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DECISION MAKING IN EMERGENCY MANAGEMENT: THE ROLE OF SOCIAL MEDIA

Research paper

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Abstract

Researchers and practitioners alike recognise the importance of emergency management (EM) in limiting the adverse impacts of crisis events, as well as the promise of social media to support these efforts. Decision making, which is crucial to ensure the effective management of immediate, emerging, and sustained crises, is one facet of EM potentially affected by social media. While much research has investigated social media in a crisis context more generally, little is known thus far about what it means for EM decision making. In this paper, we investigate the current knowledge base of this phenomenon and infer from it factors that are crucial for its understanding. To this end, we propose an analytical framework of EM decision making based on previous work on complex problem solving and social media networks. We then systematically review and rethink existing research from a decision-centred point of view to identify and synthesise key findings that are relevant to the role of social media in the EM decision-making process. Finally, we outline the research gaps that need to be closed to arrive at a more comprehensive understanding of social media for EM decision support and to begin moving towards theoretically grounded explanations of the phenomenon.

Keywords: Crisis, Disaster, Emergency Management, Social Media, Online Social Network, Decision Making, Situational Awareness, Crowdsourcing, Digital Volunteers, Systematic Literature Review.

1 Introduction

As social technologies have become pervasive in many people's daily lives, their effect on critical aspects of social life has attracted considerable attention in recent decades from researchers and practitioners (Agarwal *et al.*, 2008). One particular aspect of this attention is the adoption of novel emergency response information systems and, in particular, social media as part of emergency management (EM; Palen, 2008; Turoff, 2002).

During the past 35 years, the world has witnessed a constant increase in the number of human-made and natural crises. In 2016 alone, some 327 such events left about 11,000 persons dead or missing and caused economic losses of about US\$175 billion (Swiss Re, 2017). Crises evidently have severe negative implications for the individuals affected as well as for the social and technical systems in which they occur. Effective EM is thus indispensable to lessening these impacts (Pearson and Clair, 1998).

As with other managerial activities, one of the main tasks of emergency managers – such as those from medical, firefighting, police, civil protection, and municipal agencies (van Borkulo *et al.*, 2005) – is to take decisions. In case of EM, decisions – by which we mean committing to a particular course of action from among plausible alternatives (Klein, 2008) – are made in the context of managing immediate, emerging, and sustained crisis events. EM decisions can run the gamut from recruiting and training emergency personnel and developing emergency operations plans to evacuating threatened popula-

tions, providing emergency medical care, and conducting search and rescue operations (Altay and Green, 2006). Given the potential implications of such decisions for the outcomes of crises, the ability of emergency managers to make timely and accurate decisions based on facts is a major determinant of effective EM (Pearson and Clair, 1998).

For quite some time now, social media such as Facebook, Twitter, and YouTube, which have become ubiquitous in many people's daily lives, have also found their way into EM – a recognition of their potential to provide emergency managers with access to crisis-related information contributed by social media users (Hiltz et al., 2011). Social media enable emergency managers as well as other users among individuals, communities, public and private organisations, governments, and news media to share and receive crisis-related information (Houston et al., 2014), making it possible for all of them to take an active part in EM (e.g., Leong et al., 2015; Nan and Lu, 2014; Tim et al., 2017). But although the potential of social media to enhance EM is widely acknowledged, little is known about how this affects the organisational foundations of EM, such as decision making. As Yates and Paquette (2011, pp. 12–13) point out:

Little research exists on the design of social media and knowledge management technologies for emergency management [...]. How these systems, including social media, factor into the decision-making processes of organizations would provide the opportunity to extend out [sic] understanding of the decision-making models in extreme or high pressure environments.

To our knowledge, little has changed since this statement. While crisis informatics research as such continues to flourish, few publications address explicitly the organisational implications of social media for EM (Eriksson and Olsson, 2016). Our research approaches this gap with a systematic review of prior research relating to social media in EM from a decision-centred point of view. In particular, we critically examine what this prior research reveals about the actual role of social media in EM decision making. Our research question is: How should we expect social media to support the decision-making processes of emergency managers?

To answer this question, we propose an analytical framework of the role of social media in the EM decision-making process, based on previous work on complex problem solving and how Kane et al. (2014) explain social media networks. On this basis, we conduct a systematic literature review to identify key findings of prior research that relate to the role of social media in EM decision making, utilising the proposed framework. In doing so, we critically rethink existing insights into, and provide a structured guide for future research on, the potential of social media to support EM decision making.

The remainder of this paper is structured as follows: We first describe the conceptual background of our work in section 2. Based on this, we explain the methodology we apply to the systematic literature review in section 3 and present its results in section 4. We then, in section 5, discuss the implications of our findings and develop a tentative research agenda. In section 6, we address the contributions and limitations of as well as the future prospects for our work.

2 Conceptual background

2.1 Terminology

EM is the managerial activities through which communities mitigate, prepare for, respond to, and recover from crisis events (e.g., EMI, 2008; UNISDR, 2009). Crises, in turn, are defined as “specific, unexpected, and nonroutine event[s] or series of events that create high levels of uncertainty and threaten or are perceived to threaten an organization's high-priority goals” (Seeger et al., 1998, p. 233). Following Boin et al. (2018, p. 24), “we speak of a crisis when a group, organization or community experiences a ‘serious threat to the basic structures or the fundamental values and norms of a system, which under time pressure and highly uncertain circumstances necessitates making vital decisions (Rosenthal, Charles, & ‘t Hart, 1989, p. 10)”. We consider both natural crises that are the consequence of natural or biological phenomena (e.g., earthquakes, floods, and epidemics), and man-made crises that result from human activity (e.g., technological failure, product sabotage, and terrorist attacks).

