

From Situational Awareness to Actionability: Towards Improving the Utility of Social Media Data for Crisis Response

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People are increasingly sharing information on social media during disaster events. This information could be valuable to emergency responders, but there remain challenges for using it to inform response efforts—including filtering relevant information from the large volumes of noise. Previous research has largely focused on identifying information that can contribute to a generalized concept of situational awareness. Our work explores the value of approaching this problem from a different perspective—one of actionability—with the idea that information relevance may vary across responder role, domain, and other factors. This approach asks how we can get the right information to the right person at the right time. We interviewed and surveyed diverse responders to understand what “actionable” information is, allowing that actionability might differ from one responder to another. Through the findings, we (1) offer a nuanced understanding of actionability such that it complements existing approaches based on situational awareness; (2) describe responders’ perspective of what distinguishes good information when making rapid judgments; and (3) suggest opportunities for augmenting social media use to highlight information that needs immediate attention. We offer researchers an opportunity to frame different models of actionability to suit the requirements of a responding role.

CCS Concepts: • **Human-centered computing** → **Computer supported cooperative work**; *Empirical studies in collaborative and social computing*;

Additional Key Words and Phrases: Actionability; Humanitarian response; Emergency response; Social media; Disaster, Situational awareness

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1 INTRODUCTION

Social media use has become a regular feature of the disaster response landscape. These platforms are frequently used by affected people, emergency and humanitarian responders, and remote audiences to share information, seek information, and provide various forms of informational and emotional support during disaster events such as earthquake, hurricanes, and acts of terrorism [2, 19, 21]. Crisis informatics researchers have widely remarked upon the potential for this data to be useful to emergency and humanitarian responders [11, 14, 20, 37]. Though many responders have begun to use social media within their crisis communication plans [11, 14], these data streams are not yet well integrated into other aspects—particularly logistics planning and physical operations—of emergency and humanitarian response [29, 38].

This lack of integration can be tied back to some long-recognized technical challenges, *e.g.*, informational overload, separating signal from noise, making sense of unstructured information as well as misalignments between these data streams and the structure and practice of formal response efforts [6, 9, 36]. In addressing these challenges, several research efforts have explored the development of computing-based solutions, including automated and crowd-powered ones, for processing social media data during disaster events, *e.g.*, [2, 11, 18, 27]. Though progress has been made towards improving the usability of these data streams, there is still considerable work to be done in helping responders filter, process and integrate social media data into their decision making. Previous research in this area has largely focused on the concept of situational awareness, *e.g.*, [13, 15, 26, 39]. However, as we continue to pursue solutions for making social media data usable for responders, focusing on supporting situational awareness (SA) may have some weaknesses. In particular, the SA view takes a somewhat general and agnostic approach to available information. This approach aligns with the idea of the popular notion of a “common operating picture” that provides a shared view of a complex situation. However, it overlooks the fact that people in different roles may want different information in different forms at different times.

To address this potential weakness (and consequent opportunity), we explore approaching the challenge of social media integration into disaster response from the perspective of actionability—with the idea that information relevance may vary across responder role, domain, and other factors. This approach involves asking how we can get the right information to the right person at the right time. Though a common operating picture is useful for coordinating across organizations and roles, it may not be the only or optimal approach for filtering and representing social media data for the diverse array of individuals and organizations who respond to disasters. Our research therefore seeks to complement previous work on supporting situational awareness, while exploring the utility of a different organizing principle—one of information actionability—to better integrate social media into emergency response. For example, consider the following tweets:

@private_citizen: Mudslide Highway 530. Yikes! <photo of a road covered with mud>

@county_responder: Huge landslide on SR 530 at mp 37-38. Fire/rescue on scene. Please avoid the area. Follow here for more updates.

The first tweet, sent from the account of a private citizen (not an emergency responder) included a photograph from the road of a large mudslide covering both lanes of a small highway. This tweet was among the first reports of this mudslide, which would turn out to be a catastrophic, mass causality event. Though the tweet may be missing key information like the exact location of the slide, it functioned to call attention from responders, media, and other citizens in the area to the

emerging event and motivated actions including seeking more information, sending resources to the affected area to gauge the damage, etc.

The second tweet, sent from an official account of emergency responders about fifteen minutes later, contained more specific information about the location of the slide. For citizens in the area or other response organizations, this tweet could have informed actions such as taking another route, preparing resources, or tuning into other information sources about the event. However, for responders within the county's headquarters, this tweet contained information that they already knew, so it would not necessarily have been "actionable" to them.

