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Linda Plotnick
Jacksonville State University

Starr Roxanne Hiltz
New Jersey Institute of Technology

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Linda Plotnick* and Starr Roxanne Hiltz

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Abstract: Social media (SM) are socio-technical systems that have the potential to provide real-time information during crises and thus to help protect lives and property. Yet, US emergency management (EM) agencies do not extensively use them. This mixed-methods study describes the ways SM is used by county-level US emergency managers, barriers to effective SM use, and recommendations to improve use. Exploratory interviews were conducted with US public sector emergency managers to elicit attitudes about SM. This was followed by a survey of over 200 US county level emergency managers. Results show that only about half of agencies use SM at all. About one quarter of agencies with formal policies actually forbid the use of SM. For both disseminating (sending out) and collecting information lack of sufficient staff is the most important barrier. However, lack of guidance/policy documents is the second highest rated barrier to dissemination via SM. Lack of skills and of the training that could improve these skills is also important. For collecting data, trustworthiness and information overload issues are the second and third most important barriers, which points to the need for appropriate software support to deal with these system-related issues. There are few differences associated with agency characteristics. By understanding important barriers, technologists can better meet the needs of emergency managers when designing SM technologies.

Keywords: barriers; emergency management; Facebook; social media; Twitter.

1 Introduction

The 21st century thus far has seen two parallel trends: the rise of social media (SM), and an increase in large scale disasters that receive worldwide attention. Since SM are used daily by so many people, particularly in the younger generations, it is natural that users will turn to these familiar media in times of crisis. Citizen-side information generation and dissemination activities are increasingly playing a crit-

***Corresponding author: Linda Plotnick,** Jacksonville State University – MCIS, Jacksonville, AL, USA, e-mail: lplotnick@jsu.edu
Starr Roxanne Hiltz: New Jersey Institute of Technology – Information Systems, Newark, NJ, USA

ical role in disaster[1] preparation, warning, response and recovery (Liu et al. 2008). Users expect that the emergency response agencies that are intended to rescue and serve them will be using these media (American Red Cross 2010). Researchers on the topic of SM use in emergency management (EM) have pointed out that valuable pictures and texts shared during the early stages of a disaster, can be very useful for enhancing situational awareness (e.g. St. Denis et al. 2014), thus leading to better decisions about deployment of people and material to aid those most in need. These are the hoped for benefits of use of SM by emergency responders.

However, there are barriers to the use of SM for EM, both technical and organizational. SM are examples of "socio-technical" systems; meaning that their use and effectiveness are determined not only by the features and quality of the systems themselves, but also by social context factors such as user attributes, organizational norms and resources and the way in which the organization adapts a technology (see, e.g. Cherns 1976; Avgerou et al. 2004; Hughes and Tapia 2015). Thus, our theoretical premise is that they are best approached from the point of view of "social informatics" (see, e.g. Kling 1999; Sawyer, 2005). This is especially true of the use of SM as part of an emergency response management system, when the information in question is generated by the public and communicated via a public commercial system, rather than by trusted information systems under organizational control.

The purpose of the studies described in this paper is to explore and document the nature and extent of both of use of, and barriers to use of, SM for EM, and to suggest some ways to overcome the barriers. Our main focus is potential use of SM by US county-level government agencies, but we also draw on related studies. The overarching goal is to uncover specific barriers so that technologists, policy makers, and the Public Information Officers (PIO) or others in charge of communication related to emergencies will be able to address the issues and make it possible to fully exploit the potential of SM during disasters, both for dissemination of information and for obtaining information from the public about conditions and needs. The main research questions are:

1. How and to what extent are US government emergency managers using SM to support their work?
2. What problems or barriers do emergency managers perceive in terms of using SM, both for disseminating (sending out) and collecting information?
3. Do these perceived barriers differ by the mode of use of SM (disseminating or gathering information) or by other factors such as characteristics of the specific agency or policies?

1 In this paper, we will refer somewhat interchangeably to emergencies, disasters, and crises; the distinction is the scale of the disruption, but social media can be used for events and incidents that range from the local to the multi-national, and we mean to encompass all of these.

There are many issues when considering the use of SM by US government agencies, including issues of technology that make it difficult to use SM effectively in government and policy issues that frame the allowable use of SM by government (e.g. Hrdinová and Helbig 2011). Even with some of the new technological advances (e.g. Starbird and Stamberger 2010; Imran et al. 2015), if policies do not allow their use, the technological advances will not be used in crisis. Conversely, unless government officials are assured that perceived barriers are mitigated well by technological advances, they are unlikely to adopt policy changes. Following a literature review, we briefly describe a qualitative study based on semi-structured interviews that aimed to identify and understand the main themes and concerns to be explored. Then we discuss a study based on a survey of over 200 county-level EMs in the US. Thus this is a "mixed methods" project; the qualitative study informed the design and interpretation of the quantitative study (Venkatesh et al. 2013). We conclude with discussion of the results and recommendations for future research and action.

2 Literature Review

Recent scholarship on SM use in disasters can be grouped into studies of the use of SM during one specific or a set of disasters; research on responders' needs, behaviors and attitudes in regard to use of SM (e.g. Tapia et al. 2013); and potential technologies to promote effective use of SM. As our participants were asked to respond with the current functionality of SM in mind, we do not address this latter topic in this paper. In this section we begin with a brief summary of several studies of SM use in disasters, illustrating how SM are currently used. A description of two problems with the nature of the SM data (trustworthiness and information overload) is followed by a review of previously identified organizational barriers, including issues of policy guidelines and training. This is followed by a description of the most closely related prior research, a pair of prior interview-based studies of EMs in international humanitarian (non-governmental) organizations about their SM use and issues that limit its use. The literature review concludes with a framework applied in our studies to classify stages of adoption of SM.

2.1 Selected Studies of Use of Social Media in Disasters

There are three major ways in which SM are used in disasters. One is for the public to self-organize and keep one another informed, whether for disaster response or as part of a social movement. A second is for EMs to disseminate information and instructions to the public ("pushing" or sending out information). A third is

for EMs to use postings, especially from those "on site," to collect information about what is happening and where, and who needs what kinds of assistance (pulling information). Of course, these are very inter-connected; when the public is using SM for a disaster, then it is more useful for EMs to use it too, and visa-versa. Several relevant studies are summarized in Table 1 below to illustrate these uses. There have also recently been some accounts of SM use for inter-agency knowledge management and coordination within and among EM agencies, and two of these are also shown in Table 1.

