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DIGITAL VOLUNTEERS IN EMERGENCY MANAGEMENT

by

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June 2019

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The meteoric rise of social media applications has fundamentally altered the way citizens share information, but after more than a decade, public safety agencies continue to grapple with how to integrate them into operations. Building on prior research on digital volunteers in humanitarian response, this thesis examined whether the social media model had the potential to enrich sensemaking in emergency operations centers. Interviews were conducted with senior public safety leaders to illuminate the potential advantages and impediments to this strategy, as well as their current integration of social media information. There was universal agreement that social media offers unique insight not replicated by other means. However, the clearest use case was to assist with public messaging in a crisis event. The responders were concerned about the veracity of social media posts, expressed most clearly by law enforcement interviewees. Additionally, there were concerns about how social media information could be broadly shared across agencies to ensure a shared situational awareness. Recommendations include creating a liaison position in the emergency operations center to serve as a social media coordination point, standardizing situational awareness data standards, and leveraging new patterns of volunteer information sharing.

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DIGITAL VOLUNTEERS IN EMERGENCY MANAGEMENT

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ABSTRACT

The meteoric rise of social media applications has fundamentally altered the way citizens share information, but after more than a decade, public safety agencies continue to grapple with how to integrate them into operations. Building on prior research on digital volunteers in humanitarian response, this thesis examined whether the social media model had the potential to enrich sensemaking in emergency operations centers. Interviews were conducted with senior public safety leaders to illuminate the potential advantages and impediments to this strategy, as well as their current integration of social media information. There was universal agreement that social media offers unique insight not replicated by other means. However, the clearest use case was to assist with public messaging in a crisis event. The responders were concerned about the veracity of social media posts, expressed most clearly by law enforcement interviewees. Additionally, there were concerns about how social media information could be broadly shared across agencies to ensure a shared situational awareness. Recommendations include creating a liaison position in the emergency operations center to serve as a social media coordination point, standardizing situational awareness data standards, and leveraging new patterns of volunteer information sharing.

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LIST OF ACRONYMS AND ABBREVIATIONS

AAR	after action review
CERT	community emergency response team
DHS S&T	Department of Homeland Security, Science and Technology Division
DHS	Department of Homeland Security
EOC	emergency operations center
FEMA	Federal Emergency Management Agency
GIS	geographic information systems
JIC	joint information center
NIMS	National Incident Management System
SOP	standard operating procedure
VOST	virtual operations support team
VSMWG	Virtual Social Media Working Group (DHS)

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EXECUTIVE SUMMARY

We live in an era when the span and reach of online social networks eclipse the footprint of our relationships in the physical world, and an increasing number of people now view their own lived experience through the digitally enhanced lens of their smartphone camera. The vast webs of relationships that emerge across social media platforms provide new opportunities to increase awareness of the world; and the sheer breadth, scope, and depth of information exchanged via these channels is playing an ever-increasing role in shaping how the public perceives disasters.[1]

One means to address this torrent of information is to review a strategy already in use in the international humanitarian field: the integration of digital volunteers. Digital volunteers are self-organized collectives of individuals connected by the internet and social media who attempt to organize and process information during catastrophic scenarios.[2] In addition to reports from disasters across the globe, prior research into these technologically mediated collaboration efforts suggests that digital volunteers have the potential to dramatically increase information on the dynamics of a crisis.[3]

This thesis focused on whether the digital volunteers model provides emergency operations centers with the potential to aggregate and synthesize the unstructured information in social media platforms to increase situational awareness and serve as an adjunct to official information streams. Interviews were conducted with six senior leaders of large public safety agencies to better understand how social media has been utilized and what potential digital volunteers might bring to their efforts. The structured interviews consisted of eighteen questions drawing on respondents' experience with social media, the

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[1] Peter Hirsch and Rachel Caggiano, "Community Relations: Social Media in Crisis Response: 4 Trends, 5 Opportunities, and a Framework," *Natural Gas & Electricity* 30, no. 10 (2014), 14–19.

[2] Arifumi Utani, Teruhiro Mizumoto, and Takashi Okumura, "How Geeks Responded to a Catastrophic Disaster of a High-Tech Country: Rapid Development of Counter-Disaster Systems for the Great East Japan Earthquake of March 2011," *Proceedings of the Special Workshop on Internet and Disasters* (December 2011), https://doi.org/10.1145/2079360.2079369.

[3] David J. Coleman, Yola Georgiadou, and Jeff Labonte, "Volunteered Geographic Information: The Nature and Motivation of Produsers," *International Journal of Spatial Data Infrastructures Research* 4, no. 1 (2009): 338, https://pdfs.semanticscholar.org/fb3f/d1663330ec9f34283a9e33f93e1e5656bef6.pdf.

ways that their agencies integrated social media into their day-to-day and emergency operations, and potential impediments to more effective use.

Collectively, the interviews highlighted the potential utility of social media to enrich and amplify public safety agencies' understanding of both steady-state and crisis scenarios. There was a clear appreciation for the responsiveness and reach of several social media tools, as well as an understanding of the unique audiences available through each platform. There were several overarching themes that emerged across interviews that touched on the promise and the perils associated with integrating social media. The first was the recognition that social media provides a fundamentally different type of communication between citizens and public safety officials, one in which there is an expectation of two-way communications. The second overarching theme was the continued difficulty inherent in judging the veracity of social media posts. Several respondents reported concerns about the potential for false information that could delay or impede response operations. These concerns were most strongly expressed by interviewees who work in law enforcement, who have specific concerns that social media information could be purposely manipulated to paint an inaccurate view of a complex incident. The third theme centered on the difficulty in finding trained staff who have the technical expertise and public safety insight to properly utilize social media tools to build strong situational awareness.

The final finding was not specifically addressed through the original lines of inquiry but emerged as a clear theme as a potential implication of utilizing social media information was broadly discussed. This theme centered around how enhanced situational awareness stemming from social media highlights the fundamental differences between the hierarchical and interlocking webs of information flows within and between response agencies dealing with a disaster. In public safety agencies that work in complex and multi-jurisdictional environments, situational awareness emerges from the integration of information threads supplied by supporting entities who are each coordinating the tactical response efforts of their respective field staff. Put more simply, existing public safety entities are wholly reliant on a bottom-up flow of information, with field responders providing on-the-ground data to the incident command, who in turn compiles pertinent

information to the emergency operations center (EOC), who in turn compiles and feeds this information to a state EOC/joint field office. This traditional, hierarchical informational model is poorly equipped to adapt to the rapid pace of technological development. The integration of a vibrant community of passionate and technologically literate volunteers provides a means for bridging the gap between these legacy structures and next-generational capability in a way that is economically feasible and aligned with existing programmatic functions; and yet, after more than a decade, these capabilities have not become significant contributors to organizational sensemaking.

One potential path forward is the creation of a social media liaison position which would serves as the interface between digital volunteers and emergency response operations. The standardization of this position within the existing incident command structure would address two existing gaps that limit the greater use of social media. The first is the habitual alignment of digital volunteers with the role and function of the joint information center. The second gap that would be addressed by the creation of a liaison position is the potential disconnects that can occur when differing levels of the response structure have access to information about current conditions. It is a long-held truth that all disasters begin and end at the local level, and the creation of a social media liaison position within the incident command structure would ensure standardization of information streams to all levels of the disaster response. One additional benefit of the creation of a social media liaison position is the potential to add this capability into the resource typing format to make it available for mutual aid.

Creating an agency liaison is an important first step to better integrating the use of social media, but there are other intertwined structures that can be put into place to ensure the successful integration of digital volunteers into social media collection efforts. The first of these is the creation of standard operating procedures for the collection, synthesis, and integration of social media posts by digital volunteers. The second is the development of practical tools that allow for information to be vetted, aggregated, indexed, and integrated into existing situational awareness tools. One potential path forward that could also address many longstanding issues in data interoperability is to define standards for importing and exporting data streams across situational awareness tools.

The final, and most radical, means to integrate social media into emergency response is to fundamentally redefine the way disaster information is synthesized and promulgated. Following this path would require a fundamental reimagining of the role of digital and traditional volunteers in communities impacted by disaster events. In this conceptualization, digital volunteers would aggregate available social media information and utilize visualization tools like geospatial interfaces to provide context, but instead of sending the information to the public safety community for their exclusive use the volunteers would make the information openly available to anyone with an internet connection. There are significant impediments to the broad use of these strategies, including concerns stemming from potential liabilities that would have to be addressed. However, this approach provides a means to increase the whole-of-community response and start to build a culture of preparedness throughout the nation.

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The list of individuals to whom I owe my sincere thanks would easily fill this entire tome; I have been blessed by incredible friends, coworkers, classmates, and mentors over the last several years who have kept me going despite the frantic pace of emergency operations. Despite this, there are a few who have virtually carried me forward, and I wanted to thank them in a way befitting their sacrifice and love.

Angie—My beloved bride. I loved you when I first laid eyes on you. Thank you for standing by during the deployments and all the activations where days bled into nights and then weeks bled into months. You were strong enough for the both of us across more disasters then I can count, and you did it all while raising our two beautiful girls. Thank you from here to the silent planet.

Vivian—You are the fire that will never dim. Burn bright and fierce, little one. You are ever loved. Thank you for the elbow rubs.

Avery—You have a heart big enough to encompass this little world, and strong enough to try to bear it. I loved you when you were but a name, and my love has only grown over the years. Thank you for your smile, your hugs, and the effortless joy you bring with you like a corona.

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I. INTRODUCTION

The unprecedented string of natural disasters that swept through the United States in 2017 resulted in the single most costly disaster year on record, totaling more than $306 billion dollars in damages.[1] Against this backdrop of multiple, overlapping, billion-dollar weather disasters, first responder at local, state, and federal public safety agencies were pushed to their absolute limits. Many of the critical lessons learned are still being collected, but one ongoing struggle that was highlighted in many of these events was the need for more comprehensive situational awareness. Although several emerging technologies have been proposed to make sense of the avalanche of raw data streaming out of disaster zones, this thesis explores the use of digital volunteers as an adjunct to existing systems to better understand whether these volunteers can address long-standing gaps in information collection in crisis events.

A. PROBLEM STATEMENT

We live in an era when the span and reach of online social networks eclipse the footprint of our relationships in the physical world, and an increasing number of people now view their own lived experience through the digitally enhanced lens of their smartphone camera. The vast webs of relationships that emerge across social media platforms provide new opportunities to increase awareness of the world; and the sheer breadth, scope, and depth of information exchanged via these channels is playing an ever-increasing role in shaping how the public perceives disasters.[2] The ubiquity of social media

[1] Chris Mooney and Brady Dennis, "Extreme Hurricanes and Wildfires Make 2017 the Most Costly U.S. Disaster Year on Record," *Washington Post*, January 8, 2018, https://www.washingtonpost.com/news/energy-environment/wp/2018/01/08/hurricanes-wildfires-made-2017-the-most-costly-u-s-disaster-year-on-record.

[2] Peter Hirsch and Rachel Caggiano, "Community Relations: Social Media in Crisis Response: 4 Trends, 5 Opportunities, and a Framework," *Natural Gas & Electricity* 30, no. 10 (May 2014):14-19, https://doi.org/10.1002/gas.21760.

leads many to believe that public safety can utilize this vast storehouse of data, often resulting in outsized expectations that eclipse current capabilities.[3]

Although the value of the information contained in social media posts is widely recognized within the emergency management community, many public safety agencies face significant challenges in trying to sift through the torrent of feeds to gather actionable intelligence.[4] The need to effectively utilize social media data exists at all levels of the public safety enterprise, but one area where it has the potential to significantly increase effectiveness is within an emergency operations center (EOC).

The nation's firefighters, law enforcement officers, and emergency medical services providers respond to thousands of emergencies every day. While these events have deleterious impacts to those involved, their ebb and flow comprise routine operations for the public safety architecture. The vast majority of these routine emergencies are rapidly addressed by the responding department, but in situations that require significant and cross-disciplinary resource commitments, an incident commander is identified to coordinate the overall tactical response utilizing the Incident Command System.[5] If the situation exceeds the capabilities of the responding agencies due to its complexity, longevity, or impact, many jurisdictions will stand up an EOC in order to support the needs of the incident commander.

EOCs are tasked with executing multi-agency life safety coordination during a disaster event, including assessing resource requirements, obtaining resources, and

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[3] Laura Petersen et al., "Public Expectations of Disaster Information Provided by Critical Infrastructure Operators: Lessons Learned from Barreiro, Portugal," *4th International Conference on Information Systems for Crisis Response and Management in Mediterranean Countries* (2017): 193; Christian Reuter and Thomas Spielhofer, "Towards Social Resilience: A Quantitative and Qualitative Survey on Citizens' Perception of Social Media in Emergencies in Europe," *Technological Forecasting and Social Change* 121 (2017): 168–180, https://doi.org/10.1016/j.techfore.2016.07.038.

[4] Christian Reuter and Marc-Andre Kaufhold, "Fifteen Years of Social Media in Emergencies: A Retrospective Review and Future Directions for Crisis Informatics," *Journal of Contingencies and Crisis Management* 26, no. 1 (2017): 41, https://doi.org/10.1111/1468-5973.12196; Christian Reuter, Amanda Lee Hughes, and Marc-Andre Kaufhold, "Social Media in Crisis Management: An Evaluation and Analysis of Crisis Informatics Research," *International Journal of Human Computer Interaction* 34, no. 4 (2018), 280–294; Linda Plotnick and Starr Roxanne Hiltz, "Barriers to Use of Social Media by Emergency Managers," *Journal of Homeland Security and Emergency Management* 13, no. 2 (2016): 247–277.

[5] Gregory Bigley and Karlene Roberts, "The Incident Command System: High-Reliability Organizing for Complex and Volatile Task Environments," *Academy of Management Journal* 44, no. 6 (2001): 1283.

assigning these resources to areas where they will have the most significant impact.[6] In addition to these requirements, an EOC ensures on-scene first responders receive necessary support, coordinates the transport of casualties out of the impact area, tracks injuries and fatalities, and establishes shelters for displaced individuals.[7] The components of an EOC are designed to be modular and scalable so that, during a catastrophic incident, they can effectively integrate professional emergency managers, state agencies, fire personnel, law enforcement, utility providers, representatives of the business community, and volunteer organizations.

In order to ensure an EOC is addressing the most critical components of a disaster, it is imperative that high-fidelity information about the incident be collected, evaluated, and synthesized.[8] In the chaotic aftermath of a catastrophic scenario, the need to distill meaning out of vast swaths of inchoate data places enormous stress on the information management architecture.[9] One impediment to the rapid collection of this information stems from the physical and operational distance between the EOC and first responders in the field. In many instances, the staff of an EOC is wholly reliant on reports coming in from the responding agencies. One impediment to this occurring is the enormous operational and time pressure faced by field personnel, whose communication is frequently marked by extreme brevity. When these abbreviated communications are aggregated by staff with similar organizational experience, their common background, training, and procedures fill in many of the missing contextual cues.

When this field-level information is shared with other members of the public safety community, including EOCs at the regional and state level, subtle cues and decisions can

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[6] John R. Harrold, "Achieving Agility in Disaster Management," *International Journal of Information Systems for Crisis Response and Management* 1, no. 1 (2009): 7, https://doi.org/10.4018/jiscrm.2009 010101.

[7] Leslie D. Lutz and Michael K. Lindell, "Incident Command System as a Response Model within Emergency Operation Centers during Hurricane Rita," *Journal of Contingencies and Crisis Management* 16, no. 3 (2008): 124.

[8] Steven Curnin and Christine Owen, "Obtaining Information in Emergency Management: A Case Study from an Australian Emergency Operations Centre," *International Journal of Human Factors and Ergonomics* 2, no. 2 (2013): 138, http://doi.org: 10.1504/IJHFE.2013.057614.

[9] Ryan Burns, "Rethinking Big Data in Digital Humanitarianism: Practices, Epistemologies, and Social Relations," *GeoJournal* 80, no. 4 (2015): 477–490.

set the stage for divergent levels of situational awareness. These can stem from several causes, including time pressures, different organizational procedures, different training standards, and purposeful obfuscation. This lack of context can lead to misunderstandings. One technique for addressing many of these issues is to rely on subject matter experts with detailed operational experience and insight who have worked in the impacted jurisdictions. By thoughtfully integrating public safety experts with relevant field experience, an EOC can better assemble pertinent data into actionable information within a domain-specific arena.[10] By parceling information into several functional areas, each staffed by experienced professionals, an EOC can glean meaningful information from the reports coming in from the field. There are two significant drawbacks to this information workflow. The first is that, despite the level of experience resident in the EOC, an EOC's ability to gather actionable information is limited by the frequency and accuracy of the reports coming in from the field. The second limitation is that this organizational model predates the disaggregated form of information sharing that has become ubiquitous with the advent of social media.

Over the last decade a potential solution to these informational gaps has emerged, organized volunteer groups that partner and collaborate with humanitarian aid groups and governmental organizations to process and communicate crisis information.[11] Although these digitally enabled groups differ in composition, experience and function; two factors that unite them are the desire to help impacted communities regardless of geographic distance and a reliance on digital collaboration tools.[12] Unlike traditional volunteers who provide assistance in disaster zones by donating physical skills and labor, these digital

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[10] Laura G. Militello et al., "Information Flow during Crisis Management: Challenges to Coordination in the Emergency Operations Center," *Cognition, Technology & Work* 9, no. 1 (2007): 25, https://doi.org/10.1007/s10111-006-0059-3.

[11] Alisha Griswold, "Digital Detectives and Virtual Volunteers: Integrating Emergent Online Communities into Disaster Response Operations," *Journal of Business Continuity & Emergency Planning* 7, no. 1 (2013): 13–25.

[12] Axel Bruns et al., *#Qldfloods and @QPSMedia: Crisis Communication on Twitter in the 2011 South East Queensland Floods* (Brisbane, Australia: ARC Centre of Excellence for Creative Industries and Innovation, 2012), https://eprints.qut.edu.au/48241.

communities provide immediate aid by using their technical acumen to meet the informational challenges posed by disasters.[13]

Although digital humanitarians provide insight into the full range of capabilities that digital volunteers can bring to bear, this thesis will focus on a specific subset of their capability set; the aggregation and synthesis of the unstructured information resident in social media platforms to increase situational awareness. By focusing specifically on the use of digital volunteers to provide social media information as an adjunct to official information streams, this thesis will provide insight into the utility of integrating this capability into emergency management sensemaking.

B. RESEARCH QUESTION

The pervasiveness of social media provides opportunities for unique insight into local impacts of disasters in ways that have the potential to supplement and enrich information transmitted through official public safety channels. Can emergency management organizations utilize digital volunteers as a tool to integrate the unstructured data available through social media platforms to enhance crisis sensemaking during the response phase of disasters?

C. SIGNIFICANCE OF RESEARCH

The growing volume and depth of information available via social media has the potential to powerfully shape sensemaking in crisis situations, but efforts to integrate this unstructured data into emergency management operational workflows is still a work in progress.[14] Integrating and fusing multiple data streams has significantly increased the level of situational awareness available to first responders in disaster events, however the integration of social media streams into these efforts carries far ranging consequences for the public safety discipline. An ever-increasing segment of the population turns to social

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[13] Margaret Steen, "The Social Media Files: Virtual Operations Support Teams Help Tame the Flow of Information from Social Media," *Emergency Management* (Summer 2015): 34, https://drjdbij2merew.cloudfront.net/EM/EM_Mag_Summer15.pdf.

[14] Leysia Palen and Amanda L. Hughes, "Social Media in Disaster Communication," in *Handbook of Disaster Research. Handbooks of Sociology and Social Research*, eds. Havidan Rodríguez, William Donner, and Joseph Trainor (Cham, Switzerland: Springer International, 2018), 497.

media for insight in natural and manmade disasters, and many of the insights shared via this medium are not duplicated in official reporting channels.[15] When the information transmitted via social media is contextually richer than that available through traditional reporting, situations can arise where salient aspects of a crisis scenario are clear to the public before they are apparent to crisis decision makers.[16] In these situations, emergency response efforts are hampered and public trust in government can be eroded due to the perception that response efforts are moving too slowly or failing to address core needs.

This thesis fills a gap in the existing research by examining whether digital volunteers can aggregate and synthesize social media data during a crisis event for U.S. based public safety agencies, and whether there are organizational impediments to integrating this practice.

D. RESEARCH DESIGN

To better understand factors that may impact the integration of social media into emergency response, after action reviews (AARs) from prior emergency management and humanitarian response efforts were collected and reviewed to analyze trends, lessons learned, and existing capability gaps (see Table 1). Many of the key findings of these AARs were then used to develop a semi-structured interview to ascertain key areas of friction in social media usage and whether digital volunteer efforts offer potential solutions to these challenges.

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[15] Christian Reuter et al., "Emergency Services' Attitudes towards Social Media: A Quantitative and Qualitative Survey across Europe," *International Journal of Human–Computer Studies* 95, (2016): 96, https://doi.org/10.1016/ j.ijhcs.2016.03.005.

[16] Sophia B. Liu et al., "In Search of the Bigger Picture: The Emergent Role of on-Line Photo Sharing in Times of Disaster," *Proceedings of the Information Systems for Crisis Response and Management Conference* (2008): 140.

Table 1. After Action Reviews/Summary Reports

National Capitol Region Ice Storm AAR	2008	Winter Storm
Hurricane Irene Crisis Mapping AAR	2011	Hurricane
Looming Plume Full Scale Exercise AAR	2011	Hazmat Release
Queensland Floods	2011	Flooding
Nashville Flooding AAR	2011	Flooding
Storm Alfred AAR	2011	Winter Storm
Joplin Tornado Lessons Learned	2012	Tornado
Waldon Canyon Fire AAR	2012	Wildfire
Travis County Halloween Flood AAR	2013	Flooding
Second Avenue Building Collapse	2015	Sructure Collapse
Oklahoma Tornado Virtual Table Top AAR	2015	Tornado
Somerset Closure AAR	2016	Winter Storm
Mosier Derailment	2016	Hazmat Release/Fire
Boston Marathon Bombing	2016	Terrorist Attack

As a result of the interviews, the study was determined to contain human subjects research and a research proposal was submitted to the Naval Postgraduate School Institutional Review Board (IRB) for review. The research proposal and structured interview questions were approved and a protocol number was assigned (IRB determination number NPS20170031.0). Following IRB approval, the email addresses for senior emergency managers at the state and local level were compiled from state websites, county websites, and public safety trade associations. To better ascertain potential impediments to integrating digital volunteers, the questionnaires were targeted at the senior decision-makers (directors or assistant directors) at public safety agencies. Forty-four emails were sent out to directors of emergency management agencies across the United States utilizing an IRB-approved research script; six senior public safety leaders volunteered to participate in the interview process. The structured interview consisted of eighteen questions drawing on respondents' experience with social media, the ways that

their agencies integrate social media into their day-to-day and emergency operations, and potential impediments to more effective use. Following each interview, the discussion was transcribed, and at the conclusion of the interviews the answers to individual questions were collated and compared to identify trends across agencies. Additionally, the completed transcripts were reviewed to identify emergent themes utilizing an inductive approach.

