusted than if the information is received through a media outlet (Crowe, 2010; Earle et al., 2010; Elliott & Pais, 2006; Friese, 2009; Gregg et al., 2007; Jalarajan Raj et al., 2010; Landau, 2011; League et al., 2010; Merchant et al., 2011; Mersham, 2010; Molinari & Handmer, 2011; Nakatani et al., 2009; Samarajiva, 2005; Saylor et al., 2003; Sutton, 2009; Tekeli-Yeşil et al., 2010; Veil et al., 2011; Voorhees et al., 2007; Wang & Li, 2008; Wei et al., 2010; Yates & Paquette, 2011).

Media (TV, radio, social media, etc.) is an important source for sending out and retrieving information about different aspects of a crisis or a disaster (time, place, magnitude, etc.) Journalists are usually some of the first to be at the place of the event. Today, there might also be local individuals reporting via Facebook or Twitter from the location of the emergency or crisis. Media, whether it is news media or Twitter feeds coming from individuals, has an agenda. That implies that the coverage of an event is not necessarily accurate, that is, the disseminated information might be right, but the coverage is not complete. Media coverage has shown to be an important factor when evaluating warning dissemination processes and response activities, and when planning for future crises (Landau, 2011; Saylor et al., 2003).

Media outreach has got to do with the technical aspects of sending messages, such as coverage of a specific technique (broadband, mobile phone coverage, etc.), as well as the content and the format of the message. It is important to investigate the technical conditions for different media in the respective area and the possibility for the population to receive the message through that specific media. Native language, and the "tone" of the message in relation to the chosen media, is another important aspect for reaching the target group (Crowe, 2010; Jalarajan Raj et al., 2010; Landau, 2011; Samarajiva, 2005; Saylor et al., 2003; Stein et al., 2010; Veil et al., 2011; Voorhees et al., 2007).

Different *media channels* should be used for different warnings. For example, a warning for a tsunami, which will affect large groups of people (crop, housing, belongings) on vast land areas, should be easily heard by all in the area and easy to understand (sirens), whilst the warning for a car pileup along a main road needs to be heard by those driving in that specific area (radio). Regardless of channel, the message needs to be comprehensible, accurate, and timely (Gregg et al., 2007; League et al., 2010; Samarajiva, 2005; Sutton, 2009; Wang & Li, 2008).

4.1.2 | Social context

Connectivity, or the extent to which a region or country is connected (technology, infrastructure, dialogue) between people, other geographical areas, governmental authorities, and foreign states, has impact on how fast the population will receive emergency warnings and other important information, and therefore how fast they can react upon that information. Also, generation of crisis information by people is hindered by low connectivity, which is especially a problem in rural areas (Samarajiva, 2005).

The *use of social media* for warning dissemination has increased over the years. As a consequence, most research investigates how it has been used (by authority and individuals), rather than how

emergency response plans to use it in the future. Aspects regarding social media usage concern individuals' possibilities to inform each other and "spread the word," news media use of information from individuals' social media activities and vice versa, social media usage literacy, and social media technical coverage (Landau, 2011; Merchant et al., 2011; Mersham, 2010; Veil et al., 2011; Yates & Paquette, 2011). Veil et al. (2011) present a set of recommendations for incorporating social media tools in risk and crisis communication. Among these, recommendations are to use social media tools for environmental scanning in order to listen to the concerns of the public, and to follow public opinion changes. Another important factor for success in using social media tools is to use it for daily communication and activities, and not just in time of emergency or crisis. Also important is to be clear, honest, and precise in communication, and to share and follow messages from other credible sources.

4.1.3 | Environmental cues and receiver characteristics

The most direct warnings to be recognized by people in an affected area are certainly those that can be seen, felt, or heard (Perry & Lindell, 2006). These warnings are, however, not directly related to the use of social media for crisis communication although social media is continuously used for direct reporting from ongoing emergencies and crises. Concerning *receiver characteristics*, studies have shown that, for instance, people with previous flood experience envisioned flood consequences differently compared to previously unaffected people: People without previous experience underestimated the negative effects of floods (Siegrist & Gutscher, 2008). This may have an effect on how they react to and follow for instance evacuation instructions, which is something that needs to be considered as it is important to affect and change people's behaviour before something happens and not whilst it is already going on (Guion, Scammon, & Borders, 2007). One possible way to do this is to make use of new socio-technical behaviour, and affect people through the use of social media (Goolsby, 2010).