The study of California wildfires (Sutton et al. 2008) provides a good early example of public use of SM for information exchange. Many respondents to that study reported that they considered the information coming through the traditional mass media to be insufficient because it lacked specificity, was too slow in being updated, or was just plain wrong.

The study of 2013 Typhoon Haiyan (Athanasia and Stavros 2015) investigates the use of Twitter and the validity and reliability of the messages ("tweets") posted by the public. It analyzed nine consecutive days of Twitter messages and compared them to the actual events. It was found that the Twitter users tended to post messages to enhance situation awareness and to motivate people to act. The authors concluded that tweets were found reliable and provided valuable information content, and that there are indications that the information on an

Table 1: Summary of Selected Studies of Use of Social Media in Disasters.

Disaster and Location	Nature of Use and Key Quotes or Conclusions	Source
California Wildfires 2007	Public "backchannel" communication "The only way we all have to get good information here is for those who have it to share it. We relied on others to give us updates when they had info and we do the same for others" (p. 4).	Sutton et al. 2008
Typhoon Haiyan Philippines 2013	Public use Twitter provides fast, reliable information for response	Athanasia and Stavros 2015
China earthquake 2008	Public use and government "pushing" and "pulling"	Wu et al. 2009
Colorado Floods 2013	EM Pushing and pulling Volunteer groups(VOSTS) can help gather and organize SM information	St. Denis et al. 2014
Hurricane Sandy 2012	Pushing, pulling, and organization	DHS 2013; Hughes et al. 2014a
Haiti earthquake 2010	Inter-agency knowledge management	Yates and Paquette 2011

unfolding disaster appears faster on Twitter than in the official media. This supports the argument that Twitter has a very good potential to become a useful tool in situations where rapid emergency response is essential.

Similar findings are reported in regard to China's Sichuan earthquake on May 12, 2008, which measured at 8.0 on the Richter scale. It affected a large geographic area in China, with over 69,000 confirmed deaths, hundreds of thousands injured, and millions of people homeless. Immediately after the earthquake, the Web became one of the major places for people to share information, express feelings and opinions, and exchange mutual support. A study by (Wu et al. 2009) documents four major types of public communication following the disaster on one of the more popular Chinese social computing sites, Tianya: information-related, opinion-related, action-related, and emotion-related. Information-related threads began appearing almost immediately, with 56 reports from 22 different sites posted within 10 min of the quake, and constituted 37% of the total posts, the largest category. Some information was posted by authorities, but many by "ordinary people." For example, the military had difficulty finding a place to land a helicopter, and a message posted online by a university student from the region described a possible location in detail, which they eventually used (Wu et al. 2009).

The most recent studies of SM use by government agencies in the US (Colorado floods and Hurricane Sandy) document the emergence of some "pulling" as well as "pushing" of information by government agencies, not just use by the public. Especially relevant to our study of county managers is a report on the SM communications and work practices of the Jefferson County Colorado Incident Management Team during the severe 2013 floods (St. Denis et al. 2014). The researchers found that in addition to using SM directly to disseminate information, the team made use of a VOST (Virtual Operations Support Group, of remote volunteers) to monitor public postings for both emergency help and misinformation. The VOST group passed on postings that they felt could improve the decisions of the response team. The team felt that this integrated plan enabled them to communicate effectively and to provide "their own mass media" for the local residents. The use of volunteers to aid in organizing information and coordinating different agencies' responses is also described in the study of the Haiti earthquake (Yates and Paquette 2011).

2.2 Technical Barriers to Use: Trustworthiness and Information Overload

For use in "pulling" data to assist in situational awareness and decision making related to a disaster, EMs face two technically-related major problems: the trustworthiness of the information received (Hiltz and Gonzalez 2012), and

"information overload," or the sheer volume of the data stream, which exceeds human processing capacity (Hiltz and Plotnick 2013). We refer to these as "technical" barriers because they are related to current limitations of SM systems, which were not designed for EM use.

2.2.1 Trustworthiness

Government agencies generally wish to make decisions on the basis of information that comes from a "trusted source" and has been vetted as credible by a standard set of procedures. Posts from Twitter, Facebook, and other SM do not meet this criterion. Anybody can post anything, including information that is accidentally or deliberately false, which can be a threat to public safety in a crisis. Though most SM sites effectively "self-police" posts through immediate refutation by others, there is great fear that terrorists or others might deliberately try to spread incorrect rumors or incite terror by using these media (Hughes et al. 2014b).

2.2.2 Information Overload

Information overload has traditionally been defined as information presented at a rate too fast for a person to process (Sheridan and Ferrell 1974). In the realm of SM for EM Verma et al. (2011) state the problem well (p. 285):

> So much information is now broadcast during mass emergencies that it is infeasible for humans to effectively find it, much less organize, make sense of, and act on it. To locate useful information, computational methods must be developed and implemented to augment human efforts at information comprehension and integration.

A discussion of automation of identifying, vetting and filtering posts, still in research laboratories, is beyond the scope of this paper.

2.3 Organizational Barriers and Policy Guidelines

Several barriers have been identified related to organizational resources that can inhibit use of SM for emergency communications. Included are system support, policies and procedures, training and legal issues.

Social media use requires system support. There is a financial cost to having and maintaining computer equipment and systems, and the staff to oversee these roles. If SM are considered to be part of the public record, then both manpower and tools will be needed to maintain records (Kavanaugh et al. 2012).

Hrdinová and Helbig (2011) identified several policy and procedural issues. These include: the degree to which employees are allowed to access SM sites and the procedures for gaining access; how accounts are managed, including policies for creating, maintaining and destroying SM accounts; developing guidelines for expected SM use, including time use, purpose and types of equipment allowed; employee conduct regarding expectations, acceptable content and procedures for posting information; security procedures for both information and infrastructure; limitations and protocols for consequences of violations and protocols for managing citizen generated content. Note that these guidelines are, for the most part, focused on the use of SM to push data. Only "netiquette" is mentioned as guidelines for citizens providing data to government.

A number of policy challenges with respect to SM are discussed in Bertot et al. (2012) including governance, data management, privacy and security, accessibility, and social inclusion. They lament the inadequacy of the existing regulatory framework at the federal level to help guide decision making. Similarly, (Kavanaugh et al. 2012) note a number of policy-related organizational issues in their exploratory study of SM use in government. Considerations are needed related to management buy-in and support, including the value and organizational culture regarding SM; employee access and controls; how much control of information is necessary; the inclusion of tasks related to job descriptions; privacy concerns and what restrictions are necessary regarding what types of devices are allowed to be used (Kavanaugh et al. 2012).