To identify any emergent themes, the interview transcripts were analyzed at the sentence level utilizing an open-coding strategy. Each sentence was coded by providing a one- to two-word summary of the content. After each transcript was coded, similar and redundant codes were combined. Following the coding of all interview transcripts, a closed-coding procedure was conducted by comparing all the resulting codes and narrowing them down into dominant themes.

By developing a series of questions guided by the lessons learned from real and simulated disasters, this research methodology attempted to illuminate the unique information social media can provide emergency managers and whether digital volunteers can assist with integrating this information. It is important to note that these questions attempted to move past a theoretical understanding of whether digital volunteers can integrate social media data and instead focus on whether this is operationally feasible within existing public safety agencies. This distinction further highlights why only senior emergency management officials were selected for inclusion in this study, since these officials were most likely to understand the full range of policy and privacy concerns surrounding their use.

E. CHAPTER OUTLINE

This thesis is composed of four chapters that encapsulate existing work on digital volunteers and explore considerations for their use in assisting with the integration of social media in emergencies. Chapter II explores how sensemaking shapes the way emergency managers react to disasters, the role social media plays in gaining situational awareness in disasters, and prior efforts to utilize digital volunteers to assist in this process. Chapter III addresses specific challenges and advantages emergency managers brought to light during

interviews on social media and digital volunteers. Finally, Chapter IV provides a discussion of the findings, summarizes potential paths forward, and proposes recommendations.

This thesis is composed of four chapters that encapsulate existing work on digital volunteers and explores considerations for their use in assisting with the integration of social media in emergencies. Chapter II explores how sensemaking shapes the way emergency managers react to disasters, the role social media plays in gaining situational awareness in disasters, and prior efforts to utilize digital volunteers to assist in this process. Chapter III addresses specific challenges and advantages emergency managers brought to light during interviews on social media and digital volunteers. Finally, Chapter IV provides a discussion of the findings, summarizes potential paths forward, and proposes recommendations.

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II. LITERATURE REVIEW

To better reveal the ways in which traditional volunteer efforts converge with the growing use of digital enabling technologies, this thesis examined literature across a range of topics, including social media, crisis informatics, communications, and organizational theory. The highlights provided by each discipline shape this literature review and provide a multi-lens perspective on digital volunteerism. The literature review concludes with a review of disaster events where digital volunteers played a role and lessons learned from these experiences.

A. SENSEMAKING

Disasters and crisis events are fundamentally different from routine emergencies, and these differences run far deeper then comparisons of relative magnitude. Crisis situations require response organizations to rapidly address threatening circumstances in conditions of profound uncertainty and confusion.[17] In the face of these manifest uncertainties, one of the primary concerns for organizations is gaining situational awareness. In his influential work on crisis in organizations, Karl Weick grasped the difficulties inherent in responding to low-probability, high-consequence events, describing attempts to gain situational awareness as individuals collectively construct plausible meanings from available environmental cues in a way that lets them act.[18] This interactive process has been termed *sensemaking*, which Mallender defines as "the method through which ambiguous and uncertain events are interpreted for meaning and understanding through a dynamic process directed by social cues and enacted by the environment."[19] Two key components of Weick's conceptualization are that in a crisis event individual

[17] Deborah Ancona, "Sensemaking: Framing and Acting in the Unknown," in *The Handbook for Teaching Leadership: Knowing, Doing, and Being*, eds. Scott Snook, Nitin Nohria, and Rakesh Khurana (Thousand Oaks, CA: SAGE, 2012), 10.

[18] Karl E. Weick, "Enacted Sensemaking in Crisis Situations," *The Journal of Management Studies* 25, no. 4 (July 1988): 305–318, https://doi.org/10.1111/j.1467-6486.1988.tb00039.x.

[19] Jessica Mallender, "An Evaluation of Sensemaking in Crisis Contexts: An Organizational Perspective," *The iJournal: Graduate Student Journal of the Faculty of Information* 1, no. 1 (March 2016), https://theijournal.ca/index.php/ijournal/article/view/26478.

perception will differ, and that one of the critical first steps in shaping a response is for individuals to collectively contribute to a larger understanding of what is occurring. This conceptualization differs from prior attempts at describing crisis response by noting that gaining situational awareness requires internal and ongoing communication to make sense of incoming information. It also highlights that deciding what information should be processed, referred to in the literature as *framing the data*, powerfully shapes situational awareness by denoting what inputs could add to this collaborative understanding. Through this lens, public safety organizations can be viewed as agents whose attempts at gaining situational awareness shape how members collect and perceive environmental cues, which can in turn further shape how information is collected and integrated.

B. INFORMATION PROCESSING IN THE NATIONAL INCIDENT MANAGEMENT SYSTEM

It is important to note that the way public safety agencies address the challenges of sensemaking in disaster situations are powerfully shaped by an existing framework that provides structure and direction to emergency response efforts. In the United States this structure is provided by the Federal Emergency Management Agency (FEMA) National Incident Management System (NIMS). NIMS provides a flexible and standardized guide to the incident management of emergencies of any scale by articulating a predefined management structure and set of protocols. A critical component of this incident management model is the Incident Command System (ICS), a structure which Gregory Bigley and Karlene Roberts define as "a standardized, all-hazards approach that facilitates the integration of personnel, equipment, communication, and procedures in a common organizational structure."[20] This temporary, multidisciplinary framework imposes a defined chain of command and division of responsibility that is tailored to the specific needs of the incident.[21]

[20] Bigley and Roberts, "The Incident Command System."

[21] Kimberly S. Stambler and Joseph A. Barbera, "Engineering the Incident Command and Multiagency Coordination Systems," *Journal of Homeland Security and Emergency Management* 8, no. 1 (2011), https://doi.org/10.2202/1547-7355.1838.

As the magnitude of an incident increases, functional components are activated and scoped in order to provide participating agencies with a common process for planning and managing response efforts. This comprehensive system for tailoring the organization to meet the unique challenges posed by individual crisis events places a premium on ensuring new capabilities can be seamlessly integrated. Due to the importance of integration, a key metric for measuring the utility of digital volunteers will be their ability to fit into existing systems for managing information and workflow.

To ensure an EOC is addressing the most critical components of a disaster, it is imperative that high-fidelity information about the incident be collected, evaluated, and synthesized.[22] In the chaotic aftermath of a catastrophic scenario, the need to distill meaning out of vast swaths of inchoate data places enormous stress on the information management architecture.[23] The traditional information management model for disaster response involves centralization and segmentation. This method for integrating information is built on the assumption that subject matter experts with detailed organizational knowledge can best assemble pertinent data into actionable information within their domain-specific arena.[24] By parceling information into a number of functional areas working in parallel, this system is designed to ensure that the deluge of data is reviewed by experts with the understanding necessary to glean meaningful insight. Despite the advantages of these techniques, research suggests that this system has limited ability to address the challenges of big data. Big data describes data sets too large and unwieldy to curate and process using traditional computer processing software.[25] There are four aspects of big data that challenge traditional techniques for managing information: volume, velocity, veracity, and variety.[26] Volume refers to the overall size of the data set, which

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[22] Harrold, "Achieving Agility in Disaster Management."

[23] Burns, "Rethinking Big Data in Digital Humanitarianism."

[24] Militello et al., "Information Flow during Crisis Management," 27.

[25] Chris Snijders, Uwe Matzat, and Ulf-Dietrich Reips, "Big Data: Big Gaps of Knowledge in the Field of Internet Science," *International Journal of Internet Science* 7, no. 1 (2012): 1–5, https://pdfs.semanticscholar.org/da14/e586bd8095120221d388af97cfb6eef8d051.pdf.

[26] "The Four Vs of Big Data," IBM, accessed March 4, 2015, http://www.ibmbigdatahub.com/sites/default/files/infographic_file/4-Vs-of-big-data.jpg.

can range from terabytes (a thousand gigabytes) to exabytes (a billion gigabytes). Velocity refers to the speed at which information is created, which is steadily increasing with the proliferation of mobile applications. Veracity refers to whether the data is credible and reliable, and variety refers to the multitude of formats in which this information is captured. One example of big data is the dynamic inflow of information available on social media platforms, a data set that offers unique insight into the sensemaking challenges of crisis events.[27]

C. SOCIAL MEDIA

Although social media evolves as rapidly as the technology it is rooted in, Adrian Palmer and Nicole Koenig-Lewis succinctly describe social media as "online applications, platforms and media which aim to facilitate interactions, collaborations and the sharing of content."[28] Social media can be conceptually subdivided into several major categories: blogs, discussion forums, social/professional networks, social rating reviews, video/text chatting, podcasting, and wikis (see Table 2).

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[27] Richard Arias-Hernandez and Brian Fisher, "The 'Tunnel Vision' Effect: Structuring of Attention and use of Digital Technologies in Emergency Operation Centers," *2013 IEEE International Multi-Disciplinary Conference on Cognitive Methods in Situation Awareness and Decision Support* (2013): 195–98, https://doi.org/ 10.1109/CogSIMA.2013.6523847; Murray Turoff et al., "Multiple Perspectives on Planning for Emergencies: An Introduction to the Special Issue on Planning and Foresight for Emergency Preparedness and Management," *Technological Forecasting and Social Change* 80, no. 9 (2013): 1647–1656, https://doi.org/10.1016/j.techfore.2013.07.014.

[28] Adrian Palmer and Nicole Koenig-Lewis, "An Experiential, Social Network-Based Approach to Direct Marketing," *Direct Marketing: An International Journal* 3, no. 3 (2009): 162–76, https://doi.org/10.1108/17505930910985116.

Table 2. Social Media Applications[29]

Application	Description
Blogs	Interactive virtual journal
Discussion Forums	Online bulletin board to post questions with the expectation of receiving answers
Micro-blogs	Abbreviated blogs with strict space limitations
Photo/Video Podcasting	Exchange of multimedia content, video, and audio
Social Bookmarking	Platform for allowing the exchange of online bookmarks
Social Discovery Engines	Bulletin boards to post news and links which are prioritized based on votes
Social Networking	Environment for communicating with others within a network
Social Rating Reviews	Platform for rating user experiences
Video/Text Chatting	Multimedia platform for personal dialogue
Wikis	Website for user-generated content with no defined content owner

Over the last decade, social media has grown from a collaborative communication tool into an integral component of modern daily life. According to the Pew Research Center's Internet and American Life Project, close to 70 percent of all Americans use social media, and eight out of every ten online Americans are participate in social media actively (see Figure 1). The information being transmitted via these accounts is so voluminous it can best be measured in petabytes, with the micro-blogging site Twitter reporting more than 500 million tweets being posted daily.[30]

[29] Adapted from Brooke Fisher Liu, Julia Daisy Fraustino, and Yan Jin, "Social Media Use during Disasters: How Information Form and Source Influence Intended Behavioral Responses," *Communication Research* 43, no. 5 (2016): 626–646, https://doi.org/10.1177/0093650214565917.

[30] "Twitter Usage Statistics," Internet Live Stats, accessed January 25, 2015, http://www.internet livestats.com/twitter-statistics/.

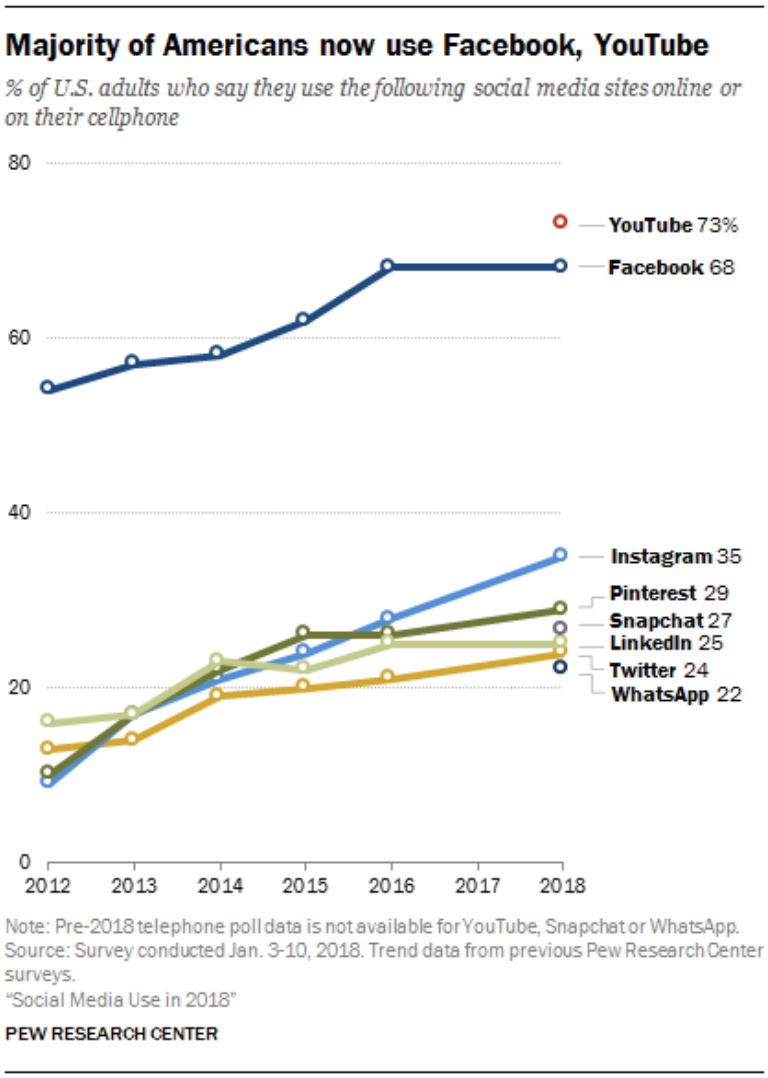

Figure 1. Social Media Use in the United States[31]

While every component of social media can be leveraged to assist with the sensemaking process, their practical utility is shaped by its capabilities and patterns of use. One of the social media platforms that can provide particular value in informing crisis response is Twitter, a site that allows users to transmit and read short, 280-character messages, referred to as tweets. One reason Twitter is of interest is because its user

[31] Source: Aaron Smith and Monica Anderson, "Social Media Use in 2018," Pew Research Center, March 1, 2018, http://www.pewinternet.org/2018/03/01/social-media-use-in-2018/. A red line for YouTube was not visible in the graphic at the time of this writing.

community increases activity in the wake of disasters and these posts occur in the public domain. An increasing body of literature has investigated how Twitter can be integrated into emergency response by providing granular insight into the scope of a disaster and coordinating citizen efforts to cope with the situation (see Table 3). These investigations include reviews of Twitter use in a series of crisis events, including catastrophic flooding, tsunamis, hurricanes, active shooters, wildfires, and earthquakes. These research efforts suggest that this medium can provide significant real-time data on the scope of a disaster, as well as contextual data that is difficult to capture by other means.[32]

Table 3. Case Studies in Social Media Use in Disaster Events

Reference	Disaster Type	Case Study
Kate Starbird and Leysia Palen. ”Pass it On?: Retweeting in Mass Emergency.”	Wildfire	Oklahoma Wildfires (2010) Red River Floods (2009)
Lise Ann St Denis, Amanda L. Hughes, and Leysia Palen. “Trial by Fire: The Deployment of Trusted Digital Volunteers in the 2011 Shadow Lake Fire.”	Wildfire	Shadow Lake Fire (2011)
Bruno Takahashi, Edson C. Tandoc Jr., and Christine Carmichael. “Communicating on Twitter during a Disaster: An Analysis of Tweets during Typhoon Haiyan in the Philippines.”	Extreme Weather	Typhoon Haiyan (2013)
Adam Acar and Yuya Muraki. “Twitter for Crisis Communication: Lessons Learned From Japan’s Tsunami Disaster.”	Tsunami	Japan Tsunami (2011)
Tomer Simon, Avishay Goldberg, and Bruria Adini. “Socializing in Emergencies—A Review of the Use of Social Media in Emergency Situations.”	Extreme Weather	Hurricane Sandy (2012)
Aditit Gupta, Hemank Lamba, Ponnurangam Kumaraguru, and Anupam Joshi. “Faking Sandy: Characterizing and Identifying Fake Images on Twitter during Hurricane Sandy.”	Extreme Weather	Hurricane Sandy (2012)
Yan Qu, Chen Huang, Pengyi Zhang, and Jun Zhang. “Microblogging after a Major Disaster in China: A Case Study of the 2010 Yushu Earthquake.”	Earthquake	Yushu Earthquake (2008)

[32] Rongjuan Chen and Yasuaki Sakamoto, “Feelings and Perspective Matter: Sharing of Crisis Information in Social Media” *Proceedings of the 47th Hawaii International Conference on System Sciences* (March 2014): 1958–1967, https://doi.org/10.1109/HICSS.2014.248.

Reference	Disaster Type	Case Study
Marcelo Mendoza, Barbara Poblete, and Carlos Castillo. "Twitter under Crisis: Can We Trust What We RT?"	Earthquake	Chile Earthquake (2010)
Kate Starbird and Leysia Palen. "Voluntweeters: Self-organizing by Digital Volunteers in Times of Crisis."	Earthquake	Haiti Earthquake (2010)
Robert Soden and Leysia Palen. "From Crowdsourced Mapping to Community Mapping: The Post-earthquake Work of OpenStreetMap Haiti."	Earthquake	Haiti Earthquake (2010)
Robert Soden, Nama Budhathoki, and Leysia Palen. "Resilience-Building and the Crisis Informatics Agenda: Lessons Learned from Open Cities Kathmandu."	Earthquake	Nepal Earthquake (2015)
Joanne White and Leysia Palen. "Expertise in the Wired Wild West."	Flood	Colorado Flood (2013)
Marc-André Kaufhold and Christian Reuter. "The Self-organization of Digital Volunteers across Social Media: The Case of the 2013 European Floods in Germany."	Flood	Germany Flooding (2013)
Pete Burnap, Matthew L. Williams, Luke Sloan, Omer Rana, William Housley, Adam Edwards, Vincent Knight, Rob Procter, and Alex Voss. "Tweeting the Terror: Modelling the Social Media Reaction to the Woolwich Terrorist Attack."	Terrorism	London Attack (2013)
Jisun An, Haewoon Kwak, Yelena Mejova, Sonia Alonso Saenz De Oger, and Braulio Gomez Fortes. "Are You Charlie or Ahmed?"	Terrorism	Charlie Hebdo Attack (2015)
Stefanie Wiegand and Stuart E. Middleton. "Veracity and Velocity of Social Media Content during Breaking News: Analysis of November 2015 Paris Shootings."	Terrorism	Paris Shootings (2015)

FEMA has been one of the federal agencies that has taken a forward-leaning approach to integrating social media technologies.[33] Since early 2009 FEMA has been monitoring social media feeds in order to better understand the full complexity of

[33] *Understanding the Power of Social Media as a Communication Tool in the Aftermath of Disasters: Testimony before the Committee on Homeland Security and Governmental Affairs*, 112th Cong. (2011) (statement of Craig Fugate, FEMA Administrator).

catastrophic events and to assist with event detection in the early phases of a crisis.[34] FEMA's early efforts included having staff at the National Response Coordination Center utilize Tweetdeck to monitor real-time feeds in disasters.[35] During the response to Hurricane Sandy, these monitoring efforts were inundated with more than 20 million tweets from the impacted area, a surprising statistic considering the damage to electrical and communications infrastructure.[36] Due to the sheer volume of social media messages, FEMA had to stand up an internal team to assist with rumor control and to amplify information being transmitted via more traditional channels. In early 2016 FEMA's Office of Response and Recovery formalized a strategy for integrating social media awareness into their efforts to maintain situational awareness.[37] As part of this initiative, FEMA tasked each of its watch centers (National Watch Center, National Response Coordination Center, ten regional watch centers, and ten regional coordination centers) with monitoring publicly available social media platforms and websites preapproved by FEMA's Office of External Affairs. This formal rollout marked a new level of standardization and integration for how social media informs situational awareness within FEMA.[38] One important facet of this operationalization is the admonition that personally identifiable information (PII) might be collected and shared with first responders in situations of extreme peril. In this situation, FEMA lays out a clear protocol for redacting PII before it is recorded in FEMA's files, after the critical information has been relayed to first responders. The operationalization of FEMA's social media monitoring highlights the importance of addressing issues related to privacy, data storage, and data sharing and suggests that, after

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[34] "Use of Social Media Tools at FEMA," FEMA, November 2, 2009, https://www.fema.gov/news-release/2009/11/02/use-social-media-tools-fema.

[35] Ed Tobias, "Using Twitter and Other Social Media Platforms to Provide Situational Awareness During an Incident," *Journal of Business Continuity & Emergency Planning* 5, no. 3 (Fall 2011): 208–223.

[36] Estes S. Cohen, "Sandy Marked a Shift for Social Media Use in Disasters," *Emergency Management*, March 7, 2013, http://www.govtech.com/em/disaster/Sandy-Social-Media-Use-in-Disasters.html.

[37] Department of Homeland Security, *Privacy Impact Assessment for the FEMA Operational Use of Publicly Available Social Media for Situational Awareness* (Washington, DC: Government Printing Office, 2016), https://www.dhs.gov/publication/dhsfemapia-041-operational-use-publicly-available-social-media-situational-awareness.

[38] Adam Mazmanian, "FEMA Tunes into Social Media for Operations," FCW, April 26, 2016, https://fcw.com/articles/2016/04/26/fema-social-ops.aspx.

long analysis, FEMA has determined the information available through social media warrants further investment.