4.2 | Interviews—technological tools for communication

This section provides a summary of the interviews conducted in the three sample regions, first in relation to the technological tools available for warning and alerting of the population (warning components), and secondly the context in relation to crisis communication.

4.2.1 | Warning components—alerting systems and crisis communication

The public warning system used in the Kalmar region in Sweden is a nationwide system for broadcasting emergency warnings and crisis alerts, so-called Important Public Announcements (VMAs), which is administered by the Swedish Civil Contingencies Agency. There are two types of VMAs that can be broadcasted: VMA Warning Message which is used when there is immediate danger, and VMA Information Message which is used to prevent and limit consequences when there may be a risk. In order to send VMAs, there are several channels that can be used: sirens, TV and radio, Internet (national and regional web pages, national Twitter feed), Radio Data System (used in households located nearby the nuclear facilities in the county), and mobile public address systems (vehicle-based).

There is no similar national or region-wide emergency warning system in Spain, but there are five different control systems for sirens in the Basque Country. The public warning systems that are in use in the Basque Country are sirens and fixed public address systems that can transmit immediate alerts and warning messages, mobile (vehicle-based) public address systems for voice broadcasts, TV and radio for alerting messages, and Internet resources. There is also an automatic call message system that can reach all homes in a municipality. Recently, the authorities have also launched Twitter feeds for crisis information dissemination. Interorganizational warnings (concerning, e.g., meteorological situations) to concerned organizations and personnel can be sent through mobile phone text messages (SMS).

In the Czech Republic, the public warning systems include Emergency Warning Messages (EWMs), which is used to alert the population in cases of immediate danger, Emergency Information Messages (EIMs), which is sent out after an EWM in order to provide more information about the situation, and Emergency Alert Messages (EAMs), which is broadcasted to alert organizations and people involved in emergency management and response in order to prevent and limit consequences of emergencies and crises. In order to send out these messages, the authorities use sirens, local information systems, mobile public address systems (vehicle-based), TV and radio, and mobile devices (for SMS broadcasting). There is also a specialized system for broadcasting warnings to people with disabilities.

All three regions clearly make use of media for broadcasting and alerting, but have limited activity in social media outlets. In Sweden, however, there is a national crisis information web page with a Twitter account associated with it where updates about current and ongoing emergencies and crises are posted.

4.2.2 | Social context—use of social media in crisis communication

In general, few of the respondents in the chosen regions had any personal experience of using social media tools for crisis communication with or alerting of the public. The Swedish Civil Contingencies Agency has a Twitter feed set up especially for crisis information and emergency warnings, which is continuously updated. The governmental agencies and municipalities have policies and formal strategies for communication through the use of media as well as social media, although the level of maturity differs greatly between regions and cities. In Sweden, social media has been important both as a source for information and for communication in general, and the government has acknowledged the need for emergency management organizations to take an active role in social media. Social

media are used both to send and to receive information, and respondents note that it is important to keep track of what is going on in social media to get a picture of the general emotive state of the population. One respondent noted: "You have to take what has been said in social media into consideration when you give out more information."

Another issue related to information and warning channels is the *trust* in the sender. According to the Swedish respondents, there is a need to allow local and regional authorities to manage the crisis information and communication as the population believes that they are more knowledgeable and trustworthy due to their contextual awareness. In management of information, it is also important to be open with available information. This will increase the trust in the governing authorities as well as relax the stress on other channels, or as one respondent put it: "The more information you give, the less people call and worry." It is important to be open with verified information as soon as it is verified.

A major issue in Sweden regarding information and warnings to the population are the channels used—the traditional media are still a major part of this activity. One respondent mentioned an incident where during an accident a fire broke out that created a large amount of smoke and toxic pollution that continued for hours. The authorities broadcasted a message to warn the public to stay indoors, but few were actually listening to the radio or watching TV at the moment, which meant that few people actually followed the instructions. One approach to widening the information broadcasting is to make more use of official web pages as well as social media, but for many smaller cities and municipalities, there are not enough resources to allow for permanent information staff. Instead, this must be solved with routines and responsibilities using the available staff.

In the Basque Country, warning messages sent out to the public are not adapted to any specific target groups, and the same message goes out to all people regardless of demographic factors. The specific plans for communication are however to some extent improvised, according to one respondent.