As SM becomes more frequently used by government agencies, policies and standards have been developed by some agencies. Training has also become available, on a more limited basis, to prepare government EMs to use SM effectively within guidelines. For example, FEMA offers an interactive web-based course on SM in EM (DHS 2013).

Emergency events can drive the development of policy and guidance. For example, during the Sandy hurricane, FEMA developed a guidance document to be used by agencies providing websites related to Sandy (DHS 2013). The policies within the guidelines document included measures to ensure consistency across agencies, enable users to navigate between federal sites and local sites, and avoid redundancy in disseminated information. The guidelines were focused on pushing data via web sites and SM, not on pulling data.

2.4 Prior Studies of Emergency Managers' Needs and Behaviors Related to SM

Closely related to this work is a pair of studies by Tapia and colleagues, based on semi-structured interviews with employees of international humanitarian relief

organizations. The first study (Tapia et al. 2011), found that while the largest of these organizations had adopted SM messaging to disseminate information as part of their public relations functions, few collected or used any form of data originating from the public during a disaster. The data from the public was generally considered to be unverifiable and untrustworthy, and thus unsuitable for incorporation into established mechanisms for decision-making. A follow-up study (Tapia et al. 2013; Tapia and Moore 2014) found "pockets of use" and acceptance in some organizations. In particular, they "found that microblogged data is useful to emergency officials in situations where information is limited, such as at the beginning of an emergency response effort, and when the risks of ignoring an accurate response outweigh the risks of acting on an incorrect one" (Tapia et al. 2013: p. 770).

State EM-level use of SM has been documented by Wukich and Mergel (2015). They collected and categorized all state EM agency messages posted during a 3-month period in 2013. Of the total of 8671 tweets collected, about half were directed to other agencies or news media, and half to citizens. Of those directed to citizens, the vast majority were related to educating citizens to increase their preparedness level, to informing them about risk reduction strategies, or to involving them in drills, such as the earthquake preparedness drill to teach citizens to "drop, cover and hold on" that occurred during the period monitored. In other words, state emergency managers were using SM frequently by 2013, but mainly to disseminate (push) information to the public as a whole.

The impact of SM on the job of EM Public Information Officers (PIO) has been studied by Hughes and Palen (2012). Larger government agencies in the US at the county or state level have a designated PIO whose job it is to communicate with the public. This communication is supposed to follow a strict command and control bureaucratic structure according to the guidelines of Homeland Security's National Incident Management System (NIMS). NIMS regulations were designed to provide a single, consistent organizational approach to all US domestic incident management (Bush 2003) including a provision that the commanding officer in charge must approve all messages released to the public. This is hardly compatible with the short, dynamic nature of SM messages. Hughes and Palen (2012) conducted telephone interviews with 25 PIOs in Colorado in 2010. They found that although the majority of these PIOs (20 out of 25) had used SM in their work in some way, "the road to regular, formalized use is still rocky." (*ibid*.). The authors conclude that PIO work is in the process of changing in significant ways, as SM expand the scope and types of their activity and create new "pathways" between them, the media, and the public.

2.5 A Framework for Conceptualizing Stages of Use of Social Media in Government

Mergel and Bretschneider (2013) propose a yet untested framework, which is a three-stage taxonomy to describe the evolution of SM use by government agencies by categorizing the "maturity" of SM use by individuals in an organization. The more "mature" the use of SM by an organization, the more effectively the agency is using the massive amount of SM data available. Stage 1 is "Decentralized, informal early experimentation by SM mavericks" (p. 393); there are no policies specifically regarding SM, but one or more individuals (mavericks) in the organization experiment with using the technology. Stage 2 is "Coordinated chaos: Making the business case for SM" (p. 394); the mavericks promote the benefits of using SM and, as more colleagues adopt it and more experience is had with it, informal standards arise. Stage 3 is "Institutionalization and consolidation of behavior and norms" (p. 394); the organization accepts the technology officially with policies, procedures, and documentation for use both within the organization and by others (e.g. public) who use it to communicate with the organization. This framework is related to the classic theory of stages of diffusion of innovations (Rogers 1962) but appears to be more oriented towards the specific case of organizational acceptance of technology. We utilized this framework for our studies and will discuss the extent to which it is applicable in the conclusion of this paper.

3 Study 1: Interviews to Identify Major Themes

To lay the foundation for a large scale survey related to these issues, we conducted a series of semi-structured interviews with US EMs in December of 2013. The purpose was to make sure that we had identified all of the major issues for inclusion in the follow-up survey, and to gain a deeper understanding of how these managers feel. We addressed such questions as: How are the issues and findings highlighted in the above literature review actually playing out "on the ground," at the level of local EMs, at the present time? How are they using and not using SM, and why? What are their concerns and experiences?

3.1 Method

The interview guide consisted of mostly open-ended questions; several of the items were adapted with permission from Tapia et al. (2013). All procedures were approved by an Institutional Review Board (IRB). The participants were instructed to think

back to the most recent disaster management incident in which they were involved when answering questions about current SM use. However, for questions asking their opinions about barriers to SM use and reactions to possible software enhancements, we asked "in general" rather than about a specific incident. (See Appendix A for the wording of the parts of the interview guide relevant to this paper).

A "snowball" sampling technique was used, starting with a list of practicing EMs known to the researchers, in several different states. Most were directors of their part of the organization, at the county level, although we had one at the federal level and several at the state level. The 11 completed interviews generally took between 30 min and an hour each. Although this may seem like a small number of interviews, the guideline for exploratory qualitative research is to interview until "theoretical saturation" is reached; that is, until no new themes are emerging. For the last several interviews, we heard no new themes.

Skype and telephone interviews were recorded using Audacity, and then transcribed by the interviewers shortly after conducting them to assure a complete and accurate transcript. Coding categories were initially developed by looking at the topics of the questions, and then expanded during coding to include the range of observed answers. The unit of coding was agreed upon to be "a thought." Thus, it could be as short as a brief phrase or as long as a paragraph. The first interview was coded jointly by the two authors, working together as coding categories were established, and discussing any disagreements on coding units and coding categorization. To establish reliability of the coding categories and procedures, the second interview was then coded separately and compared. Well over 90% agreement was achieved, measured by both Krippendorf's alpha and Scott's Pi where at least 80% overlap of coding units was considered a match. Most of the disagreements were due simply to a slightly different length of the text fragments selected as the coding unit in an answer. Those differences were resolved by discussion and then the rest of the interviews were completed by a single coder.