In an area as broad as public safety, there are significant organizational differences rooted in tradition and institutional culture; despite these disparities, meaningful patterns in how social media is utilized can still be identified. One recurring arrangement identified by the Department of Homeland Security's Science and Technology Directorate's (DHS S&T) Virtual Social Media Working Group (VSMWG) was an inclination for public safety agencies to place the social media function under the public information officer or joint information center (JIC).[39] While this alignment provides several advantages from a public messaging perspective, it highlights that many agencies see social media as a tool to communicate with the public instead of to inform their own operations. In their meta-analysis of social media use in crisis events, Christian Reuter and Marc-André Kaufhold developed a matrix that categorizes use cases by focusing on the social media message originator and the intended audience for the resultant posts (see Figure 2).[40] Using this methodology, it becomes clear that having social media tightly integrated into a JIC augments government's ability to communicate to the public but may not adequately ensure the public is able to actively communicate relevant information to public safety agencies via social media. Reuter and Kaufhold's research reinforces DHS S&T's analysis by noting that the government-to-citizen communication quadrant is the most robustly integrated within the crisis management sphere.[41] One potential limitation to the strategy of limiting social media coordination to the JIC is that the EOC's overall ability to process social media information becomes wholly reliant on the JIC's ability to glean operational information in real time. Since members of the JIC are selected from trained public information officers, this may mean that even when the JIC is adequately staffed it still

[39] Virtual Social Media Working Group and DHS First Responders Group, *From Concept to Reality: Operationalizing Social Media for Preparedness, Response and Recovery* (Washington, DC: Government Printing Office, 2016), https://www.dhs.gov/sites/default/files/publications/SMWG_From-Concept-to-Reality-Operationalizing-Social-Media-508.pdf.

[40] Reuter and Kaufhold, "Fifteen Years of Social Media in Emergencies," 47.

[41] Reuter and Kaufhold.

might lack the operational experience to meaningfully interpret the operational utility of the information.

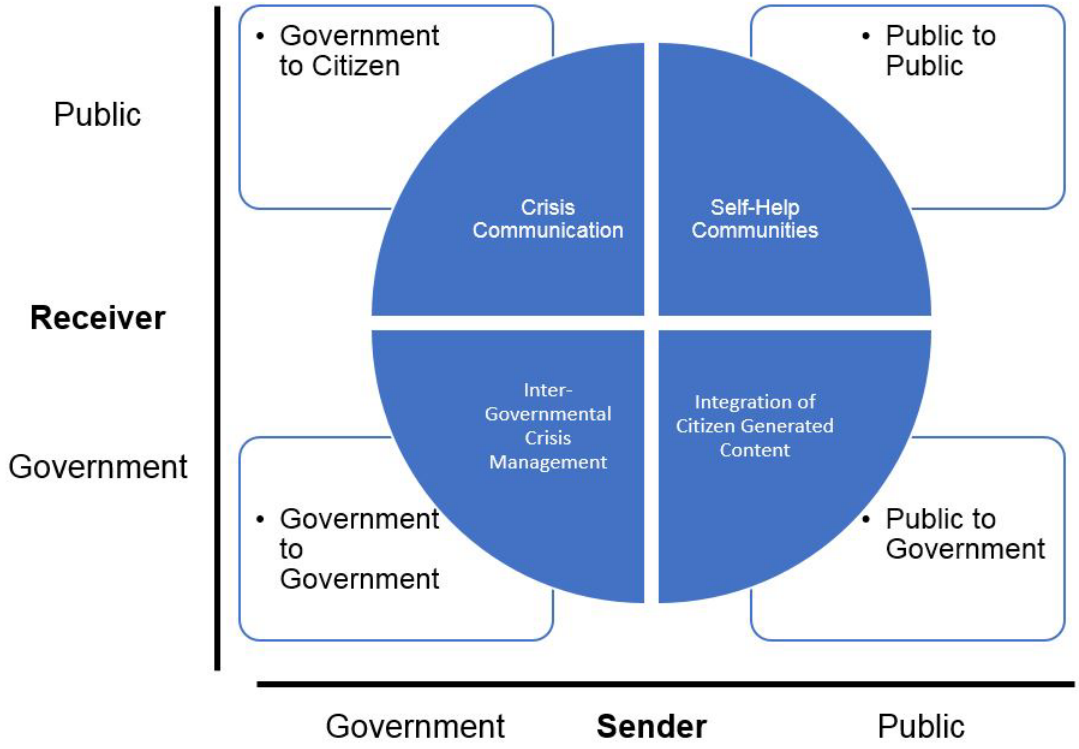

Figure 2. Social Media Communication Matrix[42]

Another potential limitation to integrating social media feeds into an EOC is related to information-processing limitations. In her review of social media integration, Kate Starbird noted four fundamental challenges to utilizing social media information: filtering signal from noise, providing context to provide meaning, sifting out rumors and disinformation, and providing a structure to unstructured messaging.[43] Each of these factors poses unique challenges in the stressful environment of an EOC, and it is important

[42] Source: Reuter, Hughes, and Kaufhold, "Social Media in Crisis Management."

[43] Kate Starbird, "Digital Volunteerism: Examining Connected Crowd Work during Mass Disruption Events," *Proceedings of the CSCW 2012 Workshop on Collaboration and Crisis Informatics* 9, no. 2 (December 2012): 113–119, https://pdfs.semanticscholar.org/f6eb/392b26f3606bf21627b3d2141a5fcd3f843f.pdf#page=113.

to note that, of these tasks, only sifting out rumors is aligned with the traditional role of public information officers operating out of a JIC. Furthermore, two of these specific challenges—providing context and providing structure—are sensemaking challenges that cannot effectively be addressed by any single component of the EOC in isolation. Another challenge to integrating social media that many EOCs would find difficult to address in their current configuration is filtering signal from noise.[44] Many EOCs are staffed to collect and process reports coming in from incident command posts (ICPs) or subordinate EOCs at the local level, in many cases utilizing pre-scripted forms. This imposed structure ensures that incoming data focus on predetermined information requirements that have already been vetted by public safety partners. A dramatic increase in real-time, media-rich, contextual information could exceed the EOC's capabilities to synthesize information by providing high-bandwidth data without the associated contextual cues that predetermined forms provide. In cases where events are rapidly unfolding, this can lead to the information being discarded, or in some cases could contribute to paralysis by analysis, where critical next steps are not taken due to the vast quantity of available information.

The difficulties inherent in integrating social media data have been supported by several quantitative reviews of public safety agencies' social media use.[45] Although there is widespread awareness of the utility of social media information, recent surveys in the United States have noted that a staggering 25 percent of all emergency responders are prohibited from utilizing social media in any capacity, and that even when utilized it is

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[44] Christian Reuter, Christoph Amelunxen, and Matthias Moi, "Semi-automatic Alerts and Notifications for Emergency Services Based on Cross-platform Social Media Data-Evaluation of a Prototype," in *Informatik 2016*, 1805–1818, https://dl.gi.de/bitstream/handle/20.500.12116/1065/1805.pdf?sequence=1.

[45] Rajib Subba and Tung Bui, "Online Convergence Behavior, Social Media Communications and Crisis Response: An Empirical Study of the 2015 Nepal Earthquake Police Twitter Project," *Proceedings of the 50th Hawaii International Conference on System Sciences* (January 2017): 284–293, http://hdl.handle.net/10125/41183; Linda Plotnick et al., "Red Tape: Attitudes and Issues Related to Use of Social Media by U.S. County-Level Emergency Managers," *Proceedings of the ISCRAM 2015 Conference - Kristiansand* (May 2015): 182–192, http://idl.iscram.org/files/lindaplotnick/2015/1225_LindaPlotnick_etal2015.pdf; Reuter et al., "Emergency Services' Attitudes towards Social Media," 98.

largely underutilized.[46] When the emergency management agencies were surveyed about social media use, their three top concerns were a lack of personnel, a lack of trust in the information provided, and information overload.[47] These concerns have driven a significant amount of research and development within the field of crisis informatics, a multidisciplinary field fusing aspects of computational science and social science.[48] Over the last decade, several increasingly astute technologies stemming from this field have started the process of reducing the potential for informational overload through automatization.[49] Although the integration of ever more complex artificial intelligence algorithms has steadily increased the utility of these systems, they remain focused on augmenting human capabilities instead of replacing them.

D. VOLUNTEERS IN CRISIS EVENTS

Altruistic members of communities have responded to crisis events long before formal efforts aimed at emergency management emerged as a framework for disaster response. Despite the lifesaving efforts of volunteers, as government assumed a more robust role in disaster management the role of volunteers became an issue of scrutiny and

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[46] Babak Akhgar et al., "Social Media in Crisis Events: Open Networks and Collaboration Supporting Disaster Response and Recovery," *2013 IEEE International Conference on Technologies for Homeland Security (HST)* (November 2013), https://doi.org/10.1109/THS.2013.6699099; Plotnick and Hiltz, "Barriers to Use of Social Media"; Kenneth A. Lachlan et al., "Social Media and Crisis Management: CERC, Search Strategies, and Twitter Content," *Computers in Human Behavior* 54 (2016): 649, https://doi.org/10.1016/j.chb.2015.05.027.

[47] Plotnick and Hiltz, "Barriers to Use of Social Media."

[48] Volkmar Pipek, Sophia B. Liu, and Andruid Kerne, "Crisis Informatics and Collaboration: A Brief Introduction," *Computer Supported Cooperative Work* 23, no. 4–6 (August 2014): 339–345, https://doi.org/10.1007/s10606-014-9211-4.

[49] Muhammad Imran et al., "AIDR: Artificial Intelligence for Disaster Response," *Proceedings of the 23rd International Conference on World Wide Web* (April 2014): 159, https://doi.org/10.1145/2567948.2577034; Muhammad Imran et al., "Coordinating Human and Machine Intelligence to Classify Microblog Communications in Crises," *Proceedings of the 11th International ISCRAM Conference* (May 2014): 712–721, http://www.iscram.org/legacy/ISCRAM2014/papers/p75.pdf; Ferda Ofli et al., "Combining Human Computing and Machine Learning to Make Sense of Big (Aerial) Data for Disaster Response," *Big Data* 4, no. 1 (2016): 47–59, https://doi.org/10.1089/big.2014.0064.

tension.[50] One of the key concerns is well-intentioned but unaffiliated volunteers spontaneously appearing at the scene of the disaster, a phenomenon that has been referred to as convergence.[51] Convergence at the scene of a disaster is frequently viewed as an impediment to effective response because it threatens the health and safety of individuals in the affected area, blocks ingress and egress to the disaster scene, introduces competition for the attention of first responders, and interferes with organized efforts at responding to the most critical components of a crisis.[52] Reviews of prior disaster scenarios suggest that efforts to deter convergence fail to address the persistence of the phenomenon, leading to local and state programs that have established procedures to try to manage this process.[53]

Despite their advantages, there are other limitations to the capabilities provided by volunteers. One factor is the changing face of modern volunteers, who are increasingly struggling with less flexibility in their work obligations.[54] Another limitation of the traditional volunteer programs is their reliance on leveraging physical capabilities instead of harnessing the cognitive capital of volunteers empowered by new technologies.[55] This

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[50] Seana Lowe, *Community Response in a Terrorist Disaster* (Boulder, CO: Natural Hazards Research and Applications Information Center, University of Colorado, 2002), http://hermes.cde.state.co.us/drupal /islandora/object/co%3A13360; Lauren M. Sauer et al., "The Utility of and Risks Associated with the Use of Spontaneous Volunteers in Disaster Response: A Survey," *Disaster Medicine and Public Health Preparedness* 8, no. 01 (March 2014): 65–69, https://doi.org/10.1017/dmp.2014.12.

[51] James J. Carafano, "Preparing Responders to Respond: The Challenges to Emergency Preparedness in the 21st Century" (Heritage Lecture no. 812, The Heritage Foundation, 2002), https://thf_media.s3. amazonaws.com/2003/pdf/hl812.pdf.

[52] Lauren Fernandez, Joseph Barbera, and Johan Van Dorp, "Strategies for Managing Volunteers during Incident Response: A Systems Approach," *Homeland Security Affairs* 2, no. 3 (2006): 1–15, https://www.hsaj.org/articles/684.

[53] Lauren S. Fernandez, "Volunteer Management System Design and Analysis for Disaster Response and Recovery" (PhD dissertation, George Washington University, 2007), 1, http://citeseerx.ist.psu.edu/ viewdoc/download?doi=10.1.1.606.3321&rep=rep1&type=pdf.

[54] Ram A. Cnaan and Femida Handy, "Towards Understanding Episodic Volunteering," *Vrijwillige Inzet Onderzocht* 2, no. 1 (2005): 29–35, https://www.researchgate.net/profile/Femida_Handy/ publication/294689552.

[55] Camille Cobb et al., "Designing for the Deluge: Understanding & Supporting the Distributed, Collaborative Work of Crisis Volunteers," *Proceedings of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing* (February 2014): 889, https://doi.org/10.1145/ 2531602.2531712.

gap is perplexing given the growing desire of many volunteers to assist in dynamic and episodic ways instead of engaging in more formal and long-term commitments.[56]

The literature on sensemaking makes it clear that emergency managers faced with a crisis situation face a cognitive gap as significant as the shortage of skilled labor at the scene of a disaster.[57] While leveraging digital volunteers differs in fundamental ways from physically mobilizing volunteers, important lessons can be gleaned from the integration of traditional disaster volunteers.[58] These lessons include the importance of identifying unique skill sets and using trained volunteers to guide the integration of spontaneous volunteers, and the need to provide information on the larger response operation in order to unify efforts.[59]

E. DIGITAL VOLUNTEERISM

Digital volunteers are self-organized collectives of individuals connected by the internet and social media who attempt to organize and process information during catastrophic scenarios.[60] While traditional volunteers have focused on providing support in catastrophic incidents through direct intervention in and around the impact zones, the

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[56] Lesley Hustinx and Frans Lammertyn, "Collective and Reflexive Styles of Volunteering: A Sociological Modernization Perspective," *Voluntas: International Journal of Voluntary and Nonprofit Organizations* 14, no. 2 (2003):167–187, https://doi.org/10.1023/A:1023948027200.

[57] Albert J. Mills and Caroline J. O'Connell, "Making Sense of Bad News: The Media, Sensemaking, and Organizational Crisis," *Canadian Journal of Communication* 28, no. 3 (2003): 323–339, http://www.library2.smu.ca/handle/01/25036.

[58] Christian Reuter, Oliver Heger, and Volkmar Pipek, "Combining Real and Virtual Volunteers through Social Media," *Proceedings of the 10th International ISCRAM Conference* (May 2013): 780–791, http://ww.w.iscram.org/legacy/ISCRAM2013/files/122.pdf; Lynette M. McDonald et al., "Developing Public Disaster Communication for Volunteer Recruitment: Understanding Volunteer Motivations," *World Public Relations Forum 2012 Research Colloquium Conference Proceedings* (November 2012): 82–86.

[59] Michael M. Gonzalez, "Citizen Involvement in Disaster Management" (master's thesis, Naval Postgraduate School, 2005), 4, https://calhoun.nps.edu/handle/10945/2045; Fernandez, Barbera, and Van Dorp, "Strategies for Managing Volunteers during Incident Response"; Tomoko Haraoka et al., "Factors Influencing Collaborative Activities between Non-professional Disaster Volunteers and Victims of Earthquake Disasters," *PloS One* 7, no. 10 (October 2012): e47203, https://doi.org/10.1371/journal.pone.0047203.

[60] Arifumi Utani, Teruhiro Mizumoto, and Takashi Okumura, "How Geeks Responded to a Catastrophic Disaster of a High-Tech Country: Rapid Development of Counter-Disaster Systems for the Great East Japan Earthquake of March 2011," *Proceedings of the Special Workshop on Internet and Disasters* (December 2011), https://doi.org/10.1145/2079360.2079369.

growth of social media has allowed concerned individuals to participate in response efforts in new and unique ways.[61] One distinctive aspect of this new incarnation of volunteerism is that the technologies facilitating this collaboration allow any individual with an internet connection and the desire to contribute to take part.[62] Research into these technologically mediated collaboration efforts suggests that they have the potential to dramatically increase information on the dynamics of a crisis.[63] One of the first large-scale cases where crowdsourced efforts contributed to emergency response was the devastating 2010 Haiti earthquake.[64] As this crisis began to unfold, disparate teams of self-organized digital volunteers mobilized to create detailed maps of the disaster zone with a greater degree of fidelity than existing geospatial information systems.[65] Over the ensuing years, digital volunteers responded to humanitarian crises in areas as diverse as Haiti, Japan, and Sudan.[66] Collectively, these varied response efforts provide opportunities to review the potential effectiveness of this form of volunteerism in multiple crisis scenarios.

Despite the considerable success of digital volunteers in Haiti, there were several recommendations published in a review of the humanitarian response effort to the

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[61] Sarah Vieweg, "Behavioral Patterns in Online Crisis Communications," *Proceedings of the CSCW 2012: Workshop on Collaboration and Crisis Informatics* (December 2012): 47–50, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.662.2471&rep=rep1&type=pdf#page=47.

[62] Cobb et al., "Designing for the Deluge," 893.

[63] David Coleman, Yola Georgiadou, and Jeff Labonte, "Volunteered Geographic Information: The Nature and Motivation of Produsers," *International Journal of Spatial Data Infrastructures Research* 4, no. 1 (2009): 341, https://pdfs.semanticscholar.org/fb3f/d1663330ec9f34283a9e33f93e1e5656bef6.pdf.

[64] Sidharth Muralidharan et al., "Hope for Haiti: An Analysis of Facebook and Twitter Usage during the Earthquake Relief Efforts," *Public Relations Review* 37, no. 2 (2011): 175–177, https://doi.org/10.1016/j.pubrev.2011.01.010.

[65] Dave Yates and Scott Paquette, "Emergency Knowledge Management and Social Media Technologies: A Case Study of the 2010 Haitian Earthquake," *International Journal of Information Management* 31, no. 1 (2011): 9, https://doi.org/10.1016/j.ijinfomgt.2010.10.001.

[66] Stefan Voigt et al., "Rapid Damage Assessment and Situation Mapping: Learning from the 2010 Haiti Earthquake," *Photogrammetric Engineering and Remote Sensing* 77, no. 9 (2011): 923–931, https://core.ac.uk/ download/pdf/11152364.pdf; Utani, Mizumoto, and Okumura, "How Geeks Responded to a Catastrophic Disaster"; "OCHA South Sudan Deployment: Curating Data for Disaster Preparedness," Standby Task Force, July 16, 2012, http://blog.standbytaskforce.com/2012/07/16/ocha-south-sudan-deployment-curating-data-for-preparedness/.

earthquake.[67] One specific concern was that the ad hoc nature of the digital volunteer effort meant that response groups were unable to establish best practices or create reliable operational processes to prepare for future events. One outcome of these findings was the development of a new form of volunteer organization, the virtual operations support team (VOST).

The concept of a VOST was developed by Jeff Phillips, an emergency manager in New Mexico, in early 2011 to assist with social media integration.[68] Many aspects of the VOST model are rooted in earlier volunteer-based organizations that support emergency response efforts, including community emergency response teams (CERTs) and Voluntary Organizations Active in Disaster (VOADs).[69] A CERT describes a group of citizens who complete a specified course of instruction on disaster-related topics in order to assist public safety personnel with responding to disasters in their local area.[70] A VOAD comprises volunteers with specific technical expertise who are willing to bring their knowledge and skill to bear in support of disaster efforts.[71] In a similar fashion, VOSTs are designed to leverage pre-screened and identified volunteers who understand the needs of emergency managers and can provide support via the internet to site responders who may be overwhelmed by the data generated in a disaster[72]

The VOST concept has matured and expanded the capabilities of organizations in the emergency management space in wildfires, floods, build collapses, and hurricanes.

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[67] John Crowley and Jennifer Chan, *Disaster Relief 2.0: The Future of Information Sharing in Humanitarian Emergencies* (Cambridge, MA: Harvard Humanitarian Initiative, 2011), https://hhi.harvard.edu/publications/disaster-relief-20-future-information-sharing-humanitarian-emergencies.

[68] M. Reddy-Hjelmfelt, "What Is VOST?" *The Red Elm* (blog), accessed April 12, 2016, https://theredelm.wordpress.com/vost/.

[69] Cobb et al., "Designing for the Deluge," 888–899.

[70] Mark A. Brennan and Courtney G. Flint, "Uncovering the Hidden Dimensions of Rural Disaster Mitigation: Capacity Building through Community Emergency Response Teams," *Southern Rural Sociology* 22, no. 2 (2007): 111–126, http://journalofruralsocialsciences.org/pages/Articles/SRS%202007%2022/2/SRS%202007%2022%202%20111-126.pdf.

[71] William L. Waugh and Gregory Streib, "Collaboration and Leadership for Effective Emergency Management," *Public Administration Review* 66, no. 1 (2006): 131–140, https://doi.org/10.1111/j.1540-6210.2006.00673.x.

[72] Griswold, "Digital Detectives and Virtual Volunteers."

According to the Virtual Operations Support Group website, there are more than thirty-eight active teams in support of local, state, and international organizations. One key to the growth of the VOST concept is its focus on augmenting the social media footprint of a jurisdiction instead of replacing it.[73] To accomplish this level of operational support and integration, every VOST has a team leader who takes his or her guidance directly from the impacted organization. When a complex catastrophe exceeds the capabilities of an individual VOST, additional VOSTs can be activated to address span-of-control issues.[74] In these contingencies, a virtual operations support group may be stood up under the direction of a group supervisor in order to coordinate the actions being performed by the activated VOSTs.[75] One unique aspect of VOSTs is that they will not act without a direct task from a public safety agency.

To ensure there is tight integration between public safety entities and the VOST supporting their information collection efforts, agencies are encouraged to identify a VOST agency liaison. The purpose of a VOST agency liaison is to play an active role in managing the members of the VOST, selecting activation criteria, pre-scripting information collection requirements, and understanding the capabilities of individual members.[76] It is important to note that although digital volunteers can describe emergent volunteers, VOST teams should be pre-identified and trained by their sponsoring organization in order to build trust and to ensure operational expectations are understood by all involved. Another important aspect of building a VOST capability is selecting a combination of local and non-local participants. In crisis scenarios that require around-the-clock operations, having

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[73] Jeffrey R. Blum et al., "Real-Time Emergency Response: Improved Management of Real-Time Information during Crisis Situations," *Journal on Multimodal User Interfaces* 8, no. 2 (2014): 161–173, https://doi.org/ 10.1007/s12193-013-0139-7.

[74] Caroline Milligan and Scott Reuter, "New Zealand VOST Training Guide" (training slides, Wellington Region Emergency Management Office, 2012), https://www.slideshare.net/CMilligan NZVOST/new-zealand-vost-training-guide-final-2012.

[75] Joseph Lane, Implementing VOST for SMEM - Social Media for Emergency Management, accessed March 12, 2017, https://vosg.org/page/13/.