Crisis mitigation then refers to activities to reduce long-term risks to human life and property (e.g., implementing risk reduction programmes). *Crisis preparedness* includes activities to develop concrete operational capabilities for responding to an emerging crisis (e.g., establishing warning systems). *Crisis response* is the activities that take place immediately before, during, and/or after crisis events, and that aim at saving lives, minimising property damage, and facilitating recovery (e.g., conducting search and rescue operations). Finally, *crisis recovery* includes both short-term activities to restore indispensable life-support systems and long-term activities to restore normal life in the aftermath of crises (e.g., restoring facilities; Lindell, 2013; Waugh and Streib, 2006).

2.2 Conceptualization of EM Decision Making

Crises are often described as complex decision-making environments (e.g., Comfort *et al.*, 2001; Seeger, 2002), and so we adopt elements of the theory of complex problem solving to structure our insights into EM decision making. From this theoretical perspective, the origin of any decision making is a *decision-making problem*, that is, the difference between a goal state and the current state as perceived by the decision maker. Decision making, then, is about identifying the benefits and limitations of available courses of action as well as weighing, selecting, and justifying these alternatives (Jonassen, 2000). Apart from their *complexity* (i.e., the respective degree of complexity and connectivity of problem elements, and the inherent dynamics, transparency, and uniqueness of decision-making goals), such decision-making problems can also vary in terms of their respective *structuredness* (i.e., the extent to which problem elements and potential solutions are knowable and understandable to decision makers) and *abstractness* (i.e., the extent to which problems are specific to a given context or situation; Funke, 2010; Jonassen, 2000).

Following Wilson (1999), we distinguish between four stages of problem solving that are potentially affected by social media. First, in the *problem identification* stage, decision makers ascertain the problem at hand, that is, the disparity between a given situation and a desired outcome state. Second, in the *problem definition* stage, they operationalise the problem and specify its concrete elements. Third, in the *problem resolution* stage, they evaluate potential solutions to the problem. Finally, in the *solution statement* stage, they commit to a specific solution, that is, to an available course of action.

However, this decision-making process is said to be potentially influenced by a number of individual-level determinants. Because dynamic decision making under conditions of stress and uncertainty, as is typical for crises, can challenge decision makers' sense-making capacities, decision-making outcomes are primarily said to depend on their *cognitive capabilities* (e.g., Comfort *et al.*, 2001; Sellnow *et al.*, 2002). Furthermore, we argue that the outcomes of EM decision making depend on decision makers' experience and knowledge in the decision-making domain. We define actors' *expertise* as the amount and organisation of their domain-specific knowledge, potentially gained through experience (Bédard and Chi, 1992). Knowledge and experience in a given domain are said to influence a decision maker's initial assessment of a situation, and thus, the subsequent operationalisation of the decision-making problem and its potential solutions. In addition, expert decision makers are said to make better use of their cognitive capabilities because they can rely on highly automated mechanisms of information processing (e.g., Glaser and Chi, 2009; Salas *et al.*, 2010).

According to Kapucu and Garayev (2011), there are furthermore four contextual factors that interact with EM decision making. The first is the individual *actors* involved in decision making, especially the number of parties, their respective levels of interdependency, mutual trust, and acceptance, and differences in their values, powers, perceptions, and time preferences (Kapucu and Garayev, 2011). Second, the *organisational system* of EM includes the involved organisations' structures, cultures, and goals, which may or may not be compatible when operating within a shared incident command system (e.g., Aldunate *et al.*, 2005; Janssen *et al.*, 2010; Moynihan, 2009). Third, there is the operational *capabilities* of decision makers, which beyond the hardware and software available to them includes the decision makers' own interoperability, experience working together, and emergent operability, that is, their ability to improvise and adapt to unforeseen circumstances (e.g., Allen *et al.*, 2014; Leidner *et al.*, 2009; Mendonça *et al.*, 2007). Finally, there is the EM decision-making *environment*, typically

described as dynamic, complex, uncertain, and, furthermore, involving considerable time pressure and high stakes (e.g., Cosgrave, 1996; Danielsson and Ohlsson, 1999; Smith and Dowell, 2000).

These individual and contextual determinants interact with and within the decision-making process to result in *decisions* pertaining to the initial decision problem. As Pearson and Clair (1998) point out, decision makers' ability to make timely and accurate decisions based on available information is crucial for EM. Following prior research, we regard the *accuracy* (i.e., the extent to which the selected problem solution corresponds to the ideal solution of a perfectly known problem) and *speed* (i.e., the time required to make a decision) as parameters of decision quality (Dane and Pratt, 2007).

2.3 EM Decision Making and Social Media

In this section, we describe how social media integrate into the EM decision-making process. Following Kane *et al.* (2014), we define social media as web-based service platforms that allow users to construct unique user profiles, create digital content, protect access to that content, establish relational connections to other users of the platform, and view and traverse those connections.

Prior research suggests that the features of social media platforms determine how they are used in times of crisis (Eismann *et al.*, 2016). In this paper, we focus on two primary mechanisms that may vary across different platforms and by which social media can influence users' performance. One mechanism is *content*, that is, resources available to users through social media, especially digital content provided by other users such as text, photos, and videos (Kane *et al.*, 2014; Kaplan and Haenlein, 2010). Apart from conveying mere information, such content may carry social influence or build social support among users (Kane *et al.*, 2014). In times of crisis, for instance, social media content can provide EM decision makers with geographical information and situational updates on an evolving situation (e.g., Olteanu *et al.*, 2015; Qu *et al.*, 2009; Vieweg *et al.*, 2010).

The other mechanism is *structure*, that is, the observable pattern of social media users and their relationships in a social media network. Generally, social media are said to facilitate identifying the relationships between users, for instance through friendship, follower, or subscriber indicators. These relationships are essential to how users access digital content in social media: As a general rule, social media platforms require users to employ their connections to other users to gain access to embedded resources (Kane *et al.*, 2014). During crises, for instance, social media facilitate connecting community members and people with a common cause by allowing them to follow others' updates or by joining groups (e.g., Brengarth and Mujkic, 2016; Dabner, 2012; Hughes and Tapia, 2015).