3.2 Findings

We will describe the main themes and tendencies in the interview data related to use and barriers to use of SM and give examples of descriptions of these themes in the words of the managers themselves.

3.2.1 Social Media Use

Information dissemination to other agencies or officials (e.g. emergency dispatchers) was accomplished primarily using traditional methods, not SM. To

disseminate information to the public, SM was one of a variety of modes used. Most of the uses of SM were for dissemination to the public rather than for gathering information.

3.2.2 Barriers to Social Media Use

Concerns that surfaced during the interviews are summarized in Table 2, with examples of supporting quotes.

Table 2: Concerns expressed by Emergency Managers During Interviews.

Type of Barrier	Illustrative Quotes
Lack of time and personnel	"We do not have a social media person." "We're really a small team." "It has to happen, the information is there… if you know what you want to look for, and you have somebody do the analytical piece and keep the personal information out, you can get a lot of good stuff."
Lack of formal policies	"We started with our social media page very early on and…the county just actually released a social media policy beyond that. So, it is a little bit retroactive for our use of social media… I think we've seen some of the social media trends and we are trying to inject them into our preparedness and mitigation strategies."
Policies-Prohibition	"It prohibits access, period. If I put up on Internet Explorer that I want to look at a certain site like Facebook it automatically comes up, 'You are not allowed.' It's because you cannot, our computers are blocked from using it." "I think the problem is the state government moves really slow and, I guess, just do not want employees to be on Facebook all day." "We would need to have government access and they would actually need to approve it and then allow people to have that set up so we would be able to access it."
Lack of training/ familiarity with social media	"Probably a bunch of old people like me who are not used to that environment. Probably that will change and it will be the wave of the future."
Trustworthiness of data	"It is no different than using the telephone or texting – it tends to be inaccurate. There is no way to control. We can just do damage control. They cannot take the time to correct or validate incoming data through social media." "I wouldn't say we use social media as far as making other key decisions… We are going to look more to our credible sources we have relationships with…"
Information overload	"I almost feel it would be burdensome to be getting this bombardment of information in real time."

The two most frequently described barriers were lack of personnel/time to work on use of SM (13 mentions), and lack of policies and guidelines for its use (11 mentions). Even when use of SM has been tried or piloted and the advantages are recognized, the lack of personnel and time can be a problem, especially if there are no volunteers or specialized software to gather and filter and organize potentially relevant posts. Formal policies and procedures related to the use of SM emerged as a very much evolving phenomenon. However, there were also mentions of official agency prohibitions on SM use and of barriers related to lack of appropriate technology, lack of training, and trustworthiness.

In sum, the themes stressed in the interviews are similar to those identified in the literature, but enabled us to gain a deeper understanding of the issues about SM of concern to US government EMs. Thus we proceeded to use the issues uncovered to conduct a large scale survey.

4 Study 2: A Survey of US County-Level Disaster Managers' Use of, and Attitudes Towards, Social Media

Practitioners need to know what shared problems they face in terms of both organizational practices and technological issues, so that they can work across agencies to remedy problems. Rather than guessing what innovations might be useful, systems designers need to know what barriers to SM use actually are most important and what types of solutions are most attractive to practitioners, so that they can focus their efforts on technological improvements that are most likely to be adopted.

Our literature review and interviews suggested that policy issues are important barriers to use, and thus these were given a prominent place in the questionnaire. Bureaucracies operate by rules and written standard operating procedures (SOPs). Therefore, they tend to be slow to adopt new technologies that would change these procedures, or to use a new technology for which there are no procedures or guidelines provided.

The overarching goal of Study 2 is to identify the main barriers to use so that technologists and policy makers will be able to address the issues and make it possible for government agencies to fully exploit the potential of SM. The main research questions are:

RQ1: What are the current patterns of use of SM, and perceptions of usefulness, by US county-level emergency managers?

RQ2: Do policies currently exist to guide the use of SM?
RQ3: What problems or barriers do these managers perceive in terms of using SM, both for disseminating (sending out/pushing) information and for collecting (pulling) information that could be used for real-time disaster management?
RQ4: Do the barriers to SM use vary by population size or urban vs. rural nature of the county served by the agency?
RQ5: Do the barriers to SM use vary with the nature of agency policies?

4.1 Method

4.1.1 Survey Development and Measures

We developed a survey (see Appendix B for the items) based upon the research questions, literature review, and results of analysis of the semi-structured interviews. It was approved by an IRB, and distributed using the online survey application SurveyMonkey®. Single items were used to measure each barrier or type of use because EMs are busy, and having multi-item scales (more questions) increases the likelihood that the survey would not be completed. While multiple items (e.g. barrier of training, barrier of trust) may address the same higher order construct (e.g. barriers to use), the higher order constructs are formative, not reflective. That is, the items are dimensions of the construct. It is inappropriate to use factor analysis on formative constructs. The full wording for items is shown in the tables of results that follow and the full survey is available on request from the first author.

4.1.2 Participants-Sampling Frame and Response Rates

We used the US Census Bureau web site (www.census.gov) to develop a list of the 3000+ county level EMA agencies in the United States. We attempted to secure email addresses for their directors or coordinators, using State EMA websites, county websites, and general Google searches. Counties were used as the unit of analysis because they are primary implementers of EM programs in the US, and when Federal declarations are made for disaster assistance it is at the county level. Also, because disasters tend to be multijurisdictional, counties often facilitate coordination between municipalities.

Email addresses were found for agencies and/or agency directors for 2980 of the counties identified. Invitations were sent out to the EMA directors or coordinators, with a link to the survey, in four "batches," between April and September 2014. For the first three batches (686 emails), a reminder email with the link was also sent out after 3 weeks. The last and largest batch, which was to the directors of agencies

serving small counties only, received one email. There were 250 responses, but nine had only one or two answers, leaving 241 useable responses. Overall, the response rate was 8% of all counties, but was higher for the larger counties (23% of large counties emailed). It should be noted that not all email addresses found in the search were valid so some emails sent did not reach the intended recipients. The survey was closed a month after the last batch of emails were sent. The particularly low (6%) response rate for the smallest counties is understandable because for many of these there is not a full time emergency manager. Rather, these managers also have other full time positions such as sheriff or firefighter; they have very little time to spend on their EM work. Although the response rate for the smallest counties was low, we do have over 100 responses for this category, so they are well represented.