[76] Amanda L. Hughes and Leysia Palen, "The Evolving Role of the Public Information Officer: An Examination of Social Media in Emergency Management," *Journal of Homeland Security and Emergency Management* 9, no. 1 (2012): 1–20, http://dx.doi.org/10.1515/1547-7355.1976.

the ability to continue operations using experienced personnel in multiple time zones becomes a key enabler.

In early 2010, the DHS S&T created the Virtual Social Media Working Group (VSMWG) to provide the emergency management community with recommendations for integrating social media into emergency efforts.[77] The VSMWG was composed of federal, state, and local subject matter experts, non-profit organizations, public safety entities, and academics focused on expanding the utility of social media in emergency management. Many of the best practices articulated by the VSMWG were integrated into a 2015 joint United States–Canada cross-border exercise entitled CAUSE III, which was specifically designed to test and validate the use of social media data in emergency response and recovery.

CAUSE III simulated a Category 3 hurricane striking the Northeast region and was designed to exercise a host of information management capabilities on both sides of the U.S.–Canadian border. With the assistance of DHS S&T, the Defence Research Centre, and Development Canada's Centre for Security Science, emergency managers on both sides of the border were able to examine whether digital volunteers could support traditional emergency management by enhancing situational awareness and improving mutual aid. The experiment integrated more than 100 participants from agencies on both sides of the border, to include Public Safety Canada, the Nova Scotia Emergency Management Office, the Canadian Red Cross, FEMA Region I, the New Hampshire Office of Emergency Management, Maine Emergency Management, New York City Emergency Management, and the National Information Sharing Consortium. In addition to these entities, a variety of digital volunteers from CanVOST, as well as VOSTs from Colorado, New York, and the Pacific Northwest, directly supported the experiment.

There were five specific vignettes within the CAUSE III exercise focused on VOST integrations, and in each an emergency management agency activated a VOST and

[77] Department of Homeland Security, *Using Social Media for Enhanced Situation Awareness and Decision Support* (Washington, DC: Government Printing Office, 2014), https://www.dhs.gov/sites/default/files/publications/Using%20Social%20Media%20for%20Enhanced%20Situational%20Awareness%20and%20Decision%20Support.pdf.

provided it with a list of essential elements of information to enhance the traditional situational awareness tools. At the end of the exercise, public safety personnel on both sides of the border reported that integrating social media provided a significant benefit to traditional information streams, including enhanced decision-making, greater collaboration internally and externally, and enhanced situational awareness.

While the VOST concept was gaining adoption within the United States, there was significant parallel growth in digital volunteers supporting the international humanitarian field.[78] Within the international humanitarian community, groups that focus on digitally supporting disaster events are referred to as virtual and technical communities, and can include newly minted self-organized groups, ongoing communities of digital volunteers, or even nonprofit organizations. Two areas of particular focus for these groups of digital enablers were crisis mapping and social media monitoring.[79]

Crisis mapping was established to address an existing technological gap within the larger humanitarian assistance. Since its development in the 1970s, the integration of geographic information system (GIS) has revolutionized how data is analyzed and operationalized by using locational data to provide context to other types of information about the environment.[80] While this capability offers significant advantages, until recently it required a great deal of technical skill and the use of expensive proprietary software. In the aftermath of the devastating Haiti earthquake in 2010, international aid organizations started to deploy personnel and equipment to the epicenter in Port-au-Prince, but they were

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[78] Johannes Anhorn and Benjamin Herfort, and João Porto de Albuquerque, "Crowdsourced Validation and Updating of Dynamic Features in Openstreetmap: An Analysis of Shelter Mapping after the 2015 Nepal Earthquake," *Proceedings of the International Conference on Information Systems for Crisis Response and Management 2016 Conference* (May 2016), http://wrap.warwick.ac.uk/78701/1/WRAP_ Nepal_ Earthquake.pdf.

[79] Luis Capelo, Natalie Chang, and Andrej Verity, *Guidance for Collaborating with Volunteer & Technical Communities* (New York: Digital Humanitarian Network, 2012), http://digitalhumanitarians.com/content/guidance-collaborating-volunteer-technical-communities; João Porto de Albuquerque et al., "A Geographic Approach for Combining Social Media and Authoritative Data towards Identifying Useful Information for Disaster Management," *International Journal of Geographical Information Science* 29, no. 4 (2015): 667–689, https://doi.org/10.1080/13658816.2014.996567.

[80] Joseph J. Breen and David R. Parrish, "GIS in Emergency Management Cultures: An Empirical Approach to Understanding Inter-and Intra-agency Communication during Emergencies," *Journal of Homeland Security and Emergency Management* 10, no. 2 (2013): 477–495, https://doi.org/10.1515/jhsem-2013-0014.

stymied by the lack of detailed maps and the magnitude of destruction to infrastructure (see Figure 3).[81] To fill this gap, a team of self-organized digital volunteers utilized an open-source digital mapping tool and commercial satellite imagery to crowdsource a map of the impacted area. While the phenomenon of spontaneous volunteerism was an established aspect of crisis response, this was the first significant spontaneous convergence utilizing digitally mediated communication.[82] In the span of less than a month, over 1.4 million edits had been made to the Haitian map, making it the most accurate georeferenced tool ever created for the country (see Figure 3).[83] In addition to these efforts, open-source tools and technologies were used to sift through more than 2,000 social media reports, text messages, and other media reports to ensure that critical supplies were making it to the most impacted sites.[84]

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[81] Patrick Meier and Jen Ziemke, "Measuring Our Response: An Executive Summary" (report, International Network of Crisis Mappers, 2010), https://docs.google.com/document/d/1qAraVZvoEf_LDHBhAuu2ZknkZSXpRJQMGMj5XSqpLE4/edit?pref=2&pli=1.

[82] Kate Starbird and Leysia Palen, "Voluntweeters: Self-Organizing by Digital Volunteers in Times of Crisis," *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (May 2011): 1071–1080, https://doi.org/10.1145/1978942.1979102.

[83] Robert Soden and Leysia Palen, "From Crowdsourced Mapping to Community Mapping: The Post-earthquake Work if Openstreetmap Haiti," *Proceedings of the 11th International Conference on the Design of Cooperative Systems* (May 2014): 311–326, https://doi.org/10.1007/978-3-319-06498-7_19.

[84] Nathan Morrow et al., "Independent Evaluation of the Ushahidi Haiti Project," *Development Information Systems International* 8 (2011), https://www.researchgate.net/profile/Nathan_Morrow/publication/265059793_Ushahidi_Haiti_Project_Evaluation_Independent_Evaluation_of_the_Ushahidi_Haiti_Project/links/5451ef8f0cf2bf864cbaaca9/Ushahidi-Haiti-Project-Evaluation-Independent-Evaluation-of-the-Ushahidi-Haiti-Project.pdf.

Left: In the immediate aftermath of the quake. Right: Showing the work of CrisisMappers one week post-quake.

Figure 3. Google Maps View of Port-au-Prince after the Quake

Once the response to Haiti reached a plateau, many of the digital volunteers who were actively engaged looked for ways to continue assisting humanitarian response efforts. This culminated in the development of CrisisMappers, which aimed to provide a venue for digital volunteers to collaborate with geospatial experts in the public and private sphere in order to advance crowdsourcing map data.[85] It is important to note that while the mapping efforts completed in Haiti were ad hoc and representative of an emergent group, the establishment of CrisisMappers marked a shift to a more formal, standards-based organization. Over the ensuing years, CrisisMappers virtually deployed members to a number of disasters to provide mapping support, including the 2010 Chilean earthquake, Typhoon Yolanda in the Philippines in 2013, the 2014 West Africa Ebola response, the response to Cyclone Pam in Vanuatu in 2015, and the 2015 Nepal earthquake.[86]

In 2010, several of the technical experts who had helped stand up CrisisMappers wanted to further operationalize the concept of digital volunteerism and created the

[85] Morrow et al.

[86] Sophia B. Liu and Jen Ziemke, "From Cultures of Participation to the Rise of Crisis Mapping in a Networked World," in *The Participatory Cultures Handbook*, eds. Aaron Delwiche and J. Henderson (New York: Routledge, 2013), 185–96; "Super Typhoon Yolanda," Digital Humanitarian Network, accessed May 18, 2017, http://digitalhumanitarians.com/content/super-typhoon-yolanda; "West Africa Ebola Response," Digital Humanitarian Network, accessed May 17, 2017, http://digitalhumanitarians.com/content/west-africa-ebola-response; "Vanuatu (Cyclone Pam)," Digital Humanitarian Network, accessed May 18, 2017, http://digitalhumanitarians.com/content/vanuatu-cyclone-pam; "Nepal Earthquake," Digital Humanitarian Network, accessed May 18, 2017, http://digitalhumanitarians.com/content/nepal-earthquake.

Standby Task Force. The task force was composed of hundreds of volunteers from across the globe who were organized into teams with specific technical skills.[87] When activated in support of a humanitarian disaster, the core team is responsible for activating the volunteer network, which is divided into multiple task groups depending on the complexity of the disaster. By subdividing larger taskings into their component parts, elements of the network can work in parallel to meet the needs of the organizing entity.[88]

Shortly after the 7.3-magnitude earthquake struck Nepal in 2015, the Standby Task Force was officially requested to activate in support of two primary tasks: the creation of a map containing open-source text and pictures in order to ensure responders arriving from outside Nepal had good information, and the creation of a tool for tracking responders' locations and missions. Over the course of the deployment, more than 416 volunteers and local representatives took part in the social media and geospatial collection efforts, significantly enhancing the overall situational awareness of responders.

The significantly higher utilization of digital volunteers performing crisis mapping in humanitarian efforts stands in contrast to their low utilization in domestic response operations. One potential reason is the wide availability of a trained, professional group of geospatial analysts available at the local, state, and federal level who can rapidly augment the capabilities of impacted jurisdictions. Existing mutual aid compacts between local jurisdictions provide the means to call on this trained workforce in exigent circumstances, and their integration into wildfires and other disaster events is already well established. Additionally, the United States has the benefit of having made significant investments in accurately plotting a wide range of information in high-resolution data layers, providing a rich source of readily available data that frequently does not exist in less developed nations. While the wide availability of geospatial data addresses one potential reason for the slow adoption of crisis mapping, it does not address the lack of widespread efforts to aggregate and synthesize social media data.

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[87] Jakob Rogstadius et al., "CrisisTracker: Crowdsourced Social Media Curation for Disaster Awareness," *IBM Journal of Research and Development* 57, no. 5 (2013): 4–15, http://doi.org/10.1147/JRD.2013.2260692.

[88] Cobb et al., "Designing for the Deluge."

F. CHAPTER SUMMARY

This chapter provided a literature review intended to highlight the information-processing challenges emergency managers face in disaster events, complications arising from an explosion in available data streams, and the ways digital volunteers have been leveraged to make sense of the available information. The sections addressed in this chapter provide a framework for understanding the information-processing work that occurs during disaster events and the challenges and potential advantages of harnessing citizen-generated information available on social media. More importantly, this review suggests that digital volunteers have the demonstrated ability to integrate information available on social media platforms to enhance situational awareness in disaster events.

There are several techniques and technologies that were empirically proven to improve existing procedures but later failed to be widely adopted due to cultural, operational, or financial implications. The following Chapter will explore the results of the senior leader interviews to understand whether the patterns of use and structural impediments noted in the literature were indicative of the current state of social media integration and use of digital volunteers.

III. ANALYSIS AND FINDINGS

A. RESPONDENT CHARACTERISTICS

In order to better ascertain key areas of friction in social media usage and whether digital volunteer efforts offer potential solutions to these challenges, six senior public safety leaders were interviewed utilizing a semi-structured interview format. The six respondents came from across the United States, with representation from the Northeast, East Coast, South, Midwest and West Coast. Four of the respondents manage public safety agencies with statewide jurisdiction, one respondent coordinates public safety at the county level, and one respondent works at the municipal level. All respondents are senior public safety leaders, with five designating their primary responsibility as emergency management and one as public health. The majority of respondents (five of six) reported that their agencies serve jurisdictions with populations over 250,000 and each of the respondents has professional experience in integrating social media in real-world response scenarios. All of the respondents reported playing a decision-making role in an emergency operations center.

B. SOCIAL MEDIA USAGE

Every interviewee reported that social media plays an important role in crisis response, with information collection, crowdsourcing, and public messaging appearing as the most frequent areas of unique value. One interesting aspect that emerged from the discussions was a lack of clarity on what constituted crowdsourcing. While the research literature generally describes crowdsourcing as a sourcing model where tasks are divided among a large pool of users, respondents described efforts more aligned with data mining.[89] What was missing from many of their responses was any efforts their agencies took to actively shape information collection efforts.

[89] Sophia B. Liu, "Crisis Crowdsourcing Framework: Designing Strategic Configurations of Crowdsourcing for the Emergency Management Domain," *Computer Supported Cooperative Work (CSCW)* 23, no. 4 (July 2014): 389–443, https://doi.org/10.1007/s10606-014-9204-3.

Perhaps more tellingly, every respondent reported that their agency monitors social media for situational awareness purposes before, during, and immediately after a disaster event. The majority of the respondents (five of six) reported that their agencies monitor social media during steady-state operations, with the remaining respondent reporting that the agency monitors social media as conditions emerge that might warrant tracking.

When respondents were asked to clarify how they use social media to increase situational awareness and information collection, they noted that one of the key uses is the early detection of life-safety events within their area of interest. In these cases, the respondents reported that the jurisdictions impacted by these emerging events are assuredly tracking the events through official information streams like their 9-1-1 dispatch centers, but that they are unlikely to report the events. When pressed for additional clarification, the leaders of three state-level emergency management departments reported that many of the jurisdictions they support are slow to report disaster events. Potential explanations for this delay in reporting information to an EOC included a lack of training on reporting procedures, the inability to enforce mandatory situational reporting in a disaster event, delays in reporting caused by personnel constraints, the prioritization of coordinating the deployment of additional personnel, and hesitation to report information until there is a need for additional support.

This pattern of use is consistent with research in social media analysis, which distinguishes three use cases for social media: event detection, event categorization, and event enrichment.[90] Event detection encompasses techniques and procedures for extracting information from social media in order to provide early warning, analysis, and predictions about emerging events. Since the emergence of disaster events may be distinguished by spikes in the steady-state pattern of social media posts, it is the use case most amenable to automation.[91] The emphasis respondents placed on providing early warning on emerging events is also consistent with prior research into social media use in emergencies. One potential impediment to the use of digital volunteers emerges from the focus on this use

[90] Muskan Garg and Makesh Kumar, "Review on Event Detection Techniques in Social Multimedia," *Online Information Review* 40, no. 3 (2016): 347, https://doi.org/10.1108/OIR-08-2015-0281.

[91] Garg and Kumar.

case. Since digital volunteers must be activated, organized, and integrated into an operation, they are not optimally suited to provide insight into emerging situations when compared with algorithm-based strategies that are always running in the background.

Of the available social media tools, Twitter appeared to be the clear favorite for gaining situational awareness, with five of six agencies using its stream as their primary social media awareness tool. Other social media tools that are utilized include Facebook (three agencies), Instagram (two agencies), and YouTube (two agencies). These responses are consistent with prior research on social media use in emergency management and suggest continuity in which platforms are most uniformly utilized.[92]

Respondents were also asked for information on how they measure the success of their social media efforts; while several reported metrics, there were no clear patterns to the techniques employed. One agency reported having no measure of successful use other than vignettes. On the other side of the spectrum, one respondent reported retroactively measuring the time between social media reports coming in and the official reports being received to determine the utility of using social media for event detection. The additional four respondents all reported using various compilations of their reads, likes, and retweets for quantifying their social media outreach efforts. These findings suggest that, despite efforts to emphasize the importance of creating metrics and evaluation criteria for utilizing social media, this emerging practice remains a work in progress.

C. SOCIAL MEDIA ADOPTION

Although there was broad consensus on the value of social media to their respective agencies, none of the respondents' agencies have in-house staff tasked with monitoring social media as a sole duty. Of the six respondents, two reported that their agencies added monitoring social media to existing positional job descriptions, three reported unofficially tasking employees with reviewing social media, and one reported assigning the responsibility on an ad hoc basis. The two agencies that added social media monitoring

[92] Mark A. Cameron, Robert Power, Bella Robinson, and Jie Yin, "Emergency Situation Awareness from Twitter for Crisis Management," *Proceedings of the 21st International Conference on World Wide Web* (April 2012): 695–98, https://doi.org/10.1145/2187980.2188183.

duties to existing job descriptions did so with staff in their twenty-four-hour monitoring centers, which provides their respective agencies with around-the-clock monitoring. The remaining four agencies utilize personnel working standard working hours, with the exception of emergency activations. Regardless of the staffing technique used to gather information from social media, all six of the respondents stated that social media information is integrated into existing agency reports through existing channels. When pressed for further clarification on what constitutes existing channels, five of the six respondents reported that the information is integrated into text-based internal situational reports. As an exception, one respondent reported geotagging relevant information into a GIS-based data layer, but the resulting data layer is only shared across users of the agency's situational awareness tool and is not available to field responders.

D. SOCIAL MEDIA TRAINING AND TOOLSETS

With an eye toward understanding what investments in social media awareness are being made in their respective agencies, respondents were asked about social media training, tools, and policy development. All the respondents reported a perceived lack of overarching guidance on social media monitoring at the federal level, which is reflected in the different training standards adopted by each agency. Two respondents reported that their training is based on external government agencies' social media training courses, two reported their training is limited to classes provided by the vendors of their social media aggregation tools, and two agencies built in-house training on social media awareness. Only two of the six respondents were familiar with the DHS and FEMA guidelines on social media use, and neither of these respondents have integrated these guidelines into their own operations.

Respondents also reported a variety of information collection techniques, with keyword searches being the most prevalent, followed by hashtags and geofencing. Interestingly, only two respondents reported having standard operating procedures (SOPs) or lists of keywords and hashtags that could be used to shape information collection efforts. The four other respondents reported that their monitoring efforts were aimed at significant events that had occurred or were emerging. It should be noted that a majority of the

respondents reported that the significant costs associated with some of the social media aggregation tools limit the information collection techniques they are able to utilize.

Of the six respondents, only one reported that the agency had a published social media policy. The remainder reported varying levels of policy development, with two having unpublished drafts, one following the parent agency's guidelines, one using internal guidelines, and one reporting no policies or procedures having been developed. Most respondents reported that this primarily poses a liability and privacy concern, and that the drafts are being compiled by—or are in the process being formally approved by—their legal departments. While this is consistent with the way many government documents are formulated, it also highlights that the operators who will execute these policies may not be the primary influencers on what is being produced.

E. SOCIAL MEDIA SCALING

To better understand whether agencies have the capability to more rapidly process the spikes in social media traffic in emergency situations, respondents were asked a series of questions related to scaling their social media monitoring capabilities. Two of the respondents reported that they can scale their ability to process social media utilizing existing staff. One reported that additional staff would be assigned this mission in the EOC while another mentioned that the agency's tewenty-four-hour warning point would be provided with additional staff who would have social media aggregation as an additional duty. Of the four respondents who stated that they have no ability to allocate additional staff, two specifically mentioned the ability to activate VOST capabilities to augment their efforts. Additionally, all respondents reported that a lack of available staffing provides an impediment to social media collection in a disaster scenario.

When asked what specific challenges they perceived are hindering their ability to effectively leverage social media in a crisis situation, the respondents reported several issues. The most frequent concern was the lack of available staff, coupled with the complexity of social media. Several respondents specifically mentioned that available training fails to address the chaos inherent to social media or the techniques to address filtering appropriate information from background chatter. Another specific concern was

that the public might misinterpret efforts to synthesize social media information and see this as government monitoring. This was an area of special emphasis with respondents reporting to or working in an agency with a law enforcement nexus.

F. UTILIZING DIGITAL VOLUNTEERS

To better understand whether respondents believe their agencies could address staffing shortfalls by utilizing digital volunteers, each participant was asked a series of questions to gauge their prior experience and potential concerns with this strategy. Of the six respondents, two reported having formally integrated digital volunteers in social media aggregation, and one additional respondent reported having test-bedded the idea. All three of the agencies who utilize VOSTs reported they were pleased with the integration, but they also pointed out that training before an incident is critical to their success. An acute concern for the majority of the respondents is proper vetting and credentialing; this concern is seen as a potential impediment to wider adoption in emergency management agencies aligned with law enforcement. The interviewees were also asked about whether their agencies actively engage traditional volunteers in their emergency operations and whether this is analogous to digital volunteers. Five of the six respondents reported their organizations are actively engaged with volunteers or volunteer networks, but there are concerns about generalizing between physical and digital volunteers. Specific concerns revolve around the difficulty with vetting volunteers who are geographically separated from the agency, and ways to train groups who are not physically present. The three respondents most concerned with potential vetting issues all reported that they are not actively pursuing VOST integrations; the remaining three reported they either utilized VOSTs in the past or are integrating them into their procedures.

When VOST capabilities were further discussed, it became clear that their primary functions are to augment the JIC's ability to address citizen concerns, conduct rumor control, conduct sentiment analysis, and to a lesser degree to actively engage social media users by replying to their posts. When initially asked about whether these efforts play a role in shaping the larger situational awareness of the EOC, all of the respondents reported that these efforts contribute to better situational awareness; however, then were unable to

identify the specific means by which this would occur. Upon further probing, respondents reported that the summaries compiled by the JIC are broadly available throughout the EOC, and there was specific mention of public information officers in the JIC discussing topics of concern with other staff within the EOC. One interesting finding was that the two agencies who tasked their twenty-four-hour warning centers with monitoring social media posts reported no meaningful collaboration between their warning centers and the social media aggregators in the JIC. In each of these cases, the warning centers remained primarily responsible for detecting operationally relevant information while the JIC took responsibility for crisis communication. This suggests that even though VOSTs are augmenting the capabilities of EOCs, their ability to significantly contribute to the larger situational awareness of an EOC remains constrained based on their placement within the larger EOC structure.

G. ANALYSIS

Collectively, the interviews highlight the potential utility of social media to enrich and amplify public safety agencies' understanding of both steady-state and crisis scenarios. There was a clear appreciation for the responsiveness and reach of several social media tools, as well as an understanding of the unique audiences available through each platform. Several overarching themes emerged across interviews that touched on the promise and the perils associated with integrating social media. The first was the recognition that social media provides a fundamentally different type of communication between citizens and public safety officials, one in which there is an expectation of two-way communications. In several of the respondents' agencies, social media monitoring involves far more than passively collecting information; staff are actively responding to citizen reports and quashing rumors as they emerge. One interviewee mentioned that the primary advantage of social media is the ability to intercept misinformation before it takes hold. The potential for these spontaneous and authentic communications to "go viral" was specifically mentioned in several interviews and could be partially responsible for the second broad finding.