As this example demonstrates, the quality of "actionability" for each tweet is a function of the relationship between its content and the role of specific responders, their area of operations, when they came across the information, etc. This research seeks to better conceptualize how responders think about actionability in the context of online social data, with the understanding that what is actionable to one person may not be the same as what is actionable to another. To do this, we conducted interviews with 12 participants and analyzed survey responses from 27 participants working across different organizations with varying experience in active emergency and/or humanitarian response. Through a qualitative and quantitative analysis of the captured data, we:

- Offer a nuanced understanding and definition of actionability such that it refines and complements existing approaches based on situational awareness.
- Describe responders' perspective of what constitutes good information and the challenges they face when deciding which information to act upon.
- Suggest opportunities for augmenting the use of social media to highlight and prioritize relevant information that needs immediate attention.

We support our qualitative findings from the interviews with survey feedback from responders on their impressions—from their vantage point within their specific responder role—of several crafted tweets representing a range of tweet types that would be present after a disaster event. Identifying actionable information from the large streams of data available across social media platforms during a disaster event could be immensely useful to emergency responders and affected people. This paper is an attempt to understand, define, and model actionability as uniquely understood by different groups of humanitarian and emergency responders.

2 LITERATURE REVIEW

2.1 Social Media as a Potential Resource for Responders

As social media have become ubiquitous, having been rapidly adopted around the world, they have also become a repeat "site" of online convergence following disaster events [8, 25, 34]. People turn to these platforms to share information, gather information, and provide various forms of support [4, 21, 25, 33, 34]. Researchers in the field of crisis informatics have repeatedly argued that the content shared on social media—including real-time photos and observations from distributed people across an impacted area—could be a valuable resource for both emergence responders and affected populations [18, 20, 24, 28, 32, 35]. In recent years, some humanitarian and emergency responders have begun to incorporate social media into their formal work practices, in particular as another channel for communicating emergency preparedness and real-time alerts and updates with their audiences and as a means for identifying and countering misinformation [9]. However, there are several persistent challenges to integrate these data streams into other aspects of formal response efforts, *e.g.*, logistics planning and physical operations.

The most obvious (and often commented upon) issue is the sheer volume of data that becomes available online after a high profile event. Disaster events often catalyze online convergence [8],

where people all over the world come together to, among other things, collectively process the event and try to contribute to response efforts [4, 21, 33]. Their sharing and re-sharing of content can result in massive amounts of data of which only a small fraction would be novel, relevant, and useful to someone responding to the event. Another related aspect of this challenge is structural, *i.e.*, the response organizations tasked with dealing with these vast new streams of data may not have the resources (personnel, time) and/or skills to process it [6, 10, 32]. Responders have complained about being forced to “drink from the firehouse” [28]. Another problem is misinformation, which responders often cite as a major limitation to the use of social media content in their decision making [6, 9, 27].

2.1.1 Tools to Support Social Media as a Resource. Using social media information to enhance crisis response requires time-critical analysis of high velocity, high volume social media streams. This involves solving multiple computational challenges, including real-time parsing of brief and informal messages, handling responders’ information overload, determining information credibility, and prioritizing useful information [2, 11]. Several systems and computational techniques based on human processing, automatic processing (*e.g.*, supervised and unsupervised techniques), or combination of both have been developed to process social media data, *e.g.*, [1, 12, 23, 27, 40]. However, researchers have noted that few of these systems have been successfully integrated into the work of formal responders [26, 28].

One weakness may be that the tools built for extracting crisis-relevant tweets do not yet address the full complexity of the situation [3]. In particular, it is likely that the utility of information may vary across dimensions like the time of the event, place of occurrence, and role of the responder. Existing solutions have not fully addressed these variations. For example, a visual analytics prototype developed by Marbouti et al. [17] fails when users intend to change the filter to make previously unimportant information relevant again; this limitation results from not including ‘time’ in the list of features. However, some systems have begun to address at least some part of this challenge. For example, Purohit et al. [24] explore categorizing social media data along spatial and temporal dimensions, with the understanding that the utility of a piece of information for those seeking or offering resources may vary across these. And, Nazer et al. [18] developed a system to specifically identify, from within a larger set of crisis-related data, requests for help. These projects suggest a recognition that specific types of information might be more or less relevant to different people at different times and highlight an opportunity for more explicitly calling out and addressing this opportunity.