When asked about the public's trust in authorities, the respondents state that in general, people have more trust in professional emergency management personnel than for instance in politicians, which is one major reason to let emergency professionals be the ones delivering information about ongoing incidents. The respondents also note the importance of information messages being "short, clear, and precise."

One factor influencing the effectiveness of warning messages is the urban–rural discrepancy. According to two of the respondents, warning people is easier in rural and sparsely populated regions as they can practically go from door to door informing people.

The Czech respondents noted that the information strategy is an important issue with regard to how the population reacts to a warning message. However, when it comes to warning messages, the emergency management personnel do not take issues such as demographics into consideration. One message and information format is used for all recipients, as is the case in the Basque Country. Specific local adjustments are handled via local voluntary fire brigades and personal contacts.

5 | ANALYSIS AND DISCUSSION

Among the main issues to consider when designing a new web screening tool for social media is the issue of trust—on behalf of both the sender and the receiver. The sender must trust in the channel, and the receiver will react differently to the warning information based on, for example, the channel used and the source of the information. Studies have shown that information is more readily trusted if the source is someone the receiver already trusts and has a relation to either directly or online (this can be family and social networks, but also authorities and organizations). The message content and its coverage are also important—the disseminated information might be right, but the coverage is not complete. Media coverage has shown to be an important factor when evaluating warning dissemination processes, rescue activities, and when planning for future emergencies and crises.

In general, the use of social media is relatively widespread in Europe (for instance used in two of the three regions mentioned in this paper), and there is reason to believe that social media use and coverage will increase rather than decrease in the future. Many recent studies exemplify the importance of concept and technology development to meet these future demands (Dhamodaran, Sachin, & Kumar, 2015; Meissen, Hardt, & Voisard, 2014; Pratihast et al., 2016; Slavkovikj, Verstockt, Van Hoecke, & Van de Walle, 2014; Westling, Brynielsson, & Gustavi, 2014).

According to the interviewees, an important success factor for using social media tools in emergency management is to use the same tools for daily communication and activities, and not just in time of emergency or crisis. This is necessary for creating a relationship with people online, as well as creating trust. It is also important for crisis communication officials to be clear, honest, and precise in communication, and to share and follow messages from other credible sources. Veil et al. (2011) also recommend the use of social media tools for environmental scanning in order to listen to the concerns of the public and to follow public opinion changes.

It is important to note that not all people are actively involved in interactions in social media, and thus, social media cannot replace other communication strategies. Communication through social media should therefore be seen as a complement to the traditional outlets for crisis communication and also as an opportunity for dialogue with the population so that communication strategies can be improved (Artman et al., 2011; Veil et al., 2011).

5.1 | Social media screening for emergency management awareness

As has been identified within this paper, there are three key issues where social media can make a difference when it comes to crisis communication: (i) the issue of trust, (ii) the need for

timely response, and (iii) the opportunity to follow up on and respond to how people perceive and react to warning messages. In the following, these perspectives are used to devise best practices for designing computer-based web screening tools for emergency management purposes. The overall aim of such tools is to enhance situational awareness (Endsley, 1995) among emergency management personnel with regard to public opinions and citizen alertness.

Of particular interest for effective crisis communication is to be able to screen with regard to an ongoing emergency or crisis situation in general (Gibson et al., 2015; Zielinski, Middleton, Tokarchuk, & Wang, 2013) and reactions to sent warning messages in particular. Hence, enabling the staff to monitor public perception of alert messages and to convey alert messages corresponding to estimated receiver susceptibility has been identified as important. Such systems form integral parts of pan-European systems and concepts being developed for crisis alerting (Párraga Niebla et al., 2011).

As a crisis communication method, social media screening is typically used for determining the state of various clusters of people. Here, "state" refers to something that can be detected by analysing social media content linguistically with regard to sentiment (Pang & Lee, 2008), for example, that persons are upset, happy, ignorant, etc.