The next overarching theme that emerged from the interviews is the difficulty inherent in judging the veracity of social media posts. There were several unique aspects to the issue of veracity, depending on how social media posts are being utilized by a responding agency. When social media posts are being utilized to judge the overall mood of a community by aggregating positive and negative posts, the relative content of each post is secondary to the overall tone of the message and there were no reported concerns with the authenticity of the information. The same holds true when agencies are utilizing social media to monitor rumors and false information. In these cases, agencies are able to clearly articulate what is occurring during an incident; when posts are made that deviate from known facts, the respondents reported that they are able to quickly provide more accurate information. The situation is very different when social media information is utilized to enhance situational awareness. Several respondents reported concerns about the potential for false information that could delay or impede response operations. These concerns were most strongly expressed by interviewees who work in law enforcement; they expressed specific concerns that social media information could be purposely manipulated to paint an inaccurate view of a complex incident. Further probing this line of concern revealed that respondents understand that these issues are not specific to the medium, since existing 9-1-1 systems could also be manipulated to provide false information. Interestingly, although respondents who reported significant concerns with the veracity of social media posts acknowledged that this issue is not unique to social media, they still believed it poses a significant concern to wider adoption of the tool. It is important to point out that these discussions are largely theoretical since no agency reported integrating social media information into operations outside detecting emerging events.

The third theme centered on the difficulty in finding trained staff who have the technical expertise and public safety insight to properly utilize social media tools to build strong situational awareness. Several respondents reported a generational gap within their agency, with younger employees having a strong technical capability and their more experienced workforce having difficulty operating some of the tools. This bifurcation in social media capability means that many of the individuals tasked with monitoring social media lack the firsthand experience that more seasoned public safety employees utilize to

make sense of disaster events. This concern was not uniform across respondents; respondents from larger agencies expressed more concerns with this generational gap.

The final finding was not specifically addressed through the original lines of inquiry but emerged as a potential implication during broad discussion. This theme centered around how enhanced situational awareness stemming from social media highlights the fundamental differences between the hierarchical and interlocking webs of information flows within and between response agencies dealing with a disaster. In public safety agencies that work in complex and multi-jurisdictional environments, situational awareness emerges from the integration of information threads supplied by supporting entities who are each coordinating the tactical response efforts of their respective field staffs. It is important to note the information collected (or not collected) by an organization is rooted in the organizational culture of that specific agency, its ability to compile information rapidly, and its jurisdictional authority. Put more simply, existing public safety entities are wholly reliant on a bottom-up flow of information, with field responders providing on-the-ground data to the incident command, who in turn compiles pertinent information to their EOC, who in turn compiles and feeds this information to a state EOC/ joint field office.

There are three important implications that emerged from discussions of this structure that have not been addressed in prior research and may account for the slow integration of social media into the operational realm. The first stems from examining the traditional role of the EOC in emergency operations. According to NIMS, the role of the EOC is to coordinate actions above the field level and to prioritize competing resource requirements. If an EOC were to collect high-fidelity information about conditions in an impacted area, the only means of verifying the information would be to forward the information to the ICP for action or to task EOC personnel to ground truth the information. The former runs counter to the traditional flow of information in a disaster and would require the ICP to dynamically integrate information from both field staff and an EOC. While this practice may not pose a significant concern in exigent circumstances, if it became a habitual pattern, defined procedures and staffing would have to be addressed. More concerningly, if media-rich data were consistently pushed down to the ICP, it could

lead to the perception that the EOC is taking an active role in tactical operations and thereby undercutting the authority of the incident commander. The alternative solution, having an EOC task its own personnel to ground truth information, raises equal concerns; it violates the principle of unity of command by sending resources into an impacted area that is not being coordinated by the ICP.

The second structural limitation to integrating social media information stems from the limitations imposed by the communicative links with field responders. Despite the proliferation of smartphones, field responders are frequently operating in austere conditions where land mobile radios serve as the primary communications backbone. Significant investments in interoperable radios have eased some of the historical issues with multiple response agencies communicating in a disaster event, but there is only a finite amount of information that can be pushed out to responders using these systems. The constraints imposed by this communication channel can not only limit the information that is transmitted to the field but also increases the potential for significant errors to be introduced when ICP staff attempt to condense media-rich information into concise voice transmissions for field responders.

The final structural constraint on sharing high-fidelity information stems from the lack of a situational awareness tool to provide a common operating picture across public safety partners. While most respondents noted that their agencies have invested in situational awareness tools that allow them to visualize and contextualize incoming information through a geospatial interface, when questioned, each of the respondents noted that they were uncertain as to whether they had the capability to broadly share this information with their public safety partners. In some cases, this was due to the wide range of available platforms being used across the public safety landscape and questions about data interoperability, but there was also acknowledgement that many of these systems require significant digital architecture to operate effectively. While access to redundant broadband internet access could reasonably be assured in EOCs, the ad hoc nature of many field ICPs means that high-bandwidth links cannot be taken for granted in disaster scenarios.

H. CONCLUSION

Analyzing the results of the six interviews with public safety leaders cannot definitively speak to the utility of integrating digital volunteers in crisis scenarios; however, there were clear themes that echoed findings in the existing literature. These themes include:

1. The recognition that social media provides a fundamentally different type of communication between citizens and public safety officials

2. The difficulty inherent in judging the veracity of social media posts

3. The mismatch between the skill sets available to many emergency management professionals and those needed to utilize social media toolsets

4. The inability of many public safety agencies to integrate real-time, media-rich information available via social media with existing text-based reports and hierarchical reporting tools

The common insights shared among the public safety professionals suggest that if trained and vetted volunteers are integrated into catastrophic response efforts, they may be able to positively augment situational awareness. But there are significant caveats. The most significant of these are the structural limitations on information sharing imposed by existing technologies and procedures. Until these underlying issues are addressed through increased investments in redundant and interoperable situational awareness tools and clearly defined procedures for sharing this information with public safety partners, the full utility of digital volunteers may not be realized.

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IV. RECOMMENDATIONS AND CONCLUSION

The interdependencies between critical components of modern infrastructure combined with increased population density and more frequent extreme weather events raises the potential for chaotic and cascading future disasters that differ in distinct and unpredictable ways from prior disaster events. In these crucibles, emergency managers will require accurate and timely information to successfully respond. When viewed collectively, online social media content is now the largest aggregation of writing, imagery, and video ever created. The use of this enormous repository of information by public safety agencies continues to be a topic of widespread discussion among the public and the agencies themselves because of the potential richness and breadth the information might bring when used as an adjunct to traditional reporting streams. Despite this recognition, interviews with public safety leaders suggest that much work remains before these capabilities are realized.

A. AUGMENTING EXISTING INFORMATIONAL MODELS

The traditional hierarchical informational model that serves as an organizational template for emergency management agencies is poorly equipped to adapt to the rapid pace of technological development. The official information streams that are utilized to communicate real-time situational awareness information germane to public health and safety remain focused on textual data providing status updates, articulating outstanding needs, and tracking ongoing missions. While this process is extremely efficient at driving prioritization and allocating scarce resources, it can frequently lead to a myopic perspective of the complexities manifested in a disaster and the view that alternative strategies for synthesizing social media need to be advanced. The integration of a vibrant community of passionate and technologically literate volunteers provides a means for bridging the gap between these legacy structures and next-generational capability in a way that is economically feasible and aligned with existing programmatic functions; yet, after more than a decade, these capabilities have not become significant contributors to organizational sensemaking.

This leads to the natural question: Why these are these capabilities not being more deeply integrated into the operational functions of EOCs outside their role in JICs? One potential contributor is the public safety community's emphasis on the use of vetted information received via authoritative communication streams to make sense of complex disaster scenarios. These workflows and procedures treat on-the-ground information as a private resource that needs to be securely transmitted from the field to decision-makers in a rigidly controlled procedure without addressing the constraints inherent in these systems. The staggering amount of data exchanged via social media is playing an increasingly large role in shaping sensemaking in the aftermath of disaster, and without the means to incorporate this data crisis leaders may develop fundamentally different perspectives on a disaster. This dichotomy, where the public has increased access to instantaneous information from the scene of a disaster while public safety agencies wait for official word to trickle in through authoritative channels, cannot be maintained. The speed of social media drives outsized expectations about government's ability to respond and places a crushing burden on first responders and emergency managers. The time lag between social media information being transmitted and official data streams reporting an incident can slow response efforts and be perceived as an indicator to the public of timidity, lack of concern, or incompetence.

B. SOCIAL MEDIA LIAISON

One potential path forward that has already been advanced in the literature is the creation of a social media liaison position to serve as the interface between digital volunteers and emergency response operations. While some public safety agencies have integrated this position as a best practice, the ad hoc nature of these assignments limits their full utilization. In order to adequately perform their role, staff members in these positions need to be clearly defined components of the incident command system, and training standards and procedures need to be developed to structure their engagement with other responders who are synthesizing information through traditional channels.

The standardization of this position within the existing incident command structure would address two existing gaps that limit the greater use of social media. The first is the

habitual alignment of digital volunteers with the role and function of the JICs. While this relationship developed because of clearly defined needs, including the ability to rapidly scale social media aggregation to better inform the public and address emerging rumors, it also limits the full utility of digital volunteers. Within the incident command system, the public information officer's role focuses on the rapid and accurate reporting of incident information provided by the EOC or ICP that has been cleared for release. In the best of circumstances, aligning digital volunteers within the JIC function requires an additional level of coordination; the JIC staff would have to relay information to other incident command system functions. And in the worst scenarios—like the chaotic response to an unfolding disaster—this coordination may not occur at all. Additionally, public information officers operating in a JIC are not required to cross-train in more operational roles and may lack the subject matter expertise required to ascertain the criticality of incoming social media data. As noted, staff in an EOC frequently must rely on their subject matter expertise or prior training to make sense of the information provided from the field, suggesting that the absence of this experience could impact how incoming information is prioritized and integrated into a larger picture of what is unfolding in the field.

The second gap that would be addressed by the creation of a liaison position is the disconnects that can occur when differing levels of the response structure have access to information about current conditions. It is a long-held truth that all disasters begin and end at the local level, and the creation of a social media liaison position within the incident command structure would ensure a standardization of information streams to all levels of the disaster. This does not indicate that the types of information needs at different coordination levels are consistent; many of the information requirements in an ICP differ from those in an EOC. However, creating a position built on a systematic framework for how information is collected, processed, and shared will ensure that, as unique information requirements are expressed, they are transparent to all levels of responders. Additionally, this structure would ensure that information needs that are consistent across all response functions are readily accessible.

One additional benefit to the creation of a social media liaison position is the potential to add this capability into the resource typing format to make it available for

mutual aid. The concept of resource typing, or typing for short, originated in the fire service and refers to a formal process for describing, defining, and specifying the requirements for equipment or personnel in order to facilitate the rapid identification of available capabilities that can be moved from one jurisdiction to fill capability gaps. Since no public safety agency is resourced and staffed with enough depth to respond to all possible contingencies, the typing of this position would ensure that agencies with lean resources would have the ability to rapidly request this capability.

C. STANDARD OPERATING PROCEDURES FOR DIGITAL VOLUNTEERS

Creating an agency liaison is an important first step to better integrating the use of social media, but there are other intertwined structures that can be put in place to ensure the successful integration of digital volunteers into social media collection efforts. The first of these is the creation of SOPs for the collection, synthesis, and integration of social media posts by digital volunteers. Although many VOSTs share their best practices and collection techniques, there is no clearly defined standard for how to gather and synthesize social media posts. If the development of standards and procedures for the role of social media liaison are built in conjunction with defined SOPs for digital volunteers, a seamless, scalable, and trainable system can be developed that meets the requirements of all impacted parties. This could be especially impactful for the growth and development of digital volunteers who are not bound by the same geographic constraints as traditional volunteers. As it now stands, many of the most practiced digital volunteers belong to VOSTs that are aligned with forward-leaning jurisdictions. While these relationships allow for integration into exercises and existing procedures, the lack of defined standards limits their ability to assist other impacted jurisdictions. By creating baseline vetting requirements and SOPs, digital volunteers have the potential to serve in a manner more akin to other components of the mutual aid system. Although there are a number of passionate and dedicated digital volunteers and support communities across the nation, there is no focal point within the existing community with the authority to create these standards; their development has to be guided by the public safety professionals ultimately responsible for promulgating national standards.

D. DATA INTEROPERABILITY ACROSS SITUATIONAL AWARENESS TOOLS

A final requirement to more successfully integrate the work of digital volunteers is the development of practical tools that allow for information to be vetted, aggregated, indexed, and integrated into existing situational awareness efforts. Given the wide disparities between the available situational awareness tools across the nation, this is no small task. One potential path forward that could also address many longstanding issues in data interoperability is to define standards for importing and exporting data streams across situational awareness tools. Although several vendors provide the means to export the information available in their proprietary systems across platforms, capabilities differ wildly and, in some instances, require significant coding to integrate across platforms. The adoption of defined data standards to facilitate the sharing of situational awareness information between proprietary systems would ensure the larger public safety community's ability to perform this critical function. This can be accomplished through several means without significantly curtailing competition between digital situational awareness vendors. The simplest strategy would be to define minimum data interoperability standards in coordination with an existing standards community like the Institute of Electrical and Electronics Engineers (IEEE). The intense competition between vendors within this segment of the software market may lead to the voluntary adoption of these standards across the marketplace. Another, more aggressive technique to ensure these standards are integrated into future iterations of situational awareness viewers is to direct that any federal grants used toward their purchase be limited to systems that are compliant with these standards. Adopting this strategy would still require the development of standardized tools for digital volunteers to aggregate and synthesize their efforts, but in the absence of this standard the proliferation of systems in the public safety space could limit how these tools are integrated across the public safety community.

An alternative solution to the standardization of existing situational awareness viewers would be to adopt a standalone platform for aggregating and synthesizing social media data. One potential best practice would be to utilize a graphical interface that leverages the power of spatial representation to provide context to the accumulated data in

a manner akin to the work of CrisisMappers. The international humanitarian community's utilization of geospatial integration and information aggregation has already highlighted the ease with which disparate communities can understand complex data regardless of organizational and language barriers. The resultant products of this fusion of techniques provide an intuitive understanding of information by using location and time as contextual reference points. A number of web-based geospatial tools could become the backbone of these efforts since they are widely available, allow multiple users to work in parallel, and have the ability to be viewed—and in some cases integrated into—many situational awareness viewers. One intriguing potential would be leveraging the significant federal investments in the Next Generation Incident Command System (NICS), an open-source situational awareness tool developed by the Massachusetts Institute of Technology's Lincoln Laboratories in collaboration with DHS S&T. This system was designed and engineered in close coordination with first responders and public safety partners and provides a simplified geospatial interface capable of being used by any computer and mobile platform with an internet connection. There are other existing vendor-based platforms that could also perform this function admirably, but the key to more standardized use of these geospatial capabilities requires defining a small set of systems that digital volunteers can actively utilize in crisis events.

E. OPEN SOURCING SITUATIONAL AWARENESS

The final, and most radical, means to integrate social media into emergency response is to fundamentally redefine the way disaster information is synthesized and promulgated. Although concepts like VOSTs have made significant strides toward processing social media data in crisis events, in some ways they lack some of the raw dynamism evident in the digital humanitarian fields. Cutting-edge concepts like crisis mapping and artificial intelligence in disaster response are continually being test-bedded and refined by digital humanitarians supporting disaster events, but only outside the United States. This raises the question: What might account for this profound gap in imaginative solutions? One potential answer is that the professionalization and specialization that is the hallmark of the public safety sector in the United States has had the unintended consequence of stifling innovation within the volunteer community. One fact supporting

this conjecture is that a common thread tying together all the successful digital humanitarian deployments is noticeable gaps in the public safety communities of the impacted countries. Perhaps the lack of robust and formalized systems for responding to disasters is itself a predicate for profound innovations within and across the digital volunteer community. This does not indicate that the significant investments in professionalizing public safety in the United States are maladaptive or should be deconstructed; to do so without a meaningful alternative is likely a calamitous course of action. However, examining this potential cause and effect raises a third path that may augment the capabilities of communities to respond to disasters while simultaneously driving innovation in the public safety sphere.

Following this path would require a fundamental reimagining of the role of digital and traditional volunteers in communities impacted by disaster events. In this conceptualization, digital volunteers would aggregate available social media information and utilize visualization tools like geospatial interfaces to provide context, but instead of sending the information to the public safety community for their exclusive use, they would make the information openly available to anyone with an internet connection. There is precedent for this new conceptualization that emerged in the response to the historic flooding experienced during Hurricane Harvey in 2017. After the greater Houston area faced catastrophic rainfall stemming from the stalled hurricane, residents of wide swaths of south Texas found themselves stranded by floodwaters. The vast scale of this flooding dwarfed the capabilities of the first responders deployed to the impacted areas, and in response an ad hoc collection of volunteers, who christened themselves the *Cajun Navy*, arrived in their personal watercraft to rescue stranded individuals. Since this loose aggregation of volunteers lacked any formal situational awareness tools, a cadre of digital volunteers aggregated available information streams and served as unofficial dispatchers to help the Cajun Navy locate people who needed evacuation.

The natural extension of these efforts would be to create standardized tools allowing digital volunteers to aggregate and synthesize traditional media and social media information, but to do so in a way that is open and transparent instead of walled off behind the veil of official response efforts. While many of the tools and pe would remain consistent

with the essential elements of information articulated by the public safety community, the intended audience for these efforts would be expanded to include residents seeking more information on the impacts to their communities and volunteers augmenting the capabilities of professional responders. There are significant impediments to the broad use of these strategies, including concerns stemming from potential liabilities that would have to be addressed. However, this approach provides a means to better execute a whole-of-community response and start to build a culture of preparedness throughout the nation.

F. CONCLUSION

This thesis advances a series of recommendations intended to increase the inclusion of digital volunteers in the emergency response phase of disasters in order to leverage their transformative information tools. Integrating their full suite of capabilities is not a binary solution, and individual emergency management agencies will have to balance their own information requirements against operational and security concerns. The summarized recommendations outlined here provide potential starting points, ranging from incremental shifts to a fundamental reimagining of how an emergency management agency can gather situational awareness in future disasters.

1. Operationalize the use of all publicly available digital information streams available from citizens within disaster zones until the available information is superseded by information vetted through on-scene personnel

2. Create a credentialed social media liaison position within the FEMA National Qualification System to serve as the interface between digital volunteers and emergency response operations

3. Promulgate standard operating procedures and credentialing for digital volunteers in order to facilitate mutual aid across impacted agencies

4. Define data interoperability standards for situational awareness tools in order to allow agencies to digitally collaborate and better leverage the efforts of digital volunteers

5. Adopt a standardized geospatial platform for aggregating social media feeds in disaster events facilitating cross-training across responding agencies and leveraging the capabilities of digital volunteers

6. Foster full data transparency to facilitate the use of trained and vetted volunteers to augment the capabilities of public safety personnel in catastrophic scenarios

The staggering amount of data exchanged via social media is playing an increasingly large role in shaping sensemaking in the aftermath of disaster; without the means to incorporate this data, crisis leaders may develop fundamentally different perspectives on a disaster. One technique capable of addressing this gap is the integration of self-organized volunteer groups that exist to augment official emergency response capabilities by communicating and synthesizing crisis information. These digitally enabled groups provide a path to actively engage the public in disaster response efforts in a way that increases an organization's cognitive capital.

This thesis asked the question, Can digital volunteers enhance crisis sensemaking in disasters? The responses of emergency management professionals across the nation indicated a resounding *yes*, but it is clear there is a gap between understanding the potential capabilities these volunteers bring and their utilization. The traditional hierarchical model that serves as an organizational template for emergency management agencies may not be optimized to deeply and fully integrate the sensemaking capabilities that technological innovation is making available. The integration of a vibrant community of passionate and technologically literate digital volunteers provides a means for bridging the gap between these legacy structures and next-generational capability in a way that is economically feasible and aligned with existing structures. Emergency response agencies must move past the implicit belief that their most critical coordination will always occur within formal channels and recognize that key pieces of operational information may lie outside the bounds of their formal systems. If this awareness can be fostered by further integration with digital volunteers, then the potential to build stronger and more resilient response capabilities can revitalize the field and fuse tradition with technology.

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APPENDIX A. QUESTION SUMMARIES

Do you believe that social media can provide valuable information in a crisis?

4 respondents	Information Collection
2 respondents	Crowdsourcing
2 respondents	Public messaging
1 respondent	Rumor control
1 respondent	Information sharing

Does your agency monitor social media to gain situational awareness before, during, or after crisis events?

5 respondents	Yes. All phases
1 respondent	Yes. Leading to events.

What types of social media platforms does your agency utilize?

6 respondents	Twitter
5 respondents	Facebook
2 respondents	Instagram
2 respondents	Dataminr
2 respondents	YouTube

Does your agency have any full-time staff tasked with monitoring social media as a sole or additional duty?

2 respondents	Additional duty in watch center
2 respondents	Additional duty in public affairs
2 respondents	No full-time staff tasked as sole or additional duty

Is social media monitored 24 hours a day?

4 respondents	Not monitored 24x7
2 respondents	Monitored 24x7

How does your agency process social media feeds—Are they analyzed as a standalone function or integrated into other analytical channels?

4 respondents	Analyzed as a standalone and then then integrated into other channels
1 respondent	Integrated into other analytical streams
1 respondent	Both; sometimes analyzed standalone and other in a integrated fashion

Does your agency provide the staff with training on social media-based information collection?

3 respondents	On-the-job training
2 respondents	Training provided by vendors
2 respondents	Training by VOST organizations
1 respondent	FEMA training course on social media
1 respondent	NDPCC training course on social media
1 respondent	No formal training

What is the primary mode of information collection—keyword searches, or tools?

6 respondents	Key word searched
2 respondents	Hashtags
2 respondents	Geofencing

Does your agency provide standardized elements or categories of information for staffers to utilize as they monitor social media to guide their information collection?

2 respondents	No
1 Respondent	SOPs for activation criteria and goals based on event
1 Respondent	List of hazards to watch for
1 Respondent	No, look for significant events
1 Respondent	No, but a list of hashtags is provided

How do these staffers route the social media information they collect for use in the rest of your agency? Are there any preset protocols or policies in place for such information sharing?