In line with previous insights, we suppose that social media, through these two mechanisms, can interact with EM decision making both directly, by providing factual information regarding the decision problem and potential solutions, and indirectly, by shaping decision makers' mental models of a situation and helping them develop situational awareness (Serman, 1994). The analytical framework in Figure 1 illustrates our assumptions regarding the role of social media in EM decision making.

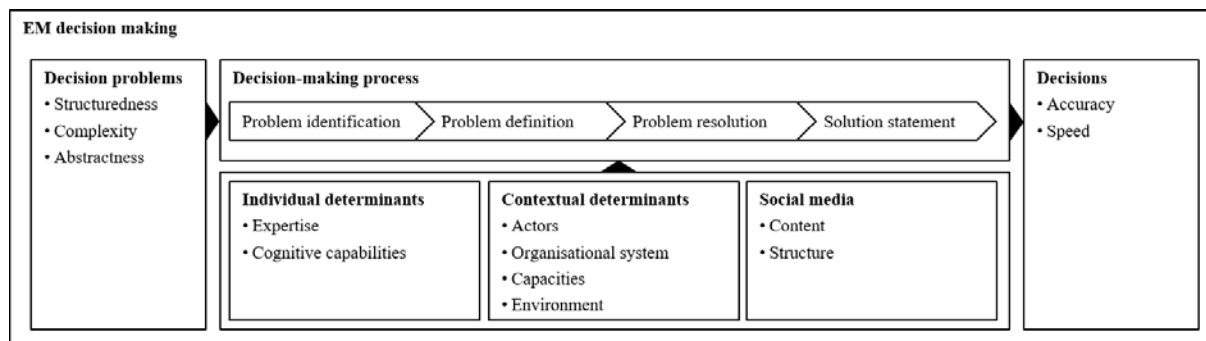


Figure 1. Analytical framework of the role of social media in EM decision making.

3 Review Methodology

The aim of our review is to understand and make sense of the findings of prior research on social media in EM more generally, and reorganise it from a decision-centred point of view utilising the analytical framework described above (Rowe, 2014). Thus, we seek to rethink critically the findings of prior research by synthesising its key findings and research thrusts, and identifying research questions and constructs that have yet to be studied, with the aim of gaining a more comprehensive understanding of the potential of social media to support EM decision making (MacInnis, 2011).

To obtain a set of pivotal research publications on the subject, we applied a three-step systematic literature search and selection procedure. Following Webster and Watson (2002), we first identified relevant publications through a keyword-based search in eight information systems and social science literature databases. We then conducted a forward and backward search to identify related readings. Finally, we identified and included a small set of additional papers not previously selected but that we nonetheless deemed highly relevant to our research purpose. Overall, this approach yielded a total of 59 papers to be analysed. Figure 2 illustrates the literature search and selection process.

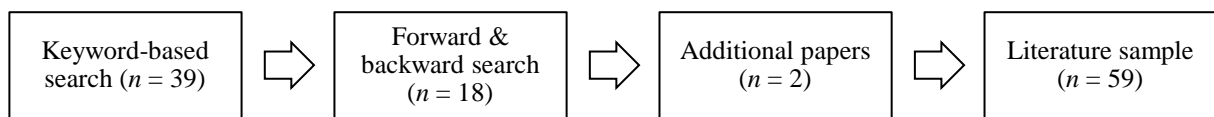


Figure 2. Schematic representation of the literature search and selection process.

For the *keyword-based search*, we applied synonyms of the two underlying research constructs – that is, social media and crises – to generate search terms. For social media, we also included “social network” to capture related concepts such as online social networks and social network(ing) sites (Berger et al., 2014). With regard to crises, preliminary searches yielded various concepts often used equivalently. Therefore, we considered common synonyms as search terms, namely, “disaster”, “catastrophe”, and “emergency” (see also Hiltz et al., 2011). Our final search phrase was: (“*social media*” OR “*social network*”) AND (*crisis OR disaster OR catastrophe OR emergency*).

Crisis research is an inherently interdisciplinary field (Perry and Quarantelli, 1998), and so we applied the search phrase above to eight information systems and social science literature databases: *ACM Digital Library*, *AIS Electronic Library*, *EBSCOhost Information Services*, *EmeraldInsight*, *IEEE Xplore Digital Library*, *JSTOR*, *ScienceDirect*, and *Social Science Citation Index*. We used the databases’ web interfaces to search the title and, if available, abstract and keywords of indexed publications. Our search extended to all database entries published through June 2017. Overall, the keyword-based search yielded 4,090 hits across all databases, as detailed in Table 1.

Database	Number of initial hits	After practical screen	After publication screen
ACM DL	92	11	2
AISeL	262	14	3
EBSCOhost	2,397	92	28
EmeraldInsight	248	14	0
IEEE Xplore	551	26	0
JSTOR	76	1	0
ScienceDirect	450	36	14
SSCI	805	65	28
Total (excluding duplicates)	4,090	175	39

Table 1. Hits based on keyword-based search and systematic screening, by database.

From the results of the keyword-based search, we selected publications to be analysed in two steps. First, in the *practical screen*, we excluded all publications whose content was not relevant to our re-

search purpose because it did not apply to our research constructs, that is, to social media and crises. We further removed publications that did not directly refer to EM activities or that were not based on empirical research because we did not expect them to contain insights into the factual role of social media in an EM context. We also excluded publications in languages other than English. Inclusion decisions were based on careful reading of titles and abstracts, and, if necessary, published texts. Table 2 is an overview of the inclusion and exclusion criteria in the practical literature screen.