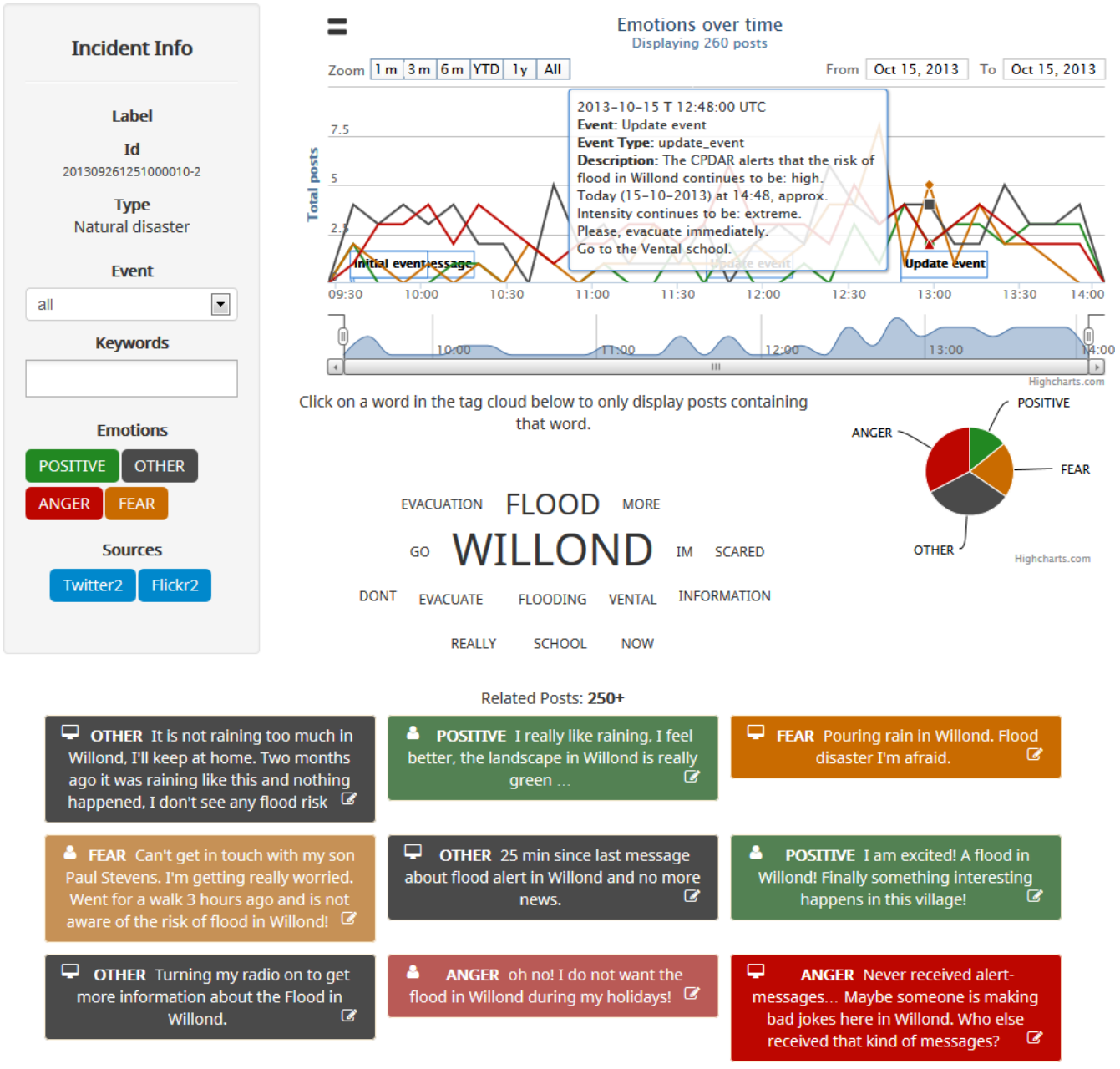

FIGURE 1 The literature study and interviews presented in this paper were used to guide the further user-centred design and development of a proof of concept "screening of new media" tool. In this figure, a fictive data set has been used to visualize how different crisis alerts affect the sentiment of the population

The relevant clusters of people refer to sections of the population that, in some relevant sense, resemble each other in some way, that is, when disseminating a warning message one can use screening to investigate whether tourists, elderly, immigrants, etc., have really been targeted by the message or if one should use another message channel or perhaps reformulate the message in order to obtain better coverage or perhaps convey the information differently.