1 Respondent	Watch center verifies with official channel then adds to executive report
1 Respondent	Generate a listening report used by plans and incident commander.
1 Respondent	Reports aggregated by VOST and sent to EOC
1 Respondent	No formal process
1 Respondent	Routed to PAO, field managers, and leads; some information only stays in the EOC
1 Respondent	Watch center routes to branch with primary reporting responsibility

Does your agency have a published social media policy?

3 Respondents	No
1 Respondent	Internal draft
1 Respondent	Yes
1 Respondent	Unpublished draft

During a crisis event do you assign additional staff to monitor social media?

4 Respondents	No
1 Respondent	Add staff who collect as a collateral duty
1 Respondent	Yes, reassign additional staff

Do you believe that limited staffing provides an impediment to social media information collection in crisis events?

6 Respondents	Yes

Do you believe that volunteers can provide assistance with monitoring social media information in crisis events?

4 Respondents	Yes, if trained/vetted
2 Respondents	Yes

What do you believe are the biggest challenges to monitoring social media in a crisis event?

1 Respondent	Having people with right focus
1 Respondent	Having enough trained people to sort through the info
1 Respondent	The scale and size
1 Respondent	The chaos, so much is going on at once, synchronizing
1 Respondent	Lots of challenges, perceptions are a concern
1 Respondent	Validate sources, communicating with the field

Does your agency have a formal volunteer support system in place to assist in crisis situations?

2 Respondents	Yes, VOST
2 Respondents	No
1 Respondent	Informal networks
1 Respondent	Yes, VOAD

Does your agency utilize, or are they planning on utilizing, trained volunteers to assist with monitoring social media in crisis events?

3 Respondents	No
3 Respondents	Yes, VOST capability

Are there any statutory, operational, or organizational impediments that you are aware of that might limit the use of volunteers to assist with filtering/monitoring social media in crisis events?

2 Respondents	Integration into structure of incident
2 Respondents	Liability
2 Respondents	Vetting

What metrics does your agency utilize to measure the success or impact of social media?

1 Respondent	Retweets and views
1 Respondent	Number of items we may have missed without monitoring
1 Respondent	Growth in followers
1 Respondent	Outreach efforts measured by reads
1 Respondent	Platform analytics—engagement, sentiment analysis, influencers
1 Respondent	No formal metrics

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APPENDIX B. INTERVIEW TRANSCRIPTS

A. INTERVIEW 1

QUESTION 1: Do you believe that social media can provide valuable information in a crisis? If so, in what ways?

> Yes, yes I do. We use it for crowdsourcing information from the public and sharing information. There are a lot of situations where the first inkling that something is occurring is via social media. Capturing those early alerts to something changing can really help in some situations. It really depends on the situation though. There have been situations where we haven't seen the amount of information we would expect and just get lots of reposts of the same information.

QUESTION 2: Does your agency monitor social media to gain situational awareness before, during, or after crisis events?

> Yes, we do it in all the time. And I mean all the time. We use a tool called Dataminr in our watch center and our EOC to aggregate social media that is important to us. We usually will have at least one staff who is familiar with how to use the tool, and they will look for events that are unusual. Many of the news outlets are big users of social media, and they report on twitter before they go live with their reports. In some cases it's like watching a news broadcast a few minutes before they have reporters on the scene.

QUESTION 3: What types of social media platforms does your agency utilize?

> We use twitter and Dataminr, it is more efficient to use. We also use Twitterfall. I believe that Twitterfall was a free client, and that we paid for Dataminr. The key for us was how could we easily display important tweets and posts. We couldn't just have people trying to find items, that would be like a needle in a haystack. I know our public affairs is heavily into Facebook also. They are posting steadily during disaster events and even in the lead up to prepare areas. And they use Youtube to push their own media streams.

QUESTION 4: Does your agency have any full-time staff tasked with monitoring social media as a sole or additional duty?

> Not as a sole duty, but all of our watch center staff have the responsibility for reviewing social media. We could probably use someone to do it full time, but we aren't funded for it. We placed it in our watch center because

> that gives us the best coverage. They are open around the clock and we have 3–4 people there at any one time so there are more eyes on the info and they can share duties.

QUESTION 5: How does your agency process social media feeds—Are they analyzed as a standalone function or integrated into other analytical channels?

> Our watch center uses social media for situational awareness and if it has applicability for intelligence related functions they pass it to the fusion center. But I would say both. We send some reports for information to the field or to our partners, and all we include is what we found so in those cases it is standalone. But in a disaster, we try to plug it into other information like a map or other product so it has more context. If it has context information because sometimes they don't have enough to go on. The biggest use case we have used it for is to use it as a trigger to get more information from the field. That has been problematic in some cases because we are asking about a situation that may not have made it to the dispatch center. There have been situations where we were blown off by a counterpart and then they call back a few minutes later and report just what we asked them about. In some ways this proves that it can play a big role. But it also shows that the systems for integrating this info aren't out there. I think the path to integrating them is going to be really bumpy because not everyone has the money or people to process this. The system isn't designed for these inputs at all levels at all times.

QUESTION 6: Does your agency provide the staff with training on social media based information collection?

> We have generic agency level training on Dataminr, but nothing unique. I don't know that there is much out there on information collection. I know we have a lot of on the job training from our own analysts in the watch centers though.

QUESTION 7: What is the primary mode of information collection—keyword searches, or tools?

> We use toolwords like "suspicious package" and geofencing on Dataminr. The toolwords that we use were all compiled from our lists of information we received through other systems. They match our essential elements of information that we try to collect on any disaster that is reported to us so we are consistent. I know the geofencing has been useful in disasters because we can only look at information in a specific area. That helps reduce the clutter.

QUESTION 8: Does your agency provide standardized elements or categories of information for staffers to utilize as they monitor social media to guide their information collection?

> I'm not aware of any. Well, I mean we use the keywords that match our other information products. And we have lists of hashtags and accounts that we follow that tend to report on disaster very quickly like the media outlets. We do have standardized elements that we don't collect. We aren't just looking at everything that is going on that would be ridiculous.

QUESTION 9: How do these staffers route the social media information they collect for use in the rest of your agency? Are there any preset protocols or policies in place for such information sharing?

> When our watch center finds a posting, they would start by confirming it through official channels. That might be actually calling a local agency and asking if there is anything amiss. If it is verified or in some cases trending they would put it in an executive staff report. There have been cases where we couldn't get confirmation locally and we didn't report it and then later it turned out to be true and we were slower to respond so we also watch if something is trending and rely on the judgement of the staff. It isn't a perfect process. We don't share the information broadly, it is just for our agency uses because of privacy concerns. I think many partners might be uncomfortable if we pushed the information broadly because that would make it more official even though the information didn't come through traditional channels. In big disaster events the information is turned over to the EOC and they make the decision on where to route the info. And I know the PAO has their own staff monitoring social media, but that is specific to their section.

QUESTION 10: Does your agency have a published social media policy?

> We have an internal document, but it isn't formally published as such.

QUESTION 11: During a crisis event do you assign additional staff to monitor social media?

> We add staff to our watch center in crisis events but not as an exclusive task. We are trying to do that though. I mean when we get to big disaster the responsibility for reporting on the event doesn't happen in the watch center it happens in the EOC. And we do have staff that we assign in the EOC to monitor social media and get the information to the right section. So we do have additional staff, usually 2–3 assigned to the role. And that doesn't

> count the PAO staff in the JIC that are always monitoring social media to see what the public is feeling about the event.

QUESTION 12: Do you believe that limited staffing provides an impediment to social media information collection in crisis events?

> Staffing and experience are the issue, in some ways they are always the issue though. How many problems couldn't be solved by adding more people? But it isn't just more people. We need more people in the right places. If we are getting a lot of information but then can't get it verified with responders in the field, or even give responders the information so they can act then we aren't solving the core problem of communication. It is the reason you see communication on every AAR ever done.

QUESTION 13: Do you believe that volunteers can provide assistance with monitoring social media information in crisis events?

> Potentially, if they are vetted and credentialed. One of the problems with the idea of vetting is that there needs to be broader standards for what constitutes vetted. Agencies all have to agree before they are comfortable with the idea of sharing information outside normal channels. I think it would be more likely to see volunteers working tightly with sworn staff though.

QUESTION 14: What do you believe are the biggest challenges to monitoring social media in a crisis event?

> Having people to focus, validate, verify the sources. It is a labor intensive process and you have to know when a source isn't the source. There is also the issue with the so what. There are a lot of information you can get on how the public is dealing with the disaster but if there is operational info then it became a question of how to action that information. The best-case scenarios would be large fire or law agencies who have clear communications structures and can take this info and get it to the field commands. But in all the other instances or as soon as you have to share across partners, I think it becomes a bug issue. The best info on the ground will always come from trained responders and I don' t think we have figured out how to integrate the two. Once we find a way to have real people verify or amplify this kind of information it is going to be tough to integrate.

QUESTION 15: Does your agency have a formal volunteer support system in place to assist in crisis situations?

> We have a VOAD representative in the EOC that we can tap into and we have an entire section that integrated the work of volunteers in the disaster areas. But we don't have any volunteers assisting with social media.

QUESTION 16: Does your agency utilize, or are they planning on utilizing, trained volunteers to assist with monitoring social media in crisis events?

> No, we don't. We have a lot of staff that we can draw from and I don't think having people is the impediment to our use. It is other issues like we talked about.

QUESTION 17: Are there any statutory, operational, or organizational impediments that you are aware of that might limit the use of volunteers to assist with filtering/monitoring social media in crisis events?

> There is always the issue of liability that seems to come up. And there are going to be issues of vetting that we discussed. But otherwise I don't think so. There are organizational culture issues, a lot of of people think social media is just a nuisance and dilutes our capacity and focus.

QUESTION 18: What metrics does your agency utilize to measure the success or impact of social media?

> We really don't have them. Maybe retweets would be the informal one. Or how many views we have to let us know how many people are looking at our stuff. I mean we have metrics for how our own information is consumed, but we don't have any on how we use it which is what I think you are asking.

B. INTERVIEW 2

QUESTION 1: Do you believe that social media can provide valuable information in a crisis? If so, in what ways?

> Totally. Especially at the local level. We view it as a tool to crowdsource and see what is happening in a community. It's easier to see types of info and we get a less filtered lens. We had users report erosion down to the street locations. That helps is target resources to the areas with the greatest

> impacts. We also use it for rumor control, to find out what bad information is out there and what inaccuracies we need to correct. We trust but verify.

QUESTION 2: Does your agency monitor social media to gain situational awareness before, during, or after crisis events?

> We do, but especially during crisis events. When storms or other issues are inbound that is when we can really get a sense of preparing that is occurring and send out information to prepare the public. I would say that a lot of our awareness of how seriously the public is preparing is coming from online.

QUESTION 3: What types of social media platforms does your agency utilize?

> We use Twitter, Facebook, Flickr and YouTube but we use different social media for different reasons. Most of the social media is to the public groups that echo out our message to their own groups and networks. We don't have any single tool that we use for gathering information though. Twitter seems to have more information, or at least I see it in more reports.

QUESTION 4: Does your agency have any full-time staff tasked with monitoring social media as a sole or additional duty?

> We have 2 staff in our public affairs shop that spend 50% of their time on social media. They work normal hours of 8 to 5, but they have phones and are always attuned to what is occurring. If we have an activation they obviously would be coming in. So its an additional duty but it can take more of their time in some situations.

QUESTION 5: How does your agency process social media feeds—Are they analyzed as a standalone function or integrated into other analytical channels?

> We consolidate the information, and have it sent to the Incident Commander, the Plans Chief or to the EOC. I know that Plans uses the info to get a sense of the scope of the disaster, but I don't think the info is sent throughout the EOC even when we send it to our EOC staffer. I haven't seen the information pulled into a report from the Incident Commanders staff though, so I don't know how they use it. I know when we pass information on road damage to public works they appreciate it. They compare it with 511 information. But public safety is facing a different problem and they have to deal with more time pressures and situations where people may be dead or injured so its different.

QUESTION 6: Does your agency provide the staff with training on social media-based information collection?

> Yes. We have a VOST Team and we schedule quarterly training with them that is mandatory to be a part of the team. We have SOPs for the team. We have had one large exercise where we integrated them into the exercise and they really assisted the public affairs cell. Our duty officers and staff love social media because it gives them a better sense of the environment, but it can be hard to simulate in an exercise.

QUESTION 7: What is the primary mode of information collection—keyword searches, or tools?

> We use a mix of keyword searches and location. The keywords in our events are always gathered after a event and then we add them to our list of keywords to look for. There are always new keywords that are coming up and the list is always changing.

QUESTION 8: Does your agency provide standardized elements or categories of information for staffers to utilize as they monitor social media to guide their information collection?

> Absolutely. We have SOPs for individual mission types outlining goals and activation criteria, amplification based on incident needs. This allows more flexibility in collection and helps us train and identify who the strong users are. Knowing who is really skilled is important because there is a lot that we can't screen for. It's like telling someone to go learn calculus some people won't be able to do it.

QUESTION 9: How do these staffers route the social media information they collect for use in the rest of your agency? Are there any preset protocols or policies in place for such information sharing?

> We generate a listening report in excel that is used by plans and the Incident Commander. We have policies, but they relate to the records retention aspect of the collection. We don't gather on investigations or provide individual case support, we don't specifically mine information from individual users, in fact we don't even dive into user data at all. We don't really gather video and photos from the scene at this time, but we have discussed that possibility in the future.

QUESTION 10: Does your agency have a published social media policy?

> We have a social media policy that provides info on operational guidelines and issues like privacy and information sharing. It is important to have a policy in place and after FEMA published their policy we took that as an indicator it was time to put one up.

QUESTION 11: During a crisis event do you assign additional staff to monitor social media?

> We do—the VOST plugs into a section in the JIC. They gather a lot of sentiment analysis information and help the JIC know when bad information is getting out there, so we don't get behind. The staff that coordinates with the VOST exercises with them, so they have strong communication on what is needed on events. The staff in the JIC don't tell the VOST how to staff just what they need and how often. The VOST figures out who is needed and slots them into times. When there are issues the staff just reached out to the VOST lead.

QUESTION 12: Do you believe that limited staffing provides an impediment to social media information collection in crisis events?

> Yes. Social media is so broad and there aren't enough people to do it full time in a disaster in the EOC. There are space limitations. When we start to get a better handle on how to integrate the information I can see the VOST supporting the EOC like they do the JIC.

QUESTION 13: Do you believe that volunteers can provide assistance with monitoring social media information in crisis events?

> Yes, but there are exceptions. Untrained volunteers have limited efficacy. They cause more problems. We need trusted agents and that is hard to do with on the job training because what we do requires background. It really requires a higher level of skill. If you lack a public safety background it is hard to know what is important. It requires a different perspective. If you don't know how they think then you are probably going to get information that isn't as useful. We still see that all the time but there is a lot of internal policing in the VOST. The exercises are important to help us identify those ones.

QUESTION 14: What do you believe are the biggest challenges to monitoring social media in a crisis event?

> The biggest challenges are having the people available to focus on validating and verifying the information. It is labor intensive to find the source or invalidating bad sources. The other issue will come up if more agencies use VOSTs because there are no standards. Fire and to a degree Law all follow similar procedures so they can share information. I don't think VOSTs can do that well at this point. They can definitely support jurisdictions who don't have a capability but how they share with others in

> the disaster area is tricky. Anything they contribute will be just for a single agency, and if they don't share it then it won't help as much as it could.

QUESTION 15: Does your agency have a formal volunteer support system in place to assist in crisis situations?

> Yes, we have this capacity for big and short duration events. Setting up a VOST on a night at 0100 would be an effective use of this capability. It may not be useful in a shorter event because they take a lot of coordination and time to really get going. There are issues though like what are the protections and liabilities? What do you do if a volunteer goes off the rails? What if they start monitoring behavior? The effects of a screw up on social media could be devastating because everything is out there. I think that is why we have focused them on the JIC up until now.

QUESTION 16: Does your agency utilize, or are they planning on utilizing, trained volunteers to assist with monitoring social media in crisis events?

> We have a VOST team of 30–40 members, but the core of that team is 10–15. They are international, but a lot of state employees come to training and plug in as unpaid volunteers. We do use them in the JOC to monitor what the public is saying, and they collect good info. Any sensitivity to volunteers is blunted because so many of the JIC group isn't traditional badges they are just communicators and because some of the volunteers are already with the state. Before we start using an international team in the EOC we would have to figure out a vetting process though because out law partners wouldn't want information leaked.

QUESTION 17: Are there any statutory, operational, or organizational impediments that you are aware of that might limit the use of volunteers to assist with filtering/monitoring social media in crisis events?

> We need more policies, but we haven't identified any issues yet.

QUESTION 18: What metrics does your agency utilize to measure the success or impact of social media?

> What would we have not found otherwise? Number of found items that if they continued would cause an issue. We had a train that was going to shut down due to weather and strand a lot of people. We were able to see the

issue and keep the train running so it didn't become a sheltering issue. That was definitely a win. There are a couple vignettes like that.

C. INTERVIEW 3

QUESTION 1: Do you believe that social media can provide valuable information in a crisis? If so, in what ways?

> Yes. It is a proactive messaging tool that helps correct bad information before it takes root. We can get a sense of when something is going to be an issue before it is an issue. I remember thinking that we would always be chasing to catch up to reporters because they are always first to the scene. With social media that isn't the case anymore. There have been a few times where I think we are the first agency finding about a unfolding situation. Once that happens it's hard not to be a believer.

QUESTION 2: Does your agency monitor social media to gain situational awareness before, during, or after crisis events?

> We don't have a lot of crisis events but when they do we do monitor social media. In October we almost had a storm that was anticipated to have a significant impact. We used social media to let people know about open shelters and other anticipated actions and we doubled our followers to 30K. You can connect with an audience in a more authentic way on social media. People expect they demand responsiveness and if they send you something you better respond quickly. There isn't a lot of tolerance for delay these days.

QUESTION 3: What types of social media platforms does your agency utilize?

> We use Facebook and Twitter. But most of our real successful outreach is on Facebook. It seems like the community we engage in Facebook is more invested in our communication whereas twitter is flighty.

QUESTION 4: Does your agency have any full-time staff tasked with monitoring social media as a sole or additional duty?

> No, our managers take on the responsibility for monitoring. There was a lot of reluctance when we first started using Facebook and concerns about getting sucked into it all day. The idea was people would just spend the day looking up video clips and messaging high school classmates. I think we were almost forced to adopt this capability because it was the only way to

> reach segments of the population. We recognized we needed engagement, and this was just where people were.

QUESTION 5: How does your agency process social media feeds—Are they analyzed as a standalone function or integrated into other analytical channels?

> We integrate with larger County efforts and integrate into operations. Everything about the community impacts and our communications is shared across departments and we share these internally, so everyone knows the themes and messages. The social media feeds provide real time feedback on what is working and what isn't and allows us to pivot if we need to.

QUESTION 6: Does your agency provide the staff with training on social media-based information collection?

> We have taken the FEMA course work and we have a VOST team in the area that provides expertise. Mostly we use a cheat sheet and track posts by type.

QUESTION 7: What is the primary mode of information collection—keyword searches, or tools?

> Keyword searches

QUESTION 8: Does your agency provide standardized elements or categories of information for staffers to utilize as they monitor social media to guide their information collection?

> No, not at this point. It is hard because you are comparing apples and oranges. Disasters are different and even across the same disaster type you have neighborhoods that react differently. You have to be flexible to get the right information from social media in an emergency.

QUESTION 9: How do these staffers route the social media information they collect for use in the rest of your agency? Are there any preset protocols or policies in place for such information sharing?

> We recently exercised with a VOST, they activated and supported us in the exercise. Law enforcement was really reluctant for them to participate and didn't want to integrate. There was a lot of fear and concern about letting the situation get away from us. They were concerned that they would be influencing operations and could compromise security. The exercise eased these fears and let them see it adds to our control. I started thinking of them

as parallel to our ham radio operators. They have common traits, they aren't always credentialed, they are highly technical and use a skill set that is scary. I like this analogy though because it highlights that we don't control them all.

QUESTION 10: Does your agency have a published social media policy?

We have one at the County level that we fall under.

QUESTION 11: During a crisis event do you assign additional staff to monitor social media?

No, but we do have 2 experienced locals in our backyard who assist. They report right to the JIC and are up and running before you know it. We get a lot of lead time for most of our situations, so this works really well.

QUESTION 12: Do you believe that limited staffing provides an impediment to social media information collection in crisis events?

Yes, and we proved the utility of volunteers in a recent exercise. But it is still hard to describe virtual support in a way that makes sense to law enforcement. They aren't there yet. There are some ICs out there who just won't integrate any info that isn't coming from their staff so I can't say its only law enforcement, but I know that the Sheriff's office doesn't want any outside assistance with information. Using them in public outreach is a no brainer though.

QUESTION 13: Do you believe that volunteers can provide assistance with monitoring social media information in crisis events?

Yes, but there are exceptions. Untrained volunteers don't have the skills to make a real difference. We need trusted agents and that is hard to do in the middle of a storm. It really requires a higher level of skill and that isn't even factoring in the stress of seeing the aftermath of these situations. We have experts who can pick the best volunteers, so we don't have that issue.

QUESTION 14: What do you believe are the biggest challenges to monitoring social media in a crisis event?

The biggest challenge is the vastness of it. It is not knowing what you don't know. How do you steer people in the right direction? How do you ensure that someone doesn't send out the wrong message or gives the impression we are monitoring. There are a lot of people concerned about their privacy. There are a lot of agencies concerned with their privacy.

QUESTION 15: Does your agency have a formal volunteer support system in place to assist in crisis situations?

> VOST is a formal system that is in place for our state, this is important because rural resources are very scarce. Without these capabilities I don't think there would be any. Not all the rural counties use them, but they are available.

QUESTION 16: Does your agency utilize, or are they planning on utilizing, trained volunteers to assist with monitoring social media in crisis events?

> Yes, but we are carefully handpicking volunteers that are the right ones. The ones that are persistent. You have to be aware. The VOST is hungry, they will be there whether you like it or not. What a waste if that info isn't used. I know there is interest in using members from all over, but I don't think law enforcement is going to go for that because how would you ever vet those people?

QUESTION 17: Are there any statutory, operational, or organizational impediments that you are aware of that might limit the use of volunteers to assist with filtering/monitoring social media in crisis events?

> No. I mean I am sure there are, but none are coming to mind. Except for vetting. That is an issue because bad information can really waste resources if they are used to task field resources. But we aren't there yet.