	Definitions and inclusion criteria	Exclusion criteria
Crisis	“Specific, unexpected, and nonroutine event or series of events that create high levels of uncertainty and threaten or are perceived to threaten an organization’s high-priority goals” (Seeger et al., 1998, p. 233)	<ul style="list-style-type: none"> • Long-term negative stages (e.g., climate change, low stages of development) • Expected, routine, or nonspecific events (e.g., road accidents, patient care in hospitals) • Lack of uncertainty (e.g., elections, annual flu epidemics) • Lack of threat to collective goals (e.g., individual crises such as depression)
Social media	Web-based service platforms that allow users to “(1) have a unique <i>user profile</i> that is constructed by the user, by members of their network, and by the platform; (2) <i>access digital content</i> through, and <i>protect</i> it from, various <i>search</i> mechanisms provided by the platform; (3) [...] <i>articulate</i> a list of other users with whom they share a <i>relational connection</i> ; and (4) <i>view and traverse</i> their connections and those made by others on the platform” (Kane et al., 2014, p. 279, emphasis in original)	<ul style="list-style-type: none"> • Non-web-based social networks (e.g., social support networks, kinship networks, institutional networks) • Other types of information and communication technologies (e.g., professional content platforms, e-mail communications) • Applications of social network analysis not referring to social media technologies
EM	“The process by which communities identify the hazards to which they are exposed and the physical [...] and social [...] impacts these hazards might inflict, as well as assess and develop their capabilities to mitigate, prepare for, respond to, and recover from these impacts” (Lindell, 2013, p. 263)	<ul style="list-style-type: none"> • Lack of reference to crisis mitigation, preparedness, response, and/or recovery activities (e.g., individual social media usage, public perceptions of EM and crises) • Non-community-related EM activities (e.g., crisis management in business organisations)
Language	Published in English	<ul style="list-style-type: none"> • Published in languages other than English
Empirical research	Based on qualitative or quantitative empirical research, including original reviews of empirical research	<ul style="list-style-type: none"> • Non-empirical publication types (e.g., book reviews, editorials) • Non-empirical research designs (e.g., computer simulations, theoretical framework and discussion papers, design of technical tools) • Based exclusively on anecdotal evidence (e.g., interviews, trend reports, best practices)

Table 2. Inclusion and exclusion criteria in the practical literature screen.

Subsequently, in the *publication screen*, we restricted our sample to seminal publications in the field. We considered an item to be seminal if it (1) was published in a relevant information systems outlet as indicated by rank *B* or better in the VHB-JOURQUAL 3 (2015); (2) was published in a generally well-respected outlet of crisis research, that is, *Disasters* or the *Journal of Contingencies and Crisis Management*; or (3) had already received considerable scholarly attention. As a proxy for the latter, we included all items with ten or more citations on average per year since publication, based on citation counts obtained from Google Scholar. Again, Table 1 shows the number of publications remaining after each step. Applying both screening criteria, we obtained a total of 39 papers for our review.

We then conducted a *forward and backward search* to identify the references of the selected articles and publications citing them in turn, based again on Google Scholar citations. We then applied the same practical and publication screening criteria described above to this list of publications whose titles seemed relevant to our research purpose, arriving at a stable set of 18 additional papers for the review in four rounds of forward and backward search.

We finally allowed for some exceptions from the systematic search and selection process. During the literature search, we came across several publications we deemed relevant to our research purpose but that did not match the selection criteria. After reading these papers, we decided to include two of them that were particularly informative. Overall, the literature search and selection process thus yielded a sample of 59 papers for the review. Table 3 is a list of papers selected in each step.

Keyword-based search	Alexander (2014); Anson <i>et al.</i> (2017); Chatfield <i>et al.</i> (2013); Dabner (2012); Eismann <i>et al.</i> (2016); Eriksson and Olsson (2016); Glowacki <i>et al.</i> (2016); Graham <i>et al.</i> (2015); Helsloot and Groenendaal (2013); Houston <i>et al.</i> (2015); Huang <i>et al.</i> (2010); Hughes and Palen (2012); Hughes and Tapia (2015); Jung and Moro (2014); Kaewkitipong <i>et al.</i> (2012; 2016); Kavanaugh <i>et al.</i> (2012); Lachlan <i>et al.</i> (2014; 2016); Lazard <i>et al.</i> (2015); Liu (2014); Liu and Kim (2011); Ludwig <i>et al.</i> (2015a); McCormick (2016); Mehta <i>et al.</i> (2017); Muralidharan <i>et al.</i> (2011); Procter <i>et al.</i> (2013); Reuter <i>et al.</i> (2015; 2016); Simon <i>et al.</i> (2014; 2015); Smith (2010); Tapia and Moore (2014); Tim <i>et al.</i> (2017); van Gorp <i>et al.</i> (2015); Wong <i>et al.</i> (2017); Wukich (2015; 2016); Yates and Paquette (2011)
Forward & backward search	Brengarth and Mujkic (2016); Briones <i>et al.</i> (2011); Crump (2011); Deneff <i>et al.</i> (2013); Hiltz <i>et al.</i> (2014); Hughes <i>et al.</i> (2014); Latonero and Shklovski (2011); Ludwig <i>et al.</i> (2015b); Plotnick <i>et al.</i> (2015); Sarcevic <i>et al.</i> (2012); Spence <i>et al.</i> (2015); Starbird and Palen (2011); St. Denis <i>et al.</i> (2012; 2014); Tapia <i>et al.</i> (2011; 2013); Vieweg <i>et al.</i> (2010); Zook <i>et al.</i> (2010)
Additional papers	Haataja <i>et al.</i> (2016); Plotnick and Hiltz (2016)

Table 3. Literature sample.

We then reviewed the selected papers in the context of the dimensions of the analytical framework presented in section 2, above.