From a technological perspective, social media screening largely consists of performing automatic linguistic analyses on streams of social media chunks, for example, tweets for the case of Twitter. For the purpose of determining people's state/sentiment according to the previous paragraph, one can either match stream content relative to a list of predefined labelled words, or use a machine learning classifier that has been trained on a number of manually labelled data chunks. Obviously, the machine learning approach is the way to go to make use of the large volumes of data that are made available due to the growth of Internet which has also been proven to be a fruitful approach for other types of classification tasks related to social media, see, for example, Pennacchiotti and Popescu (2011). In social media, however, the vocabulary tends to be very flexible and creative compared to that of traditional news media. For an operational social media screening system to be functioning well, this necessitates a continuous train–test–update cycle to keep the system up to date.

An in-depth technical description of a full-fledged crisis communication screening system would require, among other things, information retrieval software, a suitable database, algorithms for training and classification, a graphical user interface, etc. (Johansson et al., 2011, 2012). As mentioned in the beginning of this section, however, the purpose of this paper is merely to provide the basis for such technical development by exemplifying how social media monitoring can make a difference when it comes to (i) the issue of trust, (ii) the need for timely response, and (iii) how these two things can be facilitated by analysing sentiment in text stemming from social media.

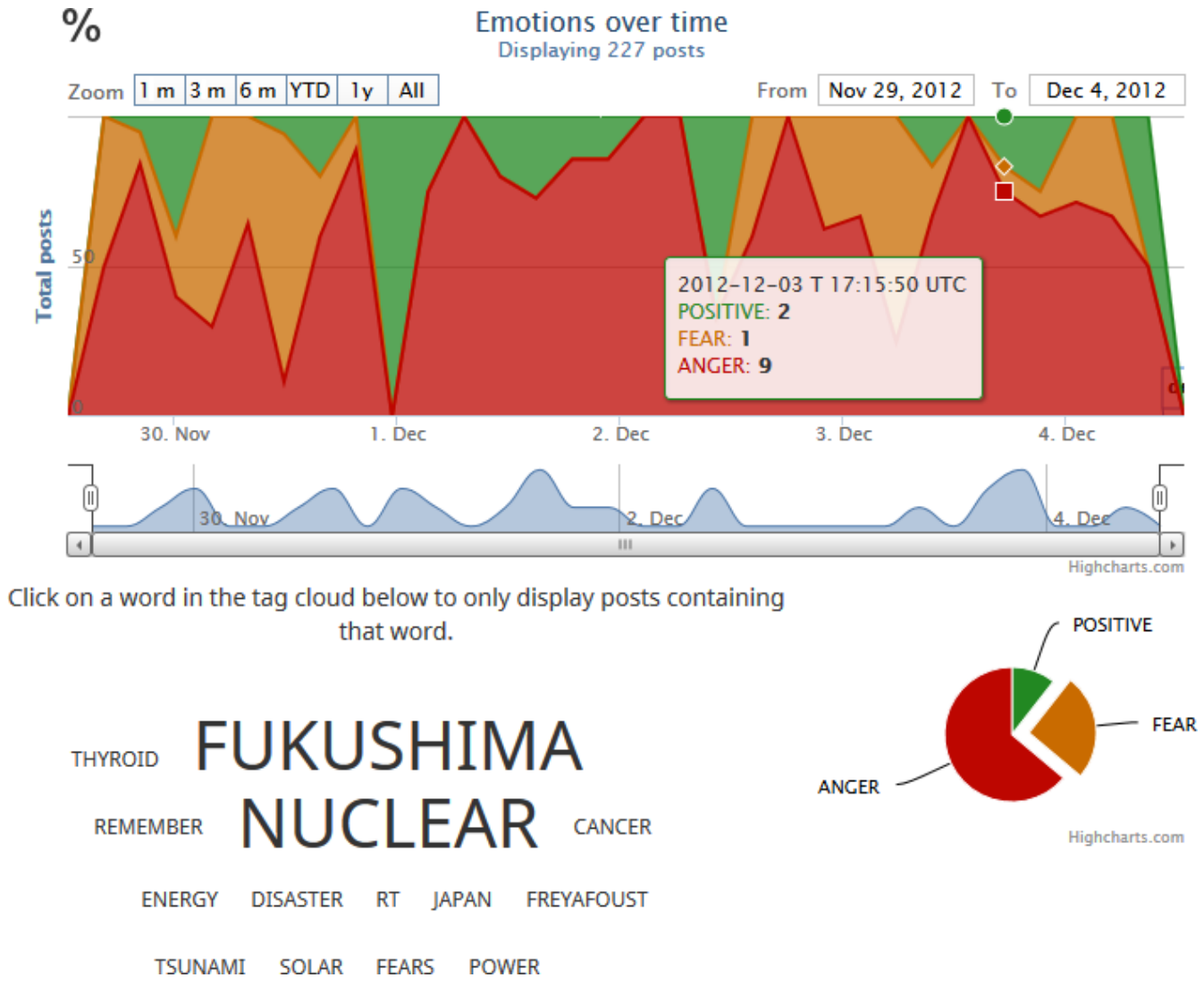

FIGURE 2 In this figure, the proof of concept tool is used to visualize the relative distribution of emotions using a data set gathered during the Fukushima disaster