QUESTION 18: What metrics does your agency utilize to measure the success or impact of social media?

> Our only metric right now is growth in followers. In the recent activation we went from 500 to 1000 followers.

D. INTERVIEW 4

QUESTION 1: Do you believe that social media can provide valuable information in a crisis? If so, in what ways?

> Yes, absolutely. We use Nextdoor which is a bulletin board social media cross to reach out throughout the county and have more than 70,000 followers. It helps us with shelter locations. We also use Twitter and Facebook to take the place of traditional press releases or news broadcasts.

> It gives us a more authentic voice and lets us know if we need to put things more into layman's terms.

QUESTION 2: Does your agency monitor social media to gain situational awareness before, during, or after crisis events?

> We monitor all the time, I have a window up when I am working to keep track in County.

QUESTION 3: What types of social media platforms does your agency utilize?

> We use Nextdoor, Twitter, Instagram, Facebook. We don't use snapchat though.

QUESTION 4: Does your agency have any full-time staff tasked with monitoring social media as a sole or additional duty?

> We don't, I have it as an additional duty, but it may become full time soon if we receive an increase in staff funds.

QUESTION 5: How does your agency process social media feeds—Are they analyzed as a standalone function or integrated into other analytical channels?

> A mix of both. We use it primarily for messaging, but we also gather citizen reports and those get documented and added into the mix of our other reports.

QUESTION 6: Does your agency provide the staff with training on social media-based information collection?

> We have training in social media that is conducted through a local consortium, the NDPCC and we have in house training that we have some more tech savvy staff put together. We had some interns that we hired after they completed their internship and they have a knack for using it.

QUESTION 7: What is the primary mode of information collection – keyword searches, or tools?

> We use hashtags and keywords for topics like #flooding. There are a lot of hashtags that we gathered from some of our interns and they are pretty comprehensive. I know they get new ones also when we have events with new names.

QUESTION 8: Does your agency provide standardized elements or categories of information for staffers to utilize as they monitor social media to guide their information collection?

> We have a collection of hazards we use to collect information on, that is the limit of it. We don't have the standardization that is in the rest of our reports.

QUESTION 9: How do these staffers route the social media information they collect for use in the rest of your agency? Are there any preset protocols or policies in place for such information sharing?

> We don't have a preset protocol, with the exception of maybe targeted damage assessments. Or I should say preliminary damage assessments. We gather it in an excel document that other parts of the agency can review though. I know the JIC is the primary user, I am not sure how much the rest of the agency uses it.

QUESTION 10: Does your agency have a published social media policy?

> We have an internal set of guidelines for social media, I'm not sure if that is a policy though. It covers how we will monitor it and aligns with the agency policy though.

QUESTION 11: During a crisis event do you assign additional staff to monitor social media?

> No, we just spend more time responding to it with existing staff. During an activation we have all hands on deck and if we need to staff a need we use someone who has the ability.

QUESTION 12: Do you believe that limited staffing provides an impediment to social media information collection in crisis events?

> It is an impediment. There are times where we have to let something by and get less responsive then we want to due to a lack of staff. People expect answers when they post messages to our agency and when we are slow they get more frustrated.

QUESTION 13: Do you believe that volunteers can provide assistance with monitoring social media information in crisis events?

> I don't know. Would they use personal accounts? I can see there being issues with plugging into our formal systems if they aren't employees. We

> don't have volunteers in any of our other systems, and if they aren't in the systems I don't think they could share what they find with our partners. That would be a problem. They aren't just going to accept info because someone says they collected it.

QUESTION 14: What do you believe are the biggest challenges to monitoring social media in a crisis event?

> The whole domain has taken a life of its own, there are a million things going on all at once and that doesn't even factor in the complaint tweets and messages. I think the whole thing is a challenge.

QUESTION 15: Does your agency have a formal volunteer support system in place to assist in crisis situations?

> No, not really. We have a lot of informal systems in place. We work a lot with some food banks and the Red Cross, and they are volunteers so I take that back, we have semi-formal structures in place. When we have issues they are there.

QUESTION 16: Does your agency utilize, or are they planning on utilizing, trained volunteers to assist with monitoring social media in crisis events?

> No. I don't know if we could even do that in the public safety sector. There are too many unknowns. Just how would they report info to? The field or to us? We can't start down the road of having different views on what is going on that is a bad as not doing anything.

QUESTION 17: Are there any statutory, operational, or organizational impediments that you are aware of that might limit the use of volunteers to assist with filtering/monitoring social media in crisis events?

> I don't know, maybe. I think that is something I would have to spend more time looking at to answer.

QUESTION 18: What metrics does your agency utilize to measure the success or impact of social media?

> We use the analytics in Hootsuite which is free, and we look at our outreach efforts via Facebook as measured in people reading our messages over time.

> The interaction with the public is really the metric and I know we have been doing better by the tone of messages aimed at us.

E. INTERVIEW 5

QUESTION 1: Do you believe that social media can provide valuable information in a crisis? If so, in what ways?

> Yes. We use it for situational awareness, for public messaging, for our executive staff, for our command and general staff, for ops and plans, for normal operations. We use it everywhere to vet new incidents occurring in our area.

QUESTION 2: Does your agency monitor social media to gain situational awareness before, during, or after crisis events?

> Yes, we use it in public information and our fusion center uses it. It is very effective at knowing when things go from normal to "uh-oh." Way faster than the old ways.

QUESTION 3: What types of social media platforms does your agency utilize?

> We monitor everything. Snapchat, Pinterest, google blog, Twitter, Facebook, Instagram, Flickr. There are so many social medias out there and each one has its own uses, so we keep it broad.

QUESTION 4: Does your agency have any full time staff tasked with monitoring social media as a sole or additional duty?

> Two staff in our strategic communications shop monitor social media, and we have one fusion center analyst who monitors social media as an additional duty. They are on it pretty much every day, and they have alerts set up to get buzzed when certain trends appear. It gives them a heads up that they are likely to get a call from a duty officer asking about a situation.

QUESTION 5: How does your agency process social media feeds—Are they analyzed as a standalone function or integrated into other analytical channels?

> We do both. It depends on the incident. In our daily ops we analyze and quantify over the course of the month. In a incident like our recent major floods we did situational analytics native to the platforms. We don't add the information to our situational awareness viewer though, too much of the

> info doesn't have the kinda detail we need to plot it accurately. And other agencies use our viewer, we haven't gotten to the point where we just add in info.

QUESTION 6: Does your agency provide the staff with training on social media-based information collection?

> To a limited degree. We conduct social media training for other PAOs and fusion center analysts, and we also train on new tools when we purchase them.

QUESTION 7: What is the primary mode of information collection—keyword searches, or tools?

> We don't geofence. We use native platform monitoring links in real time, and hashtags and comments. I hate Hootsuite and aggregators, they don't provide the full picture. They lose the conversation. When these posts are taken out of context they lose a lot of their value. We need the flow of conversations to understand how the public feels.

QUESTION 8: Does your agency provide standardized elements or categories of information for staffers to utilize as they monitor social media to guide their information collection?

> No, no directions like that. They let us know when something happens. We go to the field manager to vet it, they need to find it and find it fast. The people watching social media have all been through the cycle, so they know what we are looking for. They have the experience which is what matters at the end of the day.

QUESTION 9: How do these staffers route the social media information they collect for use in the rest of your agency? Are there any preset protocols or policies in place for such information sharing?

> All of the collected information is sent to the strategic information office, our regional field managers, and directors. We do have as policy on what they can share and what they can say. And we ensure that certain material stays in the EOC. We don't share the info outside the agency because we don't want to paint a picture that is different from the field reports or lead ICs to think we got info they don't have.

QUESTION 10: Does your agency have a published social media policy?

> We have one but it isn't published. We are finalizing a policy for internal staff use. We do have a user guideline on our public website.

QUESTION 11: During a crisis event do you assign additional staff to monitor social media?

> No, we have 2 staff that are very versed in the procedures, and we use the X VOST. The locals provide a resource request for the VOST resource. VOST shares with the state within 2 hours of their activation, usually involves 2–5 people on google workbook and slack for documentation.

QUESTION 12: Do you believe that limited staffing provides an impediment to social media information collection in crisis events?

> Only if they don't know how to monitor. Some people are just overwhelmed. In the X floods I handled all the monitoring myself. VOST adds 24 hours capability and more depth. I think 1–2 can suffice though. It just depends on the area. I think the environment is still changing and if the social media environment continues to fracture there will be a need for more.

QUESTION 13: Do you believe that volunteers can provide assistance with monitoring social media information in crisis events?

> Yes, you absolutely need to have a formal system. Application. Background check, monthly training, active on the platform, and valid state resource request. We have tried to become an EMAC resource for years, but it is on hold. Too many people are uncomfortable with using this capability and I think it is because it doesn't fit into our normal systems. The public safety is slow to get with technology. We have agencies who are still getting into basic things like GIS feeds.

QUESTION 14: What do you believe are the biggest challenges to monitoring social media in a crisis event?

> There are a lot of challenges. We were asked to support a partner who wanted not just monitoring but pushing social media information, so we denied the request. I was surprised because they were law, but they were getting buried in bad press and needed support dealing with the info. In the end we couldn't though. We can't take responsibility for pushing their messaging.

QUESTION 15: Does your agency have a formal volunteer support system in place to assist in crisis situations?

> Yes. The VOST has a process to be a volunteer. The handbook is available online. We don't accept members who aren't vetted the same way we vet our other volunteers and I know that limits some membership. It is the best we can do for now until identity issues online are addressed.

QUESTION 16: Does your agency utilize, or are they planning on utilizing, trained volunteers to assist with monitoring social media in crisis events?

> Yes, we have an application and the sheriff does a background check. We also conduct a phone interview and ask for a posting history. We haven't had to reject any people. But I think that is because when they find out about our screening the ones who might have issues just stop applying.

QUESTION 17: Are there any statutory, operational, or organizational impediments that you are aware of that might limit the use of volunteers to assist with filtering/monitoring social media in crisis events?

> Originally the VOST team had to perform a polygraph and those rules made it hard to stand up the system. But we emphasized that we look at open source information and that the volunteers don't touch our systems.

QUESTION 18: What metrics does your agency utilize to measure the success or impact of social media?

> The analytics are in our platforms. Engagement increases in followers. Increased engagement, sentiment analysis and who the influencers are.

F. INTERVIEW 6

QUESTION 1: Do you believe that social media can provide valuable information in a crisis? If so, in what ways?

> I know that it can provide information that is critical in a disaster. It is the only medium that can outpace the news cycle and cue us to emerging situations. No one expects government to be fast to understanding but this info is changing the paradigm.

QUESTION 2: Does your agency monitor social media to gain situational awareness before, during, or after crisis events?

> Our watch desk is constantly monitoring twitter. They keep a feed running during the day to keep tabs on what is happening on social media and that way they know if there is an emerging event.

QUESTION 3: What types of social media platforms does your agency utilize?

> Twitter and Facebook. We use Twitter for monitoring and Facebook for a lot of our public outreach to the communities.

QUESTION 4: Does your agency have any full-time staff tasked with monitoring social media as a sole or additional duty?

> No, but it is an additional duty for our 24-hour watch officers. Social media updates are always going, but only a fraction of those messages actually discuss events we would monitor. We are looking for large threats that would lead to large impacts. Those are rare so they make it doable by a single staff member. We could use more people in a large event but not day to day.

QUESTION 5: How does your agency process social media feeds—Are they analyzed as a standalone function or integrated into other analytical channels?

> We use it to cue an action or to prompt a request for more information through official channels. We use it like a well-trained hunting dog. We know something is there, but we still need to get eyes on. It is effective at focusing where we are looking but we can't use it alone. The field still needs to confirm.

QUESTION 6: Does your agency provide the staff with training on social media-based information collection?

> We have an in-house training program but nothing official. A lot of our staff are trained from their time with our other formal systems, so they know what they are looking for. What we are looking for isn't changing. Just where we are looking.

QUESTION 7: What is the primary mode of information collection—keyword searches, or tools?

> Hashtags and geofencing are our main modes. We have defined areas where the searches are always occurring and when they are triggered we get an alert. We aren't just randomly surfing through messages.

QUESTION 8: Does your agency provide standardized elements or categories of information for staffers to utilize as they monitor social media to guide their information collection?

> No, but we have built a pretty large list of hashtags. I know it is several pages at this point.

QUESTION 9: How do these staffers route the social media information they collect for use in the rest of your agency? Are there any preset protocols or policies in place for such information sharing?

> We usually send a clip to the branch with responsibility for gathering more information or to add context to a report. We don't ever send it outside our agency though because that could lead to a lot of confusion. Some departments monitor social media, some don't, and it can lead to a lot of mixed messages if we are telling them to look at something that they have already discounted.

QUESTION 10: Does your agency have a published social media policy?

> No, we don't. We don't store information or share it outside our agency.

QUESTION 11: During a crisis event do you assign additional staff to monitor social media?

> Yes, we bring in analysts to assist with monitoring because the volume really increases. It is also harder to vet some of the information.

QUESTION 12: Do you believe that limited staffing provides an impediment to social media information collection in crisis events?

> Yes, absolutely. The volume can be really large. Even when we try to bottle down the amount of messages there are still so many to sort through and some have the potential to be valuable.

QUESTION 13: Do you believe that volunteers can provide assistance with monitoring social media information in crisis events?

> I think they could if they were used widely. I think there is a need in small agencies to have this. They don't have the ability to sort through the deluge and this limits our abilities upstream of the incident.

QUESTION 14: What do you believe are the biggest challenges to monitoring social media in a crisis event?

> Sorting out the useful messages from the junk is hard, you really have to know what it is we are looking for and that frequently changes based on context. And coordination is something that has to be addressed. We can use the information we get in displays and out own reports but how do we get the information to everyone so they can use the information. I haven't seen a good answer to that issue yet.

QUESTION 15: Does your agency have a formal volunteer support system in place to assist in crisis situations?

> No. That's another function entirely.

QUESTION 16: Does your agency utilize, or are they planning on utilizing, trained volunteers to assist with monitoring social media in crisis events?

> Not right now. That would take a lot of coordination and I don't see the need at this time.

QUESTION 17: Are there any statutory, operational, or organizational impediments that you are aware of that might limit the use of volunteers to assist with filtering/monitoring social media in crisis events?

> I don't know. It could be a problem if they aren't vetted. What we do isn't something you just guess at. If you watch any rookie in the field, you can spot them immediately. They don't get it. It would be worse with volunteers, they haven't even been to an academy. They can get experience sure, but without that experience I would say no.

QUESTION 18: What metrics does your agency utilize to measure the success or impact of social media?

> We don't have formal metrics. We don't need metrics like other programs because we know it works it lets us know when something is happening early on. That awareness is enough. We could look at the time between when we see something on social media that helps us save response time but that would just be adding a number to what we already know.

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LIST OF REFERENCES

Acar, Adam, and Yuya Muraki. "Twitter for Crisis Communication: Lessons Learned from Japan's Tsunami Disaster." *International Journal of Web Based Communities* 7, no. 3 (2011): 392–402. https://doi.org/10.1504/IJWBC.2011.041206.

Akhgar, Babak, Dave Fortune, Richard E. Hayes, Bárbara Guerra, and Marco Manso."Social Media in Crisis Events: Open Networks and Collaboration Supporting Disaster Response and Recovery." *2013 IEEE International Conference on Technologies for Homeland Security (HST)* (November 2013). https://doi.org/10.1109/THS.2013.6699099.

An, Jisun, Haewoon Kwak, Yelena Mejova, Sonia Alonso Saenz De Oger, and Braulio Gomez Fortes. "Are You Charlie or Ahmed? Cultural Pluralism in Charlie Hebdo Response on Twitter." *ICWSM* (2016): 2–11. http://www.aaai.org/ocs/index.php/ICWSM/ICWSM16/paper/download/12997/12719.

Ancona, Deborah. "Sensemaking: Framing and Acting in the Unknown." In *The Handbook for Teaching Leadership: Knowing, Doing, and Being*, edited by Scott Snook, Nitin Nohria, and Rakesh Khurana, 3–20. Thousand Oaks, CA: SAGE, 2012.

Anhorn, Johannes, Benjamin Herfort, and João Porto de Albuquerque. "Crowdsourced Validation and Updating of Dynamic Features in Openstreetmap: An Analysis of Shelter Mapping after the 2015 Nepal Earthquake." *Proceedings of the International Conference on Information Systems for Crisis Response and Management 2016 Conference* (May 2016). http://wrap.warwick.ac.uk/78701/1/WRAP_Nepal_ Earthquake.pdf.

Arias-Hernandez, Richard, and Brian Fisher. "The 'Tunnel Vision' Effect: Structuring of Attention and use of Digital Technologies in Emergency Operation Centers." *2013 IEEE International Multi-Disciplinary Conference on Cognitive Methods in Situation Awareness and Decision Support* (2013): 195–98. https://doi.org/10.1109/CogSIMA.2013.6523847.

Bigley, Gregory, and Karlene Roberts. "The Incident Command System: High-Reliability Organizing for Complex and Volatile Task Environments," *Academy of Management Journal* 44, no. 6 (2001): 1281–1299.

Blum, Jeffrey R., Alexander Eichhorn, Severin Smith, Michael Sterle-Contala, and Jeremy R. Cooperstock. "Real-Time Emergency Response: Improved Management of Real-Time Information during Crisis Situations." *Journal on Multimodal User Interfaces* 8, no. 2 (2014): 161–173. https://doi.org/ 10.1007/s12193-013-0139-7.

Breen, Joseph J., and David R. Parrish. "GIS in Emergency Management Cultures: An Empirical Approach to Understanding Inter-and Intra-agency Communication during Emergencies." *Journal of Homeland Security and Emergency Management* 10, no. 2 (2013): 477–495. https://doi.org/10.1515/jhsem-2013-0014.

Brennan, Mark A., and Courtney G. Flint. "Uncovering the Hidden Dimensions of Rural Disaster Mitigation: Capacity Building through Community Emergency Response Teams." *Southern Rural Sociology* 22, no. 2 (2007): 111–126. http://journalofruralsocialsciences.org/pages/Articles/SRS %202007%2022/ 2/SRS%202007%2022%202%20111-126.pdf.

Bruns, Axel, Jean E. Burgess, Kate Crawford, and Frances Shaw. *#Qldfloods and @QPSMedia: Crisis Communication on Twitter in the 2011 South East Queensland Floods*. Brisbane, Australia: ARC Centre of Excellence for Creative Industries and Innovation, Queensland University of Technology, 2012.

Burnap, Pete, Matthew L. Williams, Luke Sloan, Omer Rana, William Housley, Adam Edwards, Vincent Knight, Rob Procter, and Alex Voss. "Tweeting the Terror: Modelling the Social Media Reaction to the Woolwich Terrorist Attack." *Social Network Analysis and Mining* 4, no. 1 (2014): 206. https://doi.org/10.1007/ s13278-014-0206-4.

Burns, Ryan. "Rethinking Big Data in Digital Humanitarianism: Practices, Epistemologies, and Social Relations." *GeoJournal* 80, no. 4 (2015): 477–490.

Cameron, Mark A., Robert Power, Bella Robinson, and Jie Yin. "Emergency Situation Awareness from Twitter for Crisis Management." *Proceedings of the 21st International Conference on World Wide Web* (April 2012): 695–98. https://doi.org/10.1145/2187980.2188183.

Capelo, Luis, Natalie Chang, and Andrej Verity. *Guidance for Collaborating with Volunteer & Technical Communities*. New York: Digital Humanitarian Network, 2012. http://digitalhumanitarians.com/content/guidance-collaborating-volunteer-technical-communities.

Carafano, James J. "Preparing Responders to Respond: The Challenges to Emergency Preparedness in the 21st Century." Heritage Lectures no. 812, The Heritage Foundation, 2002. https://thf_media.s3. amazonaws.com/2003/pdf/hl812.pdf.

Chen, Rongjuan, and Yasuaki Sakamoto. "Feelings and Perspective Matter: Sharing of Crisis Information in Social Media." *Proceedings of the 47th Hawaii International Conference on System Sciences* (March 2014): 1958–1967. https://doi.org/10.1109/HICSS.2014.248.

Cnaan, Ram A., and Femida Handy. "Towards Understanding Episodic Volunteering." *Vrijwillige Inzet Onderzocht* 2, no. 1 (2005): 29–35. https://www.researchgate.net/profile/Femida_Handy/ publication/294689552.

Cobb, Camille, Ted McCarthy, Annuska Perkins, Ankitha Bharadwaj, Jared Comis, Brian Do, and Kate Starbird, "Designing for the Deluge: Understanding & Supporting the Distributed, Collaborative Work of Crisis Volunteers." *Proceedings of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing* (February 2014): 888–899. https://doi.org/10.1145/2531602.2531712.

Cohen, Estes S. "Sandy Marked a Shift for Social Media Use in Disasters." *Emergency Management*, March 7, 2013. http://www.govtech.com/em/disaster/Sandy-Social-Media-Use-in-Disasters.html.

Coleman, David J., Yola Georgiadou, and Jeff Labonte. "Volunteered Geographic Information: The Nature and Motivation of Produsers." *International Journal of Spatial Data Infrastructures Research* 4, no. 1 (2009): 332–358, https://pdfs.semanticscholar.org/fb3f/ d1663330ec9f34283a9e33f93e1e5656bef6.pdf.

Crowley, John, and Jennifer Chan. *Disaster Relief 2.0: The Future of Information Sharing in Humanitarian Emergencies*. Cambridge, MA: Harvard Humanitarian Initiative, 2011. https://hhi.harvard.edu/publications/disaster-relief-20-future-information-sharing-humanitarian-emergencies.

Curnin, Steven, and Christine Owen. "Obtaining Information in Emergency Management: A Case Study from an Australian Emergency Operations Centre." *International Journal of Human Factors and Ergonomics* 2, no. 2 (2013): 131–158. http://doi.org: 10.1504/IJHFE.2013.057614.

de Albuquerque, João Porto, Benjamin Herfort, Alexander Brenning, and Alexander Zipf. "A Geographic Approach for Combining Social Media and Authoritative Data towards Identifying Useful Information for Disaster Management." *International Journal of Geographical Information Science* 29, no. 4 (2015): 667–689. https://doi.org/10.1080/13658816.2014.996567.

Department of Homeland Security. *Privacy Impact Assessment for the FEMA Operational Use of Publicly Available Social Media for Situational Awareness*. Washington, DC: Government Printing Office, 2016. https://www.dhs.gov/ publication/dhsfemapia-041-operational-use-publicly-available-social-media-situational-awareness.