2.2 Previous Focus on Situational Awareness and Shifting to Actionability

A significant portion of the existing research exploring solutions for integrating social media into emergency and humanitarian response has built upon the concept of situational awareness, *e.g.*, [7, 15, 16, 38]. In an early and impactful paper on the use of social media during crisis events, Vieweg et al. [39] explored the potential for content shared on Twitter to contribute to situational awareness (SA). In developing its conceptualization, that work borrowed from Sarter and Woods [31], who defined situational awareness information as “all knowledge that is accessible and can be integrated into a coherent picture, when required, to assess and cope with a situation”. Vieweg et al. [39] went on to introduce the concept of “situational updates”—and identified different types of information that were present in Twitter data following a disaster event and that could potentially enhance situational awareness.

That work has been valuable in shaping the field of crisis informatics, providing a framework for developing solutions to the informational overload problem, organized around the idea of enhancing situational awareness [26]. However, that approach has some weaknesses. In particular,

its push towards gathering “all knowledge” into a single “coherent picture” suggests a one-size-fits-all approach to identifying useful information and representing that to responders. This may exacerbate experiences of information overload for responders seeking to identify the information that is most relevant to them. In addition, it does not account for the fact that information needs might vary depending upon a responder’s role or other factors such as time. In thinking about better solutions for converting social media data to insight for responders, researchers have begun to argue for the need to move beyond SA, e.g. to approaches based on “decision support” [11], and to shift from a focus on supporting a “common operating picture” to developing “mission-specific” tools.

In this paper, we explore a potential shift in how we approach the use of social media data for response—to one organized around the concept of *actionability*. Though the actionability term has been invoked informally in this research context before [5, 41], it has not been explicitly defined, operationalized, and juxtaposed with the concept of situational awareness. Our work seeks to center, unpack, and extend the actionability term to a descriptive and generative concept for guiding future design. We begin with a loose definition of actionable as information containing a request or a suggestion that a person should act on [3] and an assumption that a message actionable to some responders may be irrelevant to others. An approach based on actionability—*i.e.*, delivering the right information to the right person at the right time—could help responders deal with the persistent challenges of information overload, the limited organizational capacities to deal with new streams of data (e.g., from social media), and the time- and safety-critical nature of their work. Through interviews and surveys with diverse responders, this paper explores the varying definitions of actionability as well as the factors that constitute it, specifically in the context of using social media to inform response.

3 METHODOLOGY

3.1 Interviews with Emergency and Humanitarian Responders

To get a rich understanding of how emergency and humanitarian responders conceptualize actionability, we began this study by conducting twelve semi-structured interviews. The goal of these interviews was to gather varied perspectives on how different responders (in different responder roles) decide whether or not, and how, to act upon a specific piece of information. To include a diverse set of responders, we sent email invites to several agencies who work in emergency or humanitarian responding. Based on their organizational hierarchy and role, we recruited participants who can be classified roughly as humanitarian responders, emergency managers, and emergency responders. At least four participants had extended tenures working with International humanitarian organizations, including extensive experience overseeing and volunteering in both digital and on-ground crisis response. At least three participants were official government representatives with experience in administering emergency operations centers in different cities in USA. We also recruited five firefighters and police officers with a first-hand experience in dealing with different types of emergency events.

Each interview followed the same format, which included both open questions and a scripted “coding” task. After introducing our participants to the purpose of this research, we first asked participants to describe the different positions they held and the role or various roles they had (ever) served within the area of humanitarian or emergency response. To hone in on a specific, rather than a general, view of actionability, we then advised them to choose one of these responder-related roles (usually the most recent) to answer the remaining questions. Some responders who wore multiple hats would often reflect upon the implications of that in their responses. Second, we asked them about information which they come across in their work life to guide their actions;

topics included the types of information, their sources, channels of communication, their trust with respect to that information, and their perception and use of information that specifically comes through the medium of social media. Third, we conducted a tweet-rating task in which the participants rated (from the vantage point of their respective responding role) how actionable they thought a displayed tweet message was, and talked aloud about the reason behind the perceived actionability. For the tweet-rating survey task, four researchers pre-selected 18 tweet messages from a pool of 350 actual crisis-related tweets that reflected different types of information sharing during crisis events. Finally, we concluded the interviews by asking participants what actionability means to them, as well as if they use the term ‘actionable’ or any other alternate terms to convey urgent/important information in their work practices.

Three of the interviews were conducted online via Skype, and the rest in-person, each with one interviewer and one scribe. In analyzing the interview, we collaboratively conducted a grounded, interpretative analysis using affinity-diagramming to identify common themes across the different interviews. We also used the participant responses from the tweet-rating survey task to inform these themes, and to help us guide the design of a follow-up survey (described below).