4.1.3 Methodology for Analysis

Tests of normality (Kolmogorov-Smirnov) were made to ascertain which variables were normally distributed so that a decision could be made about whether to use parametric or nonparametric tests. Because only two of the variables were normally distributed, non-parametric statistical tests were performed, using the.05 level of significance. Means, medians, standard deviations, and skewness were then calculated for all of the variables. Frequencies of the nominal and ordinal level variables were also obtained.

To test research questions 4 and 5, Kruskal-Wallis tests were performed to see if variables significantly differed by categorical variables of interest.

4.2 Findings

4.2.1 Characteristics of the Respondents

The respondents are well educated and experienced. At least a bachelor's degree was earned by 52.7% of respondents. Only 7.4% have worked for their current EM agency for less than a year. A quarter of the respondents have been working for their agency for 6–10 years and 35.6% have been working there for over 10 years.

4.2.2 Characteristics of Respondents' Agencies

Most of the respondents work for county agencies that serve relatively small (in terms of population) and/or rural areas. Over half of the respondents (53.3%) indicated that their agency serves a jurisdiction with a population of fewer than

50,000 people; 11.3% of the respondents' agencies serve populations of 50,000–99,999 people; 24.6% serve populations of 100,000–499,999; 6.7% serve populations of 500,000–1 million; 3.8% serve populations of over a million. Over 59% of the agencies serve counties that are mostly rural, 7.9% serve counties that are mostly urban, and the remaining 32.9% serve counties that are about an equal mix of rural and urban. A majority (83.3%) of the respondents work in agencies with a small staff of from one to nine persons (paid and volunteer).

About half (52%) of the respondents reported that members of their agency staff use SM for job-related activities, even if not officially sanctioned.

Although most of these agencies (77%) have been using SM from 1 to 5 years, few have formal policies and procedures for disseminating (26%) or gathering (16%) information. However, many do have informal policies and/or procedures for sending (22%) or gathering (40%) information. The remainder of the respondents indicated that their agency has no formal or informal SM policies. Of those that have a policy, 25% have policies preventing SM use.

4.2.3 Social Media Overall Use and Perceived Usefulness (RQ1)

Table 3 displays the highest (over 4.5) means of the uses of SM reported by the survey respondents who used SM in any way. The scale is from 1 to 8 (1=not used; 2=not often; 8=very often). Agencies use SM primarily for public alerting or reassurance, public relations, monitoring special events, increasing situational awareness, providing specific information to the public, countering rumors, sharing information with other organizations, and sharing information on behalf of partners. These uses fall into two categories: dissemination of information and passive monitoring of information. That is, the primary current use of SM is for dissemination of information. When data is collected, it is not seen as trustworthy enough to use directly, but rather is seen as worthwhile as a first step (monitoring, situational awareness) in gathering the data needed for action.

Table 3: Means for Leading Uses of Social Media (n=108–110).

Use	Mean	SD	Skewness
Provide specific information to the public	6.0	2.2	−1.12
Risk communication (public alerting or reassurance)	5.8	2.3	−0.81
Public relations	5.8	2.2	−0.90
Counter rumors/misinformation	5.0	2.5	−0.32
Increase situational awareness	5.0	2.4	−0.39
Sharing information with other organizations	4.9	2.5	−0.25
Sharing information/press releases with/on behalf of partners	4.8	2.6	−0.15

Usefulness of Social Media In a related set of questions, the average of the assessment of the usefulness of SM was high (5.4 on a 7-point scale). The average rating of whether the agency was accomplishing its SM goals was notably lower.

Are social media goals being attained? The average response to the question of whether the agency SM goals are being met effectively was a moderately high 4.4 on a scale from 1 (not at all) to 7 (to a great extent). However, when reviewing this result, one must take into account that SM is not, in general, used by these agencies to collect information. That is, the limited goals may be met but the potential of SM may not be realized.

4.2.4 Types of Social Media Policy (RQ2)

Twenty-one percent of respondents indicated that their agency has no SM policy or procedures for collecting data, 19% reported that the agency has informal policies and/or procedures for collecting data, and only 8% reported that their agency has formal policies and procedures for collecting data. The reported frequency for having policies and/or procedures for disseminating information was higher (22% informal, 12% formal, 14% no formal or informal policy or procedures). Note that the percentages do not add up to 100 because some respondents failed to answer the question. As the agencies use SM more for disseminating information than for collecting it, this is not surprising. The several comments made in response to open-ended survey questions about lack of policies reflected the themes that had been raised in the semi-structured interviews, e.g.:

> "If we wanted to get Twitter accounts for our own division, it's mostly making sure that you have processes in place, you are representing the organization, to make sure it is accurate, timely, relevant, that it's not just anybody's personal opinion being put out there."

> "Yes, definitely, we also are talking about records retention too and, you know, anytime the government wants to do anything, you have to kind of go through committee after committee to get approval and that takes a while."

4.2.5 Barriers to using Social Media (RQ3)

Respondents were asked, in two different questions, "Please indicate the extent to which each of the following are barriers to SM use for sending out/collecting information for your agency." The items were scaled from 1 for not a barrier to 7 for a large barrier. An option for "Don't know" was also provided. However, the responses of "Don't know" were excluded from the analyses.

Figure 1 shows the means for the variables that represented potential barriers to using SM with a mean of 3 or over. For both sending out and collecting information, lack of sufficient staff is the most important barrier. This is not surprising since EMs are often stretched to the limit performing their usual duties – not including the use of SM. However, lack of guidance/policy documents (the "red tape") is the second highest rated barrier to dissemination via SM. Lack of skills and of the training that could improve these skills are also important. For pulling data, trustworthiness and information overload issues are the second and third most important barriers. What is surprising is that other potential barriers are not seen as significant to the survey respondents. The following potential barriers were rated on the average under 3.0 for both disseminating and collecting information, and thus are not shown in the results displays: legal or privacy issues, lack of software, lack of hardware, and compatibility with the agency's information system.

These results, along with the results of examining RQ1, suggest that the usefulness of SM is accepted but that technological advances and organizational changes need to be made to both make it easier to use (so that the staff is not overwhelmed) and provide some sort of vetting and filtering of public data to increase trustworthiness, as well as improvements to staff and advances in clear agency policies to guide SM use.