6 | DEVELOPMENT OF A PROOF OF CONCEPT SYSTEM

Trust, timely response, and the necessity to follow up on the population's reactions to warning messages created a "point of departure" in a series of conducted user-centred workshops (Brynielsson et al., 2013a). The aim of the workshops was to make stakeholders define and describe their ideas concerning important features in a social media screening tool, and for the researchers and designers to transform those ideas into design.

Results from those workshops showed that within emergency management, it is more important to be able to distinguish between negative emotions such as fear and anger than to be able to differentiate between different positive emotions. Also, a social media screening tool needs to be focused on trend analysis as, in emergency management, relevant actions are to be undertaken for the purpose of improving a situation, that is, going from one state to a better state.

Based on those results, an emotional classifier that automatically distinguishes between the emotional classes "positive," "fear," "anger," and "other" was developed, and used as a basis for the design and implementation of a decision support system in which emotional trends are visualized. In the developed tool, a number of interactive chart components are used in order to visualize how the emotional content in a data set changes as a function of time, that is, show changes in emotional state over time in relation to, for example, a warning message.

The graphical user interface provides a number of ways to apply filters to the underlying data set. As can be seen in Figure 1, there are three main components for applying the filters: a timeline for filtering the time interval to be used, a tag cloud for filtering based on keywords, and the grey box located to the upper left that provides means to filter based on keywords, emotion classes, and data sources. Further, the posts are colour-coded so that it is easy to see which emotion a certain post has been classified as. However, the classification is not always correct, and therefore, the user has the possibility to manually reclassify a post and, at a later stage, use the manually classified post as a basis for improving the classifier.

An important part of the graphical user interface is the possibility to shift between the absolute probability distribution according to Figure 1 vis-à-vis the relative probability distribution as depicted in Figure 2. Most often, it will be important to visualize both the relative graph and the absolute graph as it will be easier to visualize the trend using the relative graph whilst the absolute graph is still needed in order to visualize, for example, trends regarding how the total volume of posts vary.

To evaluate the tool, it has been integrated with the Alert4All system (Párraga Niebla et al., 2011), which is an implemented prototype of a future pan-European public alert concept. As shown during the final demonstration of the Alert4All system and through the collocated user-centred activities, the social media analysis component of Alert4All provides additional benefit for command and control personnel in terms of providing immediate feedback regarding the development of an emergency or a crisis in general and regarding the reception of crisis alerts in particular.

7 | FINAL COMMENTS

This paper has described a study where a literature review and interviews with emergency management personnel were used as the basis for identifying key factors to be considered for the design of a crisis communication social media screening tool. The findings were used to inform the development of a proof of concept system. The developed crisis communication support system is based on analysis of large amounts of social media posts. The system design supports the identified variables concerning trust, timely response, and the possibility to follow up on crisis communication, through different visualizations where both detailed information (specific social media content) and aggregated data (general emotional state of the population) are presented over time. Hence, the design supports emergency management situation awareness and the possibility to dynamically make informed decisions in terms of what to communicate when, in order to communicate how the emergency management actions serve the purpose of gradually improving the situation.

By utilizing social media, emergency managers can take advantage of several of the human reactions to crisis information. One of the main factors that influence how people react and behave during emergencies and crises is their social network and the information that they receive. Social media incorporates several of the main influencing factors identified by Perry and Lindell (2006); they include social networks, they are a channel and source of information, and they are a platform for sharing experiences. These experiences can provide important information to emergency managers and crisis communication officials in terms of how the information was received, and regarding the current state of the emergency or crisis. A screening tool based on technologies for analysing online natural language texts related to an event can thus be a very helpful tool for crisis communication.

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ENDNOTES

[1] https://newsroom.fb.com/company-info/

[2] https://about.twitter.com/company

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