4 Review Results

4.1 Content and Structure of Social Media in Crises

In the first step, we present our review results relating to the content and structure of social media in the context of crises. In particular, we try to answer the following questions: What types of digital content are available to decision makers through social media? From what users is this content available? What value does it deliver to decision makers? And what role do the relational structures of social media play in how this content is accessed? Table 4 on the following page summarises these findings.

With respect to the digital content available to decision makers through social media, most of the papers reviewed emphasise the importance of *situational information*, that is, information about crisis events, their impacts, and their consequences. The availability of nearly real-time information from an immediate crisis area is often considered to be particularly promising (e.g., Ludwig *et al.*, 2015a; Tapia and Moore, 2014; Wukich, 2015). Furthermore, prior research presents evidence of the availability through social media of *news reports* as well as information on *other EM stakeholders' needs and activities, citizens' crisis-related concerns and needs, their volunteer activities, and their perceptions of EM activities and crises*. Apart from that, they provide information regarding *rumours and misinformation* that may be circulating (e.g., Alexander, 2014; Houston *et al.*, 2014; Wukich, 2015).

Our findings support the notion that social media enable EM decision makers to access crisis-related digital content shared by all sorts of social media users. While *citizen users* and *members of local communities* are most frequently mentioned as sources of digital content, there is also evidence that digital content is available from *EM agencies and individual EM stakeholders, local and national gov-*

ernments, and news media and journalists (e.g., Houston et al., 2014; Jung and Moro, 2014). Digital content includes both user-generated content as well as contributions from professional journalists and takes the form of *text messages*, such as first-hand reports, as well as *photo and video materials* (e.g., Ludwig et al., 2015a; Wukich, 2015). Typically, retweeted or otherwise redistributed content is predominant (Helsloot and Groenendaal, 2013).

Dimension	Findings	Selected references
Social media content	<ul style="list-style-type: none"> • Social media grant EM decision makers access to situational information. Furthermore, they provide access to news reports, rumours and misinformation that may be circulating, as well as information on EM stakeholders' needs and activities, citizens' volunteer activities, and their crisis-related concerns and perceptions of EM and crises. • Social media grant EM decision makers access to user-generated content, photos, and videos contributed by citizens and communities, EM stakeholders, governments, and media representatives. • Digital content conveys information, physical and non-physical support, trust and legitimacy, and, as a consequence, social influence to EM decision makers. 	Alexander (2014); Houston et al. (2014); Kaewkitipong et al. (2016); Lachlan et al. (2014); Lazard et al. (2015); Ludwig et al. (2015a); St. Denis et al. (2014); Wukich (2015); Zook et al. (2010)
Social media structure	<ul style="list-style-type: none"> • Social media facilitate engaging in personal relationships with users as well as community building, both of which enhance trust and legitimacy as well as access to crisis-related information. • Social media facilitate interactive communications, which facilitates access to crisis-related information. • Social media facilitate crowdsourcing to engage users in specific EM tasks, especially in the co-production of crisis-related knowledge. • The enhanced visibility of social relationships and the relational structure of digital content enabled by social media facilitate establishing targeted relationships with users who own specific pieces of information. 	Anson et al. (2017); Briones et al. (2011); Latonero and Shklovski (2011); Procter et al. (2013); Tapia and Moore (2014); Tim et al. (2016); Wukich (2015); Yates and Paquette (2011)

Table 4. Summary of findings on the content and structure of social media in crises.

Notably, digital content has been reported to provide value to EM decision makers in multiple ways. There seems to be an implicit consensus in the literature that *information* is the most valuable resource available through social media (e.g., Alexander, 2014; Haataja et al., 2016; Wukich, 2015). Research also indicates that social media can grant EM decision makers access to *physical and non-physical support*, for instance, receiving encouraging messages and appraisals of their work, and acquiring material, financial, and labour resources from individual and community users of social media (e.g., Brengarth and Mujkic, 2016; Briones et al., 2011; St. Denis et al., 2012). Additionally, social media can also promote users' *trust* in EM. As Eriksson and Olsson (2016, p. 204) explain, social media can be understood "as a channel for preventive, confidence-building dialogue". Thus, they can foster trustful relationships between EM decision makers and their constituencies, which in turn can promote the *perceived legitimacy* of EM and, as a consequence, help decision makers develop *social influence* on connected users (e.g., Crump, 2011; Haataja et al., 2016; Latonero and Shklovski, 2011).

The potential of the relational structures in social media to facilitate connecting otherwise disconnected crisis stakeholders is often considered especially relevant (Eismann et al., 2016). For instance, social media are known to enable communication among people willing to assist in EM (e.g., Dabner, 2012; Smith, 2010), between EM agencies and citizen volunteers (e.g., St. Denis et al., 2012; Zook et al., 2010), and among professional responders within and across EM agencies (e.g., Sarcevic et al., 2012; Yates and Paquette, 2011). We believe, however, that this analysis of prior research fails to capture the full extent of relational structures in social media in a crisis context.

The reviewed papers refer to the ability of social media to *develop and maintain personal relationships* among users and to facilitate *community building*. By establishing personal relationships with

citizens, EM decision makers can foster trust and a sense of community, which can, in turn, enhance the perceived legitimacy of EM and facilitate receiving information from users and communities (e.g., Briones *et al.*, 2011; Hughes and Palen, 2012; Latonero and Shklovski, 2011). Furthermore, social media enable EM professionals to sustain existing relationships with their colleagues within and across EM agencies, which allows them to share information (Tapia and Moore, 2014).

A related but somewhat distinct aspect is the *interactive nature of social relationships* in social media. Social media are generally known to enable two-way communication between EM decision makers and other social media users. For instance, decision makers were found to engage purposefully in dialogue with citizens, answer their questions, and respond to their comments (e.g., Crump, 2011; Latonero and Shklovski, 2011; St. Denis *et al.*, 2014). Interactive communications is seen as a convenient way to obtain information from citizen users without establishing personal relationships with them (e.g., Haataja *et al.*, 2016; Mehta *et al.*, 2017).