———. *Using Social Media for Enhanced Situation Awareness and Decision Support*. Washington, DC: Government Printing Office, 2014. https://www.dhs.gov/sites/ default/files/publications/ Using%20Social%20Media%20for%20Enhanced%20Situational%20Awareness%20and%20Decision%20Support.pdf.

Digital Humanitarian Network. “Nepal Earthquake.” Accessed May 18, 2017. http://digitalhumanitarians.com/content/nepal-earthquake.

———. “Super Typhoon Yolanda.” Accessed May 18, 2017. http://digitalhumanitarians.com/content/super-typhoon-yolanda.

———. “Vanuatu (Cyclone Pam).” Accessed May 18, 2017. http://digitalhumanitarians.com/content/vanuatu-cyclone-pam.

———. “West Africa Ebola Response.” Accessed May 17, 2017. http://digitalhumanitarians.com/content/west-africa-ebola-response.

FEMA. “Use of Social Media Tools at FEMA.” November 2, 2009. https://www.fema.gov/news-release/2009/11/02/use-social-media-tools-fema.

Fernandez, Lauren S. “Volunteer Management System Design and Analysis for Disaster Response and Recovery.” PhD dissertation, George Washington University, 2007. http://citeseerx.ist.psu.edu/ viewdoc/ download?doi=10.1.1.606.3321&rep=rep1&type=pdf.

Fernandez, Lauren, Joseph Barbera, and Johan Van Dorp. “Strategies for Managing Volunteers during Incident Response: A Systems Approach.” *Homeland Security Affairs* 2, no. 3 (2006). https://www.hsaj.org/articles/684.

Garg, Muskan, and Makesh Kumar. “Review on Event Detection Techniques in Social Multimedia.” *Online Information Review* 40, no. 3 (2016): 347–61. https://doi.org/10.1108/OIR-08-2015-0281.

Gonzalez, Michael M. “Citizen Involvement in Disaster Management.” Master’s thesis, Naval Postgraduate School, 2005. https://calhoun.nps.edu/handle/10945/2045.

Griswold, Alisha. “Digital Detectives and Virtual Volunteers: Integrating Emergent Online Communities into Disaster Response Operations.” *Journal of Business Continuity & Emergency Planning* 7, no. 1 (2013): 13–25.

Gupta, Aditi, Hemank Lamba, Ponnurangam Kumaraguru, and Anupam Joshi. “Faking Sandy: Characterizing and Identifying Fake Images on Twitter during Hurricane Sandy.” *Proceedings of the 22nd International Conference on World Wide Web* (2013): 729–736. https://doi.org/10.1145/2487788.2488033.

Haraoka, Tomoko, Toshiyuki Ojima, Chiyoe Murata, and Shinya Hayasaka. “Factors Influencing Collaborative Activities between Non-professional Disaster Volunteers and Victims of Earthquake Disasters.” *PloS One* 7, no. 10 (2012): e47203. https://doi.org/10.1371/journal.pone.0047203.

Harrold, John R. "Achieving Agility in Disaster Management." *International Journal of Information Systems for Crisis Response and Management (IJISCRAM)* 1, no. 1 (2009): 1–11. https://doi.org/10.4018/jiscrm.2009010101.

Hirsch, Peter, and Rachel Caggiano. "Community Relations: Social Media in Crisis Response: 4 Trends, 5 Opportunities, and a Framework." *Natural Gas & Electricity* 30, no. 10 (2014): 14–19.

Hughes, Amanda L., and Leysia Palen. "The Evolving Role of the Public Information Officer: An Examination of Social Media in Emergency Management." *Journal of Homeland Security and Emergency Management* 9, no. 1 (2012): 1–20. http://dx.doi.org/10.1515/1547-7355.1976.

Hustinx, Lesley, and Frans Lammertyn. "Collective and Reflexive Styles of Volunteering: A Sociological Modernization Perspective." *Voluntas: International Journal of Voluntary and Nonprofit Organizations* 14, no. 2 (2003): 167–187. https://doi.org/10.1023/A:1023948027200.

IBM. "The Four Vs of Big Data." Accessed March 4, 2015. http://www.ibmbigdatahub.com/sites/default/files/infographic_file/4-Vs-of-big-data.jpg.

Imran, Muhammad, Carlos Castillo, Ji Lucas, Patrick Meier, and Jakob Rogstadius. "Coordinating Human and Machine Intelligence to Classify Microblog Communications in Crises." *Proceedings of the 11th International ISCRAM Conference* (May 2014): 712–721. http://www.iscram.org/legacy/ISCRAM2014/papers/p75.pdf.

Imran, Muhammad, Carlos Castillo, Ji Lucas, Patrick Meier, and Sarah Vieweg. "AIDR: Artificial Intelligence for Disaster Response." *Proceedings of the 23rd International Conference on World Wide Web* (April 2014): 159–162/ https://doi.org/10.1145/2567948.2577034.

Internet Live Stats. "Twitter Usage Statitics." Accessed January 25, 2015. http://www.internetlivestats.com/twitter-statistics/.

Kaufhold, Marc-André, and Christian Reuter. "The Self-organization of Digital Volunteers across Social Media: The Case of the 2013 European Floods in Germany." *Journal of Homeland Security and Emergency Management* 13, no. 1 (2016): 137–166. https://doi.org/10.1515/jhsem-2015-0063.

Lachlan, Kenneth A., Patric R. Spence, Xialing Lin, Kristy Najarian, and Maria Del Greco. "Social Media and Crisis Management: CERC, Search Strategies, and Twitter Content." *Computers in Human Behavior* 54, (2016): 647–652. https://doi.org/10.1016/j.chb.2015.05.027.

Liu, Sophia B. "Crisis Crowdsourcing Framework: Designing Strategic Configurations of Crowdsourcing for the Emergency Management Domain." *Computer Supported Cooperative Work (CSCW)* 23, no. 4–6 (2014): 389–443. https://doi.org/10.1007/s10606-014-9204-3.

Liu, Sophia B., Julia Fisher, Julia D. Fraustino, and Yan Jin. "Social Media use during Disasters: How Information Form and Source Influence Intended Behavioral Responses." *Communication Research* 43, no. 5 (2016): 626–646. https://doi.org/10.1177/0093650214565917.

Liu, Sophia B., Leysia Palen, Jeannette Sutton, Amanda L. Hughes, and Sarah Vieweg. "In Search of the Bigger Picture: The Emergent Role of on-Line Photo Sharing in Times of Disaster." *Proceedings of the Information Systems for Crisis Response and Management Conference* (2008): 140.

Liu, Sophia B., and Jen Ziemke. "From Cultures of Participation to the Rise of Crisis Mapping in a Networked World." In *The Participatory Cultures Handbook*, edited by Aaron Delwiche and J. Henderson, 185–96. New York: Routledge, 2013.

Lowe, Seana. *Community Response in a Terrorist Disaster*. Boulder, CO: Natural Hazards Research and Applications Information Center, University of Colorado, 2002. http://hermes.cde.state.co.us/drupal /islandora/object/co%3A13360.

Lutz, Leslie D., and Michael K. Lindell. "Incident Command System as a Response Model within Emergency Operation Centers during Hurricane Rita." *Journal of Contingencies and Crisis Management* 16, no. 3 (2008): 122–134.

Mallender, Jessica. "An Evaluation of Sensemaking in Crisis Contexts: An Organizational Perspective." *The iJournal: Graduate Student Journal of the Faculty of Information* 1, no. 1 (2016). https://theijournal.ca/index.php/ijournal/article/view/26478.

Mazmanian, Adam. "FEMA Tunes into Social Media for Operations." FCW, April 26, 2016. https://fcw.com/articles/2016/04/26/fema-social-ops.aspx.

McDonald, Lynette M., Melissa Creber, Huichun Sun, and Melissa Creber. "Developing Public Disaster Communication for Volunteer Recruitment: Understanding Volunteer Motivations." *World Public Relations Forum 2012 Research Colloquium Conference Proceedings* (November 2012): 82–86.

Meier, Patrick and Jen Ziemke. "Measuring Our Response: An Executive Summary." Report, International Network of Crisis Mappers, 2010. https://docs.google.com/document/d/1qAraVZvoEf_LDHBhAuu2ZknkZSXpRJQMGMj5XSqpLE4/edit?pref=2&pli=1.

Mendoza, Marcelo, Barbara Poblete, and Carlos Castillo. "Twitter under Crisis: Can We Trust What We RT?." *Proceedings of the First Workshop on Social Media Analytics* (2010): 71–79. https://doi.org/10.1145/1964858.1964869.

Militello, Laura G., Emily S. Patterson, Lynn Bowman, and Robert Wears. "Information Flow during Crisis Management: Challenges to Coordination in the Emergency Operations Center." *Cognition, Technology & Work* 9, no. 1 (2007): 25–31. https://doi.org/10.1007/s10111-006-0059-3.

Milligan, Caroline, and Scott Reuter. "New Zealand VOST Training Guide." Training slides, Wellington Region Emergency Management Office, 2012. https://www.slideshare.net/CMilliganNZVOST/new-zealand-vost-training-guide-final-2012.

Mills, Albert J., and Caroline J. O'Connell, "Making Sense of Bad News: The Media, Sensemaking, and Organizational Crisis." *Canadian Journal of Communication* 28, no. 3 (2003): 323–339. http://www.library2.smu.ca/handle/01/25036.

Mooney, Chris, and Brady Dennis. "Extreme Hurricanes and Wildfires Make 2017 the Most Costly U.S. Disaster Year on Record." *Washington Post*, January 8, 2018. https://www.washingtonpost.com/news/energy-environment/wp/2018/01/08/hurricanes-wildfires-made-2017-the-most-costly-u-s-disaster-year-on-record.

Morrow, Nathan, Nancy Mock, Adam Papendieck, and Nicholas Kocmich. "Independent Evaluation of the Ushahidi Haiti Project." *Development Information Systems International* 8 (2011). https://www.researchgate.net/profile/Nathan_Morrow/publication/265059793_Ushahidi_Haiti_Project_Evaluation_Independent_Evaluation_of_the_Ushahidi_Haiti_Project/links/5451ef8f0cf2bf864cbaaca9/Ushahidi-Haiti-Project-Evaluation-Independent-Evaluation-of-the-Ushahidi-Haiti-Project.pdf.

Muralidharan, Sidharth, Leslie Rasmussen, Daniel Patterson, and Jae-Hwa Shin. "Hope for Haiti: An Analysis of Facebook and Twitter Usage during the Earthquake Relief Efforts." *Public Relations Review* 37, no. 2 (2011): 175–177. doi:10.1016/j.ijinfomgt.2010.10.001.

Ofli, Ferda, Patrick Meier, Muhammad Imran, Carlos Castillo, Devis Tuia, Nicolas Rey, and Julien Briant. "Combining Human Computing and Machine Learning to make Sense of Big (Aerial) Data for Disaster Response." *Big Data* 4, no. 1 (2016): 47–59. https://doi.org/10.1089/big.2014.0064.

Palen, Leysia, and Amanda L. Hughes, "Social Media in Disaster Communication." In *Handbook of Disaster Research. Handbooks of Sociology and Social Research*, edited by Havidan Rodríguez, William Donner, and Joseph Trainor. Cham, Switzerland: Springer International, 2018.

Palmer, Adrian, and Nicole Koenig-Lewis. "An Experiential, Social Network-Based Approach to Direct Marketing." *Direct Marketing: An International Journal* 3, no. 3 (2009): 162–176. https://doi.org/10.1108/17505930910985116.

Petersen, Laura, Laure Fallou, Paul Reilly, and Elisa Serafinelli. "Public Expectations of Disaster Information Provided by Critical Infrastructure Operators: Lessons Learned from Barreiro, Portugal." *4th International Conference on Information Systems for Crisis Response and Management in Mediterranean Countries* (2017): 193–203.

Pipek, Volkmar, Sophia B. Liu, and Andruid Kerne. "Crisis Informatics and Collaboration: A Brief Introduction." *Computer Supported Cooperative Work (CSCW)* 23, no. 4–6 (2014): 339–345. https://doi.org/10.1007/s10606-014-9211-4.

Plotnick, Linda, and Starr Roxanne Hiltz. "Barriers to Use of Social Media by Emergency Managers." *Journal of Homeland Security and Emergency Management* 13, no. 2 (2016): 247–277.

Plotnick, Linda, Starr Roxanne Hiltz, Jane A. Kushma, and Andrea H. Tapia. "Red Tape: Attitudes and Issues Related to use of Social Media by U.S. County-Level Emergency Managers." *Proceedings of the ISCRAM 2015 Conference - Kristiansand* (May 2015): 182–192. http://idl.iscram.org/files/lindaplotnick/2015/1225_LindaPlotnick_etal2015.pdf.

Qu, Yan, Chen Huang, Pengyi Zhang, and Jun Zhang. "Microblogging after a Major Disaster in China: A Case Study of the 2010 Yushu Earthquake." *Proceedings of the ACM 2011 Conference on Computer Supported Cooperative Work* (2011): 25–34. https://doi.org/10.1145/1958824.1958830.

Reuter, Christian, Christoph Amelunxen, and Matthias Moi. "Semi-automatic Alerts and Notifications for Emergency Services Based on Cross-platform Social Media Data-Evaluation of a Prototype." In *Informatik 2016*, 1805–1818. https://dl.gi.de/bitstream/handle/20.500.12116/1065/1805.pdf?sequence=1.

Reuter, Christian, Oliver Heger, and Volkmar Pipek. "Combining Real and Virtual Volunteers through Social Media." *Proceedings of the 10th International ISCRAM Conference* (May 2013): 780–791. http://ww.w.iscram.org/legacy/ISCRAM2013/files/122.pdf.

Reuter, Christian and Marc-Andre Kaufhold. "Fifteen Years of Social Media in Emergencies: A Retrospective Review and Future Directions for Crisis Informatics." *Journal of Contingencies and Crisis Management* 26, no. 1 (2017): 41–57, https://doi.org/10.1111/1468-5973.12196.

Reuter, Christian, Thomas Ludwig, Marc-André Kaufhold, and Thomas Spielhofer. "Emergency Services' Attitudes towards Social Media. A Quantitative and Qualitative Survey across Europe." *International Journal of Human–Computer Studies* 95, (November, 2016): 96–111. https://doi.org/10.1016/ j.ijhcs.2016.03.005.

Reuter, Christian, and Thomas Spielhofer. "Towards Social Resilience: A Quantitative and Qualitative Survey on Citizens' Perception of Social Media in Emergencies in Europe." *Technological Forecasting and Social Change* 121, (2017): 168–180. https://doi.org/10.1016/j.techfore.2016.07.038.

Reuter, Christian, Amanda Lee Hughes, and Marc-Andre Kaufhold. "Social Media in Crisis Management: An Evaluation and Analysis of Crisis Informatics Research." *International Journal of Human Computer Interaction* 34, no. 4 (2018): 280–294.

Rogstadius, Jakob, Maja Vukovic, C. A. Teixeira, Vassilis Kostakos, Evangelos Karapanos, and Jim Alain Laredo. "CrisisTracker: Crowdsourced Social Media Curation for Disaster Awareness." *IBM Journal of Research and Development* 57, no. 5 (2013): 4–15. http://doi.org/10.1147/JRD.2013.2260692.

Sauer, Lauren M., Christina Catlett, Robert Tosatto, and Thomas D. Kirsch. "The Utility of and Risks Associated with the Use of Spontaneous Volunteers in Disaster Response: A Survey." *Disaster Medicine and Public Health Preparedness* 8, no. 01 (2014): 65–69. https://doi.org/10.1017/dmp.2014.12.

Simon, Tomer, Avishay Goldberg, and Bruria Adini. "Socializing in Emergencies—A Review of the Use of Social Media in Emergency Situations." *International Journal of Information Management* 35, no. 5 (2015): 609–619. https://doi.org/ 10.1016/j.ijinfomgt.2015.07.001.

Smith, Aaron, and Monica Anderson. "Social Media Use in 2018." Pew Research Center, March 1, 2018. http://www.pewinternet.org/2018/03/01/social-media-use-in-2018/.

Snijders, Chris, Uwe Matzat, and Ulf-Dietrich Reips. "Big Data: Big Gaps of Knowledge in the Field of Internet Science." *International Journal of Internet Science* 7, no. 1 (2012): 1–5.

Soden, Robert, Nama Budhathoki, and Leysia Palen. "Resilience-Building and the Crisis Informatics Agenda: Lessons Learned from Open Cities Kathmandu." *ISCRAM* (2014). https://pdfs.semanticscholar.org/95c0/40abcf3a922c59e160cbda300ae e082087ef.pdf.

Soden, Robert, and Leysia Palen. "From Crowdsourced Mapping to Community Mapping: The Post-earthquake Work of OpenStreetMap Haiti." *Proceedings of the 11th International Conference on the Design of Cooperative Systems* (May 2014): 311–326. https://doi.org/10.1007/978-3-319-06498-7_19.

Stambler, Kimberly S., and Joseph A. Barbera. "Engineering the Incident Command and Multiagency Coordination Systems." *Journal of Homeland Security and Emergency Management* 8, no. 1 (2011). https://doi.org/10.2202/1547-7355.1838.

Standby Task Force. "OCHA South Sudan Deployment: Curating Data for Disaster Preparedness." July 16, 2012. http://blog.standbytaskforce.com/2012/07/16/ocha-south-sudan-deployment-curating-data-for-preparedness/.

Starbird, Kate. "Digital Volunteerism: Examining Connected Crowd Work during Mass Disruption Events." *Proceedings of the CSCW 2012 Workshop on Collaboration and Crisis Informatics* 9, no. 2 (December 2012): 113–119. https://pdfs.semanticscholar.org/f6eb/392b26f3606bf21627b3 d2141a5fcd3f843f.pdf#page=113.

Starbird, Kate, and Leysia Palen. "Pass it On?: Retweeting in Mass Emergency." *International Community on Information Systems for Crisis Response and Management* (2010).

———. "Voluntweeters: Self-Organizing by Digital Volunteers in Times of Crisis." *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (May 2011): 1071–1080. https://doi.org/10.1145/1978942.1979102.

St. Denis, Lise Ann, Amanda L. Hughes, and Leysia Palen. "Trial by Fire: The Deployment of Trusted Digital Volunteers in the 2011 Shadow Lake Fire." *Proceedings of the 9th International ISCRAM Conference* (April 2012): 1–10. http://idl.iscram.org/files/stdenis/2012/207_St.Denis_etal2012.pdf.

Steen, Margaret. "The Social Media Files: Virtual Operations Support Teams Help Tame the Flow of Information from Social Media." *Emergency Management* (Summer 2015): 34.

Subba, Rajib, and Tung Bui. "Online Convergence Behavior, Social Media Communications and Crisis Response: An Empirical Study of the 2015 Nepal Earthquake Police Twitter Project." *Proceedings of the 50th Hawaii International Conference on System Sciences* (January 2017): 284–293. http://hdl.handle.net/ 10125/41183.

Takahashi, Bruno, Edson C. Tandoc Jr., and Christine Carmichael. "Communicating on Twitter during a Disaster: An Analysis of Tweets during Typhoon Haiyan in the Philippines." *Computers in Human Behavior* 50 (2015): 392–398. https://doi.org/ 10.1016/j.chb.2015.04.020.

Tobias, Ed. "Using Twitter and Other Social Media Platforms to Provide Situational Awareness during an Incident." *Journal of Business Continuity & Emergency Planning* 5, no. 3 (Fall 2011): 208–223.

Turoff, Murray, Starr Roxanne Hiltz, Víctor A. Bañuls, and Gerd Van Den Eede. "Multiple Perspectives on Planning for Emergencies: An Introduction to the Special Issue on Planning and Foresight for Emergency Preparedness and Management." *Technological Forecasting and Social Change* 80, no. 9 (2013): 1647–1656.

Utani, Arifumi, Teruhiro Mizumoto, and Takashi Okumura. "How Geeks Responded to a Catastrophic Disaster of a High-Tech Country: Rapid Development of Counter-Disaster Systems for the Great East Japan Earthquake of March 2011." *Proceedings of the Special Workshop on Internet and Disasters* (December 2011). https://doi.org/10.1145/2079360.2079369.

Vieweg, Sarah. "Behavioral Patterns in Online Crisis Communications." *Proceedings of the CSCW 2012: Workshop on Collaboration and Crisis Informatics* (December 2012): 47–50. http://citeseerx.ist.psu.edu/viewdoc/ download?doi=10.1.1.662.2471&rep=rep1&type=pdf#page=47.

Virtual Social Media Working Group and DHS First Responders Group. *From Concept to Reality: Operationalizing Social Media for Preparedness, Response and Recovery*. Washington, DC: Government Printing Office, 2016. https://www.dhs.gov/sites/default/files/publications/SMWG_From-Concept-to-Reality-Operationalizing-Social-Media-508.pdf.

Voigt, Stefan, Tobias Schneiderhan, André Twele, Monika Gähler, Enrico Stein, and Harald Mehl. "Rapid Damage Assessment and Situation Mapping: Learning from the 2010 Haiti Earthquake." *Photogrammetric Engineering and Remote Sensing* 77, no. 9 (2011): 923–931. https://core.ac.uk/ download/pdf/11152364.pdf.

Waugh, William L., and Gregory Streib. "Collaboration and Leadership for Effective Emergency Management." *Public Administration Review* 66, no. 1 (2006): 131–140. https://doi.org/10.1111/j.1540-6210.2006.00673.x.

Weick, Karl E. "Enacted Sensemaking in Crisis Situations." *The Journal of Management Studies* 25, no. 4 (1988): 305–318. https://doi.org/10.1111/j.1467-6486.1988.tb00039.x.

White, Joanne I., and Leysia Palen. "Expertise in the Wired Wild West." *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing* (2015): 662–675. https://doi.org/10.1145/2675133.2675167.

Wiegand, Stefanie, and Stuart E. Middleton. "Veracity and Velocity of Social Media Content during Breaking News: Analysis of November 2015 Paris Shootings." *Proceedings of the 25th International Conference Companion on World Wide Web* (2016): 751–756. https://doi.org/10.1145/2872518.2890095.

Yates, Dave, and Scott Paquette. "Emergency Knowledge Management and Social Media Technologies: A Case Study of the 2010 Haitian Earthquake." *International Journal of Information Management* 31, no. 1 (2011): 6–13. https://doi.org/10.1016/j.ijinfomgt.2010.10.001.

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