4.2.6 Differences by Agency Characteristics (RQ4)

The characteristics of the agencies for which the respondents work varied by size of the county and whether it was urban or rural. In terms of differences by county size, significant differences were found only for two of the barriers

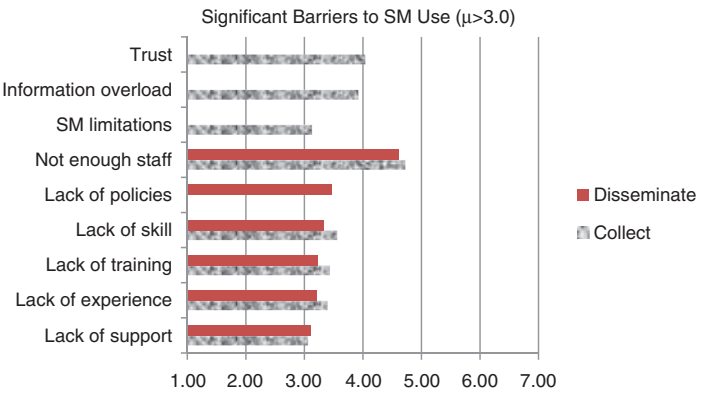

Figure 1: Means of Important Barriers to Use of SM.

Table 4: Results of Kruskal-Wallis Tests for Barriers by County Size.

Size	*n*	Mean Rank	
		DissemHW	DissemSW
Below 50,000	119	122.22	122.76
50,000–99,999	25	101.16	101.06
100,000–499,000	55	96.06	95.78
50,000–1 million	15	118.93	117.43
More than 1 million	9	92.78	90.11

to disseminate information: lack of hardware (χ^2=11.083, p=0.026) and lack of software (χ^2=11.515, p=0.021). The Mean Ranks are slightly higher for these two items for the smallest counties (as shown in Table 4) indicating that respondents from the smallest counties believe that the lack of hardware and software is more of a barrier to use than do respondents from the larger counties. It is likely that the agencies serving the counties with small populations do not have the funds to invest in SM infrastructure or staff.

Significant differences by county population were not found for any other barriers to using SM, for perceptions of the usefulness of SM, for the level that the agency was meeting its SM goals, or for how SM is currently used by the agency. This is important since our sample over-represented areas with large populations; if there were many differences by county size, our overall results would not be valid without weighting for different response rates.

In terms of differences by urban vs. rural nature of counties, only three variables showed a significant difference: the use of SM to counter rumors (χ^2=6.142, p=0.046), the use of SM to engage with mainstream media (χ^2=10.366, p=0.006), and the level at which the SM goals of the agency are being achieved (χ^2=6.982, p=0.030) as shown in Table 5. Mostly rural and mixed rural and urban counties use SM significantly more frequently to dispel rumors than do agencies servicing mostly urban areas. Mostly urban counties believe that their agencies have achieved agency SM goals to a lesser degree than those respondents in either mostly rural or mixed counties.

Table 5: Results of Kruskal-Wallis Tests for Barriers by County Type.

Type	*n*	UseRumor	UseEngage	*n*	Goalaccomp
Mostly rural	70	58.59	49.35	64	55.05
Mostly urban	8	29.44	48.94	8	26.25
About equal mix of urban/suburban and rural	32	55.25	70.59	30	50.67

None of the characteristics of the agencies (population served or the size of the staff) significantly modified the intention to use SM in EM. However, while there was no difference in intention to use SM in EM by the age of the respondents, not surprisingly, when the respondents were divided into two groups based upon their stated frequency of use of SM, those managers who use SM more have a significantly higher intention to use SM for work than those who use SM less ($r=0.54$, $p<0.001$).

In sum, the results for examining RQ4 indicate that there are few differences in SM use or perceived barriers associated with county characteristics of population size or urban vs. rural composition.

4.2.7 Differences related to Agency Policies (RQ5)

There were no significant differences for the perception of the adequacy of agency policies during crisis or daily use based upon whether the agency has formal, informal, or no policies regarding SM use. However, there was difference for the level to which the agency was achieving its goals ($\chi^2=9.87$, $p=0.007$) such that the respondents from agencies with formal or informal policies and procedures reported a higher degree of goal attainment than did those from agencies that did not have any policies or procedures.

Tests were also performed to assess whether having a policy/procedure for using SM to collect information results in differences in responses of respondents from agencies with such policies and those from agencies without them. There were significant differences for the perception of adequacy of policies to gather information during a crisis ($\chi^2=7.11$, $p=0.029$) and for the level of SM goal attainment ($\chi^2=10.92$, $p=0.004$). Policies for collecting information in a crisis are perceived as significantly more adequate when the policies were formal than when they are informal, and significantly better when informal than when nonexistent. Goals for SM use are significantly more highly rated as being reached when there are policies and procedures (formal or informal) for disseminating information than where there are no policies or procedures. The only barriers to collecting data that differ by policy type are the lack of sufficient number of staff ($\chi^2=7.08$, $p=0.029$) and the potential for information overload ($\chi^2=6.68$, $p=0.035$) such that the both are bigger barriers when there are no or only informal policies for the collection of data than when there are formal policies.

Thus, the result of examining RQ5 is that in most cases whether or not there are policies does not affect the variables being examined, but when there are significant differences, having some policy is better than none, and having formal policies tends to be better than having informal policies.

5 Discussion, Contributions, and Conclusions and Future Research

Social media are often adapted and used for purposes for which they were not designed. This is the first study to provide both depth and breadth in examining SM use in disasters at the key county level of EM. As technology advances are made in SM and tools to support the use of SM, technologists and users want the best fit for effective use of SM. This study contributes to that effort by uncovering the major barriers to use of SM by government EM agencies in the US. It is the first study of its kind, using a large sample of US county-level EMs. This research is an important contribution to the field by elucidating the EMs' perceptions about the viability and usefulness of SM. By quantifying some of these issues, we now have an effective resource for communicating how important certain issues are to emergency responders – for instance, that yes, perceived trustworthiness of information on SM is a major barrier to collecting information.

Mergel and Bretschneider's framework (2013) is useful to identify where, in the continuum of maturity of adoption, SM use by government agencies fall. Our findings from both the interviews and survey suggest that the use of SM for pushing data to the public is more likely to be at the highest level, Stage 3, than is the use for pulling data, (which appear to be at Stage 2) because of barriers such as lack of trust in pulled data and limited policies and procedures for using SM to pull data. Mergel and Bretchneider (2013) note that "Some authors have argued that the effects of new technology are typically mitigated by preexisting rules and regulations and therefore do not necessarily lead to wholesale change (p. 390)." Our research supports that by our finding that a significant barrier to the use of SM is the lack of policies and procedures to permit it. The need is clearly there to assure the policy makers and the EMs that the data pulled is both manageable and trustworthy in order for use of it to be institutionalized, resources allocated for its use, and policies and procedures to be developed, thus moving SM use in EMAs for both dissemination and collection of information to Stage 3 of Mergel and Bretschneider's framework.