Crowdsourcing is another pattern of social relationships enabled by social media. EM decision makers can invite social media users to participate collectively in specific EM tasks, such as the co-production of knowledge. Whereas community building is about allying with social media users, crowdsourcing focuses on engaging them jointly in specific tasks. Thus, decision makers can directly harness the social relationships among users for their own purposes (e.g., Haataja *et al.*, 2016; Mehta *et al.*, 2017; Wukich, 2015).

Two special features of relational structures in social media enhance information accessibility. Kane *et al.* (2014) discuss the first: the *enhanced visibility of social relationships*. Sarcevic *et al.* (2012), for instance, explain that social media can be used to communicate not only information, but also who owns the information. Similarly, Yates and Paquette (2011) point out that knowing who contributed digital content to a social media platform facilitates connecting users who might otherwise be unaware of each other. This enables EM decision makers to purposefully establish relational connections with other users in order to access specific information they own.

Furthermore, social media enable what we might call a *relational structure of digital content*, that is, finding relevant content based on the relationship between the pieces of content, as indicated by markers such as hashtags and keywords, rather than on the relationship between the users who provide it. This enables access for EM decision makers to digital content even if they do not have personal relationships or interact directly with other users; they gain this access primarily by monitoring known markers that relate to crises or by observing patterns of crisis-related social media activity (e.g., Mehta *et al.*, 2017; Wukich, 2015).

4.2 Role of Social Media in the EM Decision-Making Process

We now turn to our findings on the role of social media content and structure in the EM decision-making process. The central questions of this section are: In the literature, which functionalities of social media support problem identification, problem definition, problem solution, and solution statement? And which individual and contextual determinants are relevant in this process? Table 5 on the following page summarises our findings.

EM decision makers' *problem identification* is said to benefit primarily from increased situational awareness, that is, their general overview and understanding of crises. Harnessing situational information available from social media, decision makers can learn about crisis events, impacts, and consequences (e.g., Haataja *et al.*, 2016; Tapia and Moore, 2014). Thus, social media can serve as social sensors or incident notification systems for emerging crises, security threats, or rumours circulating among a population (e.g., Hughes and Palen, 2012; Plotnick *et al.*, 2015). If multiple stakeholders are involved (e.g., decision makers from different EM agencies), social media can also help them develop a common operating picture of crises (e.g., van Gorp *et al.*, 2015; Wukich, 2015).

Similarly, the *problem definition* stage of EM decision making has been found to benefit from increased situational awareness. EM decision makers can utilise social media, for instance, to collect situational information that enables them to judge where and how EM resources should be allocated (e.g., Sarcevic *et al.*, 2012; Tapia and Moore, 2014; Zook *et al.*, 2010), analyse public sentiment to

determine which needs and concerns should be addressed (e.g., Kavanaugh *et al.*, 2012; Glowacki *et al.*, 2016; Lazard *et al.*, 2015), or learn about other EM stakeholders' activities so they can align their actions and coordinate responses (e.g., Haataja *et al.*, 2016; Tapia and Moore, 2014).

Dimension	Findings	Selected references
Problem identification	<ul style="list-style-type: none"> • Situational awareness can help EM decision makers develop an overview and understanding of crises. • Situational awareness can serve as an incident notification system to alert EM decision makers of emerging events such as crises, security threats, and rumours circulating among a population. • If multiple decision makers are involved in EM, situational awareness can help them develop a common operating picture. 	Haataja <i>et al.</i> (2016); Tapia and Moore (2014); Vieweg <i>et al.</i> (2010); Wukich (2015); Zook <i>et al.</i> (2010)
Problem definition	<ul style="list-style-type: none"> • Situational awareness enables EM decision makers to judge the state of crises, EM activities, and public perceptions that are part of decision problems, such as resource allocation or crisis communication. • Situational awareness facilitates coordinating responses of multiple EM stakeholders. 	Haataja <i>et al.</i> (2016); Procter <i>et al.</i> (2013); Sarcevic <i>et al.</i> (2013); Tapia and Moore (2014)
Problem solution	<ul style="list-style-type: none"> • Crowdsourcing facilitates collecting and verifying information relevant for specific decision problems. • Crowdsourcing enables EM decision makers to raise material, financial, and labour resources from social media users that are required for EM activities. 	Brengarth and Mujkic (2016); Liu (2014); Mehta <i>et al.</i> (2017); Wukich (2015)
Solution statement	<ul style="list-style-type: none"> • Integrating digital volunteers enables them to assume formal EM tasks, such as information collection and verification or social media monitoring. 	Hughes and Tapia (2015); Ludwig <i>et al.</i> (2015b); St. Denis <i>et al.</i> (2012)

Table 5. Summary of findings on the role of social media in the EM decision-making process.

Problem solution, in contrast, is typically discussed as a potential application area of crowdsourcing. Generally, crowdsourcing refers to participative online activities through which decision makers issue open calls to encourage social media users to participate in specific tasks (Estellés-Arolas and González-Ladrón-de-Guevara, 2012). While participative information collection and verification is the most prominent purpose of crowdsourcing in EM (e.g., Mehta *et al.*, 2017; Wukich, 2015), the literature also reports that decision makers try to raise specific community material, financial, and labour resources needed for EM activities (e.g., Brengarth and Mujkic, 2016; Houston *et al.*, 2014). We thus argue that crowdsourcing can enrich decision makers' knowledge of potential solutions to known decision-making problems.

Finally, we identified initial evidence that the *solution statement* phase can benefit from integrating digital volunteers into EM. Research has explored their potential to assume a variety of EM tasks, such as information collection and verification and social media monitoring. This implies that citizen users can become part of formal EM via social media, for instance as virtual teams that keep track of social media streams and communicate official news to the public (e.g., Hughes and Tapia, 2015; Ludwig *et al.*; 2015b; Starbird and Palen, 2011). While this line of research is at an early stage, it provides insights that social media can be applied not only to detect and specify decision problems and potential solutions, but also to commit to and execute concrete problem solutions.

To conclude, we focus on the individual and contextual determinants that are said to influence EM decision making. Our review results suggest that several factors are crucial to understanding the actual role of social media in EM decision making. With respect to the *contextual determinants* of EM decision making, prior research has identified various barriers to social media adoption that can be related to the EM organisational system. In particular, the research discusses incompatibility of social media practices with hierarchical organisational structures and cultures, lack of organisational approval and formal policies for social media usage, and lack of organisational resources such as time, budget, and

designated personnel (e.g., McCormick, 2016; Plotnick and Hiltz, 2016). Furthermore, the relevance of *technical capacities*, especially access to the Internet and to social media technologies, has been explored (e.g., Anson et al., 2017; Haataja et al., 2016; Plotnick and Hiltz, 2016).

Considering the *individual determinants* of EM decision making, prior research asserts that decision makers' perceived lack of skills, training, and experience using social media can impede the adoption of social media in EM (e.g., McCormick, 2016; Plotnick and Hiltz, 2016). Furthermore, their cognitive capabilities are a common theme in the reviewed literature. In particular, EM decision makers' ability to process available information is often considered as crucial. As Ludwig et al. (2015a) explain, EM decision makers can be easily overwhelmed by the need to make sense of digital content; the vast amount of information of unknown quality and reliability available from social media surpasses their cognitive capabilities to assess it. This is especially true under the conditions of dynamically evolving and inherently stressful crisis events. Therefore, feelings of information overload are a common research theme (e.g., Ludwig et al., 2015a; Plotnick and Hiltz, 2016; Reuter et al., 2016).

Finally, we observed an individual determinant of EM decision making of which we were not previously aware: EM decision makers' *trust in social media*. Lack of trust seems to be one of the primary factors that hinder emergency managers' adoption of social media in the first place (e.g., McCormick, 2016; Plotnick and Hiltz, 2016). Furthermore, it has been pointed out that EM decision makers typically do not trust using information obtained through social media from sources not personally known to them to inform decision problems that may involve high stakes (e.g., Ludwig et al., 2015a; Tapia et al., 2011; Tapia and Moore, 2014). Also, lack of trust has been found to hinder the integration of digital volunteers into EM (Hughes and Tapia, 2015). In contrast, EM decision makers' trust in social mechanisms that produce information, such as personal interactions and crowdsourcing, can be considerable (Mehta et al., 2017; Tapia and Moore, 2014). Therefore, we suspect that tasks are delegated to social media to the extent that decision makers trust involved users or collaborative mechanisms of information production in social media.

5 Towards a Research Agenda

While only a few publications to date have addressed explicitly the role of social media in EM decision making, our findings demonstrate that much is already known regarding their relevance in the EM decision-making process. The analytical framework described in section 2 has assisted us in reorganising, from a decision-centred point of view, the insights from previous research. In this section, we turn to the implications of our findings and discuss not only what they reveal about the actual role, but also about the potential of social media to support EM decision making. Furthermore, we explore gaps in the current literature that need to be closed to gain a more comprehensive understanding of the potential of social media to support EM decision making and to begin moving beyond concepts towards theories that capture the potential role social media could play for decision-making processes and outcomes in a crisis context.

Our focus is on the three identified mechanisms through which social media interact with EM decision making: enhanced situational awareness, crowdsourcing, and integration of digital volunteers. We begin with the *further description and classification of these mechanisms*. We have already described their basic functionalities based on the reviewed papers, noting however that consistent classification schemes are thus far not available. Nevertheless, we believe that understanding the characteristics of these mechanisms could help emergency managers to purposely employ those that are useful for their work. While there have been attempts to elaborate categories in crisis research (e.g., Starbird, 2011), applying established classification systems (e.g., Geiger et al., 2012; Malone et al., 2009; Schenk and Guittard, 2011) could be helpful in consistently characterising the mechanisms. Additionally, comparative analyses of the patterns of crisis-related social media activity could also prove useful. Such work could, for instance, extend research on collective sense-making (e.g., Heverin and Zach, 2012; Oh et al., 2015; Stieglitz et al., 2018) to cover systematically different types of crisis and non-crisis events.

This gap is particularly evident with respect to *crowdsourcing*, which is explored not only in EM, but also in a variety of information systems contexts (Saxton et al., 2013). From this research, various

suggestions for future research opportunities – such as the composition of the contributing crowd, as well as contribution barriers and incentives – are readily available (e.g., Brabham, 2008). While Hughes and Tapia (2015) argue social media users' and EM decision makers' preferences generally seem to align, profound evidence on the nature and compatibility of users' preferences and incentives to contribute to EM tasks is rare. Thus, we recommend investigating the motivations that drive social media usage in times of crisis, building, for instance, on prior work that investigates usage behaviours more generally (e.g., Park *et al.*, 2009; Quan-Haase and Young, 2010; Raacke and Bonds-Raacke, 2008). We also suggest exploring the interactive processes through which users' behaviours integrate into the observed collective patterns, as well as the role of social media technologies in moderating these processes. In addition to the empirical analyses suggested above, we think formal analytical approaches and agent-based modelling techniques could make a contribution to clarifying the relationship between users' interactions and the observed collective outcomes.

Furthermore, we believe it is also crucial to address in more detail the *characteristics of decision problems* and the *constituents of the decision-making process* that benefit from social media. In our review, we noted that the role of social media in EM decision making is typically discussed along a hierarchy of problem structuredness: Whereas ill-structured problems (e.g., being notified of events) are typically said to profit from enhanced situational awareness through social media, crowdsourcing and the integration of digital volunteers have thus far been discussed only for rather narrowly confined decision problems (e.g., judging the validity of content). This is in line with the earlier insight that the type of information decision makers seek is typically related to the complexity and structuredness of the tasks they are facing (Vakkari, 1999). Therefore, we propose to explore which types of decision-making problems can actually profit from social media in which ways, and which individual and contextual determinants play a role in this, based not only on field reports and case studies, but also on substantial theoretical groundwork. That could help us move beyond a descriptive approach towards theoretical accounts that contribute to the realisation of the full potential of social media in EM.