We find that while most county level EMs accept the inevitability of SM use and see it as useful, the agencies and their representatives are not ready to embrace SM and use it to its fullest potential, thus impeding effective use. For the most part, current SM use is for dissemination of information, not the collection of it. The results suggest that in addition to technological advances, policy and management changes are needed as well, to remove the "red tape" (lack of guidelines or even prohibitions against use) that impedes the effective use of SM for gathering data. A large barrier to SM use in general is the lack of staff in

the agencies. EM professionals are stretched thin and this is exacerbated during times of crisis – precisely when SM has a potential to be most beneficial. A related barrier to using SM is the threat of information overload. While filtering and other technologies now being explored may be quite helpful to mitigate this barrier, having too few staff will keep it as an issue despite technological advances.

For collection of data, the trustworthiness of the data is a major concern. While this is a concern for all means of collecting data from the public, it is a barrier that does prevent the use of SM for information collection at this time. This may be because SM use is a relatively new phenomenon and/or because of the much larger quantity of data that can be collected via SM. According to Tapia and Moore (2014), "trust in people trumps trust in information." This echoes what is found in this study. Our results encourage the development of systems that clearly require and show networks and affiliations to emergency responders scanning and employing SM in their practice.

Especially in light of the agency staffing issues, the results of these studies suggest that technologists should focus a large effort on finding ways to automatically vet data collected and reduce information overload. Studies and systems development are underway in this area (e.g. Imran et al. 2014) and should, eventually, provide some relief in this area as they become available for operational use. Other barriers are felt to be important as well, but if appropriate technological and policy advances are made, many of those barriers will reduce in strength. Although some differences were found by county characteristics in terms of barriers and use, they were few in number. Thus, the issues are fairly pervasive.

A limitation of this study is that for the survey, our subjects were limited to county-level managers in the US. Note that although our sample over-represented large counties, we had a large number of responses from the smallest counties, and our analyses show that there are practically no significant differences in perceptions of barriers and reports of use, by county size. Thus, the overall results can be considered representative of the population of counties. In the future it would be useful to compare these results to those for other countries and other levels of government, as well as to NGOs.

The field of EM already makes decisions based on incomplete data, often from second-hand sources. The inherently complex and uncertain nature of any disaster limits responders' ability to both gather and assess the quality of information from traditional sources. Social media data can serve as an additional source of information. We find that EMs lack practical guidance as to how to judge SM, evaluate it, categorize it and make it useful. Because of a lack of understanding and the widespread perceptions that using systems like Facebook at work encourages "loafing," (Andreassen et al. 2014), response organizations offer blanket rejections of SM.

One implication of our findings is the need to open up channels of communication among EMs, software developers and communities of practice, where new techniques and devices are being tried to solve some of the issues identified. Although many research systems to deal with information overload or trustworthiness have been demonstrated, it is time for large scale field studies of their use in actual EM. Such studies need to employ "action research" which requires the presence of the researchers in the field settings, and their recognition of and work with practitioners to develop appropriate regulations and policies for the use of SM in their agencies. The results also suggest that it is not only a matter of better technological tools, but also of needed changes in organizational policies and procedures. Our results provide a foundation for further research on the technologies that EMs want, need, and will use, and for EM agencies to update their policies concerning the use of SM in EM. We posit that as SM technologies improve and alleviate concerns of EM professionals, policy makers will be more amenable to modify policies to promote effective SM use.

In conclusion, these studies have explicated what barriers to full SM use are most significant (for collecting as well as disseminating information) by county level EM agencies in the US. They have, through the literature review and interviews and survey, confirmed the importance of mitigating these barriers. Finally, we have provided, based on the study, recommendations for how to do that.

Through future research we believe that we can help develop best practices for use of SM, create a synergy between technologists and EMs that will make SM use and development more effective, and provide for convincing proof of concept evidence for administrators to be willing and enthusiastic about changing policies and procedures that currently limit the use of SM in crises.

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Portions of this paper were adapted, updated and expanded from three conference papers that reported initial results of the project (Hiltz and Plotnick 2013; Hiltz et al. 2014; Plotnick et al. 2015).

Appendix A: Excerpts from the Interview Guide

We (are conducting a study of how government agencies involved in emergency management currently use social media and other sources of information, and how their use of social media might change in the future. We are focusing on large-scale events, from both natural and man-made causes, that are usually

referred to as "disasters" or "Crises," – ones that are too big to be handled solely by local first responders.…

A. (Background info about respondent and organization)

B. Decisions and Information Sources

Please think of a specific type of sudden onset disaster with which you have recent experience, such as a tornado or hurricane, and let's review your information needs and sources currently: We would like to address, specifically, the warning/preparedness phase and/or the response phase. That is, at this time, we are not including the planning and mitigation phases of the disaster.

1. Which disaster have you chosen and when did it occur?
   What was the major source of the information required for this decision to be made?
   How fast was information from (this source) delivered?
   Did you have a procedure in place to assess the quality and accuracy of the information?
   If so, how was quality and accuracy determined?
   What information was missing from this source, that you needed?
2. What other major sources of information did you use for this incident?…
   Did your organization's use of social media change following this disaster? If so, how?
3. Now please think about the whole set of actions and decisions that you typically make in all stages of disaster management.. I'm going to start asking some questions about your organization's use of social media, currently and then how your organization might use it in the future.

Is social media data (e.g. from Twitter or Facebook or similar systems) already influencing the key decisions?

   a. Formally through policies and procedures for information gathering and channels?
   b. Informally through use by individuals who then share what they find?

C. Current use of social media

1. Does your organization formally or informally make use of Twitter, or any Twitter-like services, or Facebook or similar systems, to disseminate data? If so, please explain.
2. Does your organization formally or informally make use of Twitter, or any Twitter-like services, or Facebook or similar services, to gather data/learn about emergency situations? If so, please explain.

3. What are the main barriers to your organization's current use of Twitter services and data?

D. Future

1. What about your organization, its policies and its practices will have to change in order for social media data to become more useful to decision-making?
2. What about the social media data itself will have to change in order for it to become more useful to decision-making?...
3. Do you have any other observations or thoughts about the future use of social media by your organization to manage disasters?
4. Is there anything else you would like to tell us about your organization's use and/or perceptions of use of Social Media?