Most prominently in that regard, our findings allow us to challenge the *potential of the increased situational awareness* that can be gained through social media monitoring, which has been considered as a relatively inexpensive baseline type of social media usage in EM (Haataja *et al.*, 2016; McCormick, 2016). However, while prior research has investigated technical options for data aggregation and filtering, it has rarely questioned the overall appropriateness of monitoring social media to enhance situational awareness. In contrast to this, we conclude from our results that successful monitoring of social media is not only a matter of computational efficiency, but also of decision makers' trust. Inspired by Mehta *et al.* (2017), we therefore propose to investigate how emergency managers can harness the social interactions of users to make sense of social media, such as through crowdsourcing. Furthermore, we suggest investigating the kinds of information needs that can be filled by information available from social media monitoring, based for instance on theories of human information behaviour (e.g., Kuhlthau, 1991; O'Reilly, 1983; Salancik and Pfeffer, 1978; Tushman and Nadler, 1978). Insights from such research could help avoid the frustration and disappointment that is likely from overly high expectations regarding how social media can support decision making in EM.

What role social media play in the *cognitive processes of decision making* is another question our findings cannot yet answer. In this paper, we have focused on the general structure of decision making, while neglecting the cognitive processes that occur along the way. However, research into the role of social media in the mental processes underlying decision making could afford novel insights into the concrete potential and limitations of these technologies to support EM decision making. Our findings let us assume that social media interact with EM decision making both directly – as a source of information upon which decisions can be based and that can be subject to issues of information credibility and overload – and indirectly – as a trigger for enhanced situational awareness, which might serve as a moderator of social media impact on decision makers' cognitions. In our view, it is crucial that any theoretical approach in that direction account for this dual role. With respect to theoretical resources, naturalistic decision making might provide a useful starting point (Conrado *et al.*, 2016). More specifically, given the prominent role of the situational awareness construct in our findings, situational awareness theory could be advantageous (e.g., Endsley, 1995).

Based on our findings, we also argue for extending work on the *adoption of social media in EM*, since technology adoption necessarily precedes its successful usage. While there is already plenty of research on the barriers to social media adoption in EM (e.g., McCormick, 2016; Plotnick and Hiltz, 2016; Reuter *et al.*, 2016), our current perceptions are by and large static. We suggest that a dynamic approach to social media adoption in EM – one that takes into account the temporal sequence of adoption decisions and their determinants – could provide a more comprehensive picture and could lead to a more theoretically driven approach that builds, for instance, on earlier adaptive approaches such as that provided by DeSanctis and Poole (1994). Furthermore, we note that EM decision makers' trust in social media should receive far more attention as a determinant of their social media usage. Prior research has already explored the nature of trust in detail (Mayer *et al.*, 1995; Rousseau *et al.*, 1998), and there are initial models for trust in digital information (e.g., Kelton *et al.*, 2008). Applying this theoretical work to extend and explain the initial insights into the nature and evolution of trust in social media in an EM context could help us develop a more comprehensive view.

Finally, readers will also have noticed that we initially considered the *speed and accuracy of decision making* as key indicators of decision quality, but did not address in our review findings the implications of social media for decision outcomes. This is basically due to a striking lack of insights into the effects of social media on the outcomes of EM decision making, as prior research has by and large relied on the seemingly apparent promise of social media to provide valuable decision support to emergency managers. Building on the work of Westerman *et al.* (2014) and prior experimental research in other fields (e.g., Fisher *et al.*, 2003; Lurie, 2004; Speier *et al.*, 2003), future research could thus make a contribution by assessing the implications of the relevance and interactions of the unique determinants of real-world decision making in the increasingly relevant context of crises.

6 Conclusion

Given the increase in natural and man-made crises, the importance of EM to limit the impacts of such events is evident. While the potential of social media to enhance EM by improving crisis-related information flows and communication has been the subject of much research, we lack an understanding of their role in organisational processes such as decision making.

In this paper, we have investigated what previous research into social media in an EM context more generally reveals about their role in EM decision making. In doing so, we have provided an analytical framework of social media in the EM decision making. We have systematically reviewed and critically rethought a large research body from a decision-centred point of view. In doing so, we have identified key findings and research thrusts of prior research that relate to the role of social media in the EM decision-making process. Furthermore, we have outlined research gaps that need to be addressed to develop a more comprehensive understanding of the phenomenon, thereby providing a tentative research agenda. We have thus contributed to clarifying the potential of social media to provide decision support in an area of operation that is increasingly relevant for researchers and practitioners alike.

The main contribution of this paper is in reviewing and critically revising existing research, and so there are of course limitations to our work. While we can validly point to gaps in previous research, we do not yet attempt to close them. Instead, we focus on disclosing promising routes for future research. While our proposed framework is useful for analysing and understanding prior research, it is only a first step towards theoretically grounded work. Another limitation follows from our systematic literature search and selection procedure. Although we believe our approach is generally suited to detecting the larger part of relevant research, we cannot be sure that we have not missed some contributions. We are not, however, aware of alternative ways to obtain a rigorous and comprehensive picture of existing research. Still, we believe that open-ended reviews and discussions contributed by experienced researchers could further enrich our insights.

Considering the findings and implications of our review, we believe we are basically on a good path to understanding the current role and future potential of social media for decision support in EM. Still, further efforts are needed to close the existing knowledge gaps and strive for theoretically founded explanations of the phenomenon.

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