Appendix B: Survey Items

Item	Scale
State	Drop down menu
The county my agency serves has a population of approximately___ residents	Below 50,000; 50,00–99,999; 100,000–499,999; 500,000–1 million; more than 1 million, do not know
My agency is	Stand alone, nested in another agency, do not know, other
Is your county government consolidated with a city?	Yes/no/do not know
I would characterize the county my agency serves as	Mostly rural, mostly urban, about equal mix
On average, the number of paid and volunteer staff in my EM agency is	1–9; 10–30; 31–50; 51–100; over 100; do not know
During 2013 and/or 2014 has your agency responded to a major diaster?	Yes/no
(Optional) Please name the disaster and briefly describe if there were any major issues or successes with the use of social media	Text box
Please indicate the extent to which each of the following are barriers to social media use for sending out information from your agency	
Lack of hardware	1:not a barrier to 7:a large barrier + 8:do not know
Lack of software	
Legal or privacy issues	
Lack of staff (quantity)	

Appendix B (continued)

Item	Scale
Lack of staff (skills)	
Lack of experience with social media	
Lack of training opportunities	
Lack of support from senior management	
Lack of guidance/policy documents	
Lack of compatibility with my agency's information systems	
Social media limitations	
Other (please specify)	
Please indicate the extent to which each of the following are barriers to social media use for collecting information for your agency	
Lack of hardware	1:not a barrier to 7:a large barrier + 8:do not know
Lack of software	
Legal or privacy issues	
Lack of staff (quantity)	
Lack of staff (skills)	
Lack of experience with social media	
Lack of training	
Lack of support from senior management	
Lack of compatibility with my agency's information systems	
Trustworthiness of public generated content	
Social media limitations	
Information overload	
Other (please specify)	
In my personal use and/or professional life, I have ___ used social media	1:never to 7:frequently
In general, I find social media ___ to use	1:very easy to 7:very challenging
Interacting with social media platforms requires ___ of my mental effort	1:very little to 7: a great deal
Assuming that I have, or could have, access to social media and permission to use it in my job, I ___ intend to use it	1:definitely do not to 7: definitely do
(Optional) Please describe a positive experience you have had using social media	
(Optional) Please describe a negative experience you have had using social media	
Does staff in your agency use social media for job related activities even if it is not officially sanctioned?	Yes/no/do not know
With regard to the sending out of information using social media, which answer best fits your agency's policies and procedures that allow use of social media?	No formal or informal, informal, formal

Appendix B (continued)

Item	Scale
With regard to the gathering of information using social media, which answer best fits your agency's policies and procedures that allow use of social media?	No formal or informal, informal, formal
(Optional) Please comment on your agency's policies and procedures regarding use of social media	
Do any of your agency's policies prevent the use of social media?	Yes/no
If you answered above that your agency has formal policies and/or procedures ….please check "yes"…. (used for logic)	Yes/no
Please check all areas addressed by your social media policies and/or procedures	
Access for sending out information from your agency	
Appropriate use of social media	
Content sent out by your agency	
Security	
Legal issues	
Training of agency employees regarding use of social media	
Establish citizen conduct guidelines for their use of your social media platforms	
Guidelines for enabling collaboration between ad hoc or nonstandard technology partners and government entities	
Guidelines for using nonstandard resources and/or solutions in the case of an emergency	
From whom data can be gathered	
Designated central agency contact(s) for social media oversight and permission to use	
Centralized record of access passwords	
Administrator access to add or remove registered users	
Other (please specify)	
I think that our social media policies are ___ for our every day needs	1:very inadequate to 7:very adequate
I think that our social media policies are ___ for our needs during a disaster	1:very inadequate to 7:very adequate
My agency has a person or group dedicated to the management and use of social media	Yes/no
Our agency policies prescribe/allow for using social media to gather information from (select all that apply)	
The public	
Other government agencies	

Appendix B (continued)

Item	Scale
NGOs with whom we have an established relationship	
NGOs with whom we do not have an established relationship	
Citizens with whom we have a prior relationship	
Citizens with whom we do not have a prior relationship	
Other (please specify)	
Does your agency have a process for assessing the quality of information gathered via social media in the case of a disaster?	Yes/no/not applicable
Our proces is ____	Automated, manual, both automated and manual, do not know
Do you have access to technology support and information regarding social media?	Yes/no
What goals are you trying to accomplish using social media? Please choose all that apply	
Representing the agency on social media	
Informing before, during, and after emergency situations	
Individualized citizen/customer service during emergency situations	
Creating poublic awareness between events for protection, preparation, etc	
Increasing trust in responsiveness of government	
Listening to community and intervene when necessary	
Increasing interactions with the public	
Increasing our agency's transparency and accountability	
Enabling internal collaboration	
Increasing our efficiency and effectiveness	
Other (please specify)	
To what degree do you feel you are accomplishing your social media goals effectively?	1:not at all to 7:to a great extent; 8:we do not have social media goals;9:do not know
Please indicate if/how your agency is currently using the following social media platforms (select all that apply) for each: not using; to gather information; to send out information; do not know	
Twitter	
Facebook	
Linkedin	
Google+	
YouTube	
Flickr	

Appendix B (continued)

Item	Scale
Instagram	
Pintarest	
Nixle	
Blog (any)	
Other	Other (please specify)
My agency has been using some form of social media for	Less than 1 year; 1–2 years; 3–5 years; more than 5 years; do not know
Social media platforms are ___ useful for my agency	1:not at all to 7:very
Social media are used by my agency for the following activities (1:not used; 2:not often to 8:very often; 9:do not know)	
Risk communication	
Requesting incident information from the public	
Public relations	
Intelligence gathering	
Engage with mainstream media	
Monitoring specific events	
Update incident commander/operations	
Increase situational awareness	
Identify people directly affected by an incident	
Identify potential eyewitnesses	
Provide specific information to the public	
Counter rumors/misinformation	
Sharing information with other organizations	
Sharing information/press releases with/on behalf of partners	
Other (please specify)	
My highest completed educational degree is	High school, associates, bachelors, graduate
Other (please specify)	
I have Certified Emergency Manager (CEM) certification	Yes/no
I have been working, in some capacity, for my current EM agency for	Less than 1 year, 1–2 years, 3–5 years, 6–10 years, more than 10 years
My age is	Under 30, 30–49, 50 or older, decline to answer
(Optional) Please tell us one thing about your organization, your organization's policies or technology that you think would be most important to change to make social media useful for gathering data from the public during an emergency	

Appendix B (continued)

Item	Scale
(Optional) Please enter any other feedback you would like to give us regarding either this survey or the research project	
(Optional) – email for follow-up studies and/or publications	
(Optional) would you like to receive a copy of any publications that result from this study?	Yes/no

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