3.2 Survey Design and Deployment

To gain a broader (in terms of role) understanding of potential actions (or non-actions) by responders, we conducted an online survey, including another tweet-rating task, to gauge “actionability” judgments from a larger and more diverse group of responders. For recruiting survey participants, we sent email invites (with a link to the online survey) to organizations who do humanitarian or emergency responding. We also posted the survey link on Twitter. In both instances, we explained that the survey could be taken by anyone who works in humanitarian or emergency response. Out of the 93 responses, we used the 27 that had at least a 75% completion rate for the purpose of analysis. These included 13 women and 14 men, ranging between 25 and 75 years of age. More than half were over 45 years of age. Five respondents had less than 5 years of experience, while ten had at least 20 years of experience in humanitarian or emergency response work.

We conducted the survey using 18 pre-selected tweets, which we adapted from a large set of “real” tweets sent during previous disaster events to vary:

- (1) Type of impact: (a) infrastructure damage (b) risk to human health, i.e., food, shelter and water or (c) risk of direct human injury
- (2) Time of the disaster as mentioned in the tweet: (a) past (b) present or (c) future
- (3) Information about location: (a) absent or (b) present

We varied these factors such that exactly six tweet messages had a similar type of impact, exactly six tweet messages mentioned a similar time of impact, and exactly nine messages had information about the location of the impact in the tweet content. For example:

OMG! This is what you call a STORM! 3rd mainland bridge is SHAKING!!!

This tweet contains (a) infrastructure damage; from the (b) present time; with location information (a) absent. Such adapting of tweets (unlike real tweet messages used in the tweet-rating survey task during the interviews) allowed us to compare the importance of specific factors in governing actionability.

We randomized the sequence of tweets when displaying them to the participants. Participant responses to these tweets included how useful was the tweet to them, whether it was actionable or not, what action they might take, what the appropriate time to act upon it would be, and what piece of information would make it more useful to them from the vantage point of their respective

Table 1. Participant-reported definitions of actionability

P1	It means something that you could follow up with in a concrete manner and get results.
P2	The action of doing something based on the info I received. That's how I categorize it
P3	Information that's responsive. That you can take action on.
P4	Depends on my role. Actionable data is really variable on context and what you do.
P5	Actionable would mean something that is emergent & we must respond to it.
P6	Information that... has been verified that we know that something needs to be done.
P9	...something you can move on, which is useful- like a suspect description, a location...
P10	Something to move on, or take an immediate action on.

role. These mandatory five responses for each of the 18 tweets made this an exhaustive survey that may have contributed to only 27 (out of 93) participants reaching 75% completion. We used the insights from responses of these 27 participants to support our qualitative findings for investigating actionability. Based on the responses about their present affiliated organization, job title within the organization, and description of their present role, researchers inferred each participant's primary role and sector within the emergency and humanitarian responding workspace (which appears in the findings below). For this assessment, we considered the information about the organization and its projects as described on the organization website.

4 HUMANITARIAN AND EMERGENCY RESPONSE: HOW INFORMATION SHAPES ACTION

4.1 Defining Actionability

The broader question of our research is “how can the right information reach the right person at the right time.” In this study, we wanted to highlight and unpack how different humanitarian and emergency responders perceive actionability. We use the actionability term as a frame to first understand what responders mean by it, and then to identify different aspects of information that make it relevant to a responder's role. The focus is not to have a universal agreed upon definition of actionability, but rather the opposite—*i.e.*, to have them define it in their own words and thereby learn how definitions of actionability converge or diverge across roles and contexts.

In each interview, we asked the participant explicitly if they used the term “actionability” in their work and, if so, how they defined it. Table 1 reports some of the self-reported definitions. In general, responders thought of actionable information as anything which either they or their organization could use at that moment to assist, enact, or expedite the solution to a (potentially) identified issue. Table 1 reports these self-reported definitions of actionability by some of our participants. Most of the definitions simply equated actionability with information that necessitated response. In general, participants described actionable information as anything which either they or their organization could use at that moment to assist, enact, or expedite the solution to a (potentially) identified issue. Some (P5, P10) noted the emergent or timely quality of actionable data, and one (P6) suggested that actionability implied that the information had been verified. Though most of the participants gave a certain response to what actionability were for their specific role and/or organization, P4 chose to highlight the dependence of what actionable could mean to different responder roles, and the context of operations undertaken by the responder. One of the participants mentioned that while all information is important, only some is actionable and “some is just FYI”—a statement that hints towards the core premise of this paper: the distinction between actionability and situational awareness.

An inherent dimension to conceptualizations of actionability was what constitutes an action or response. On the lower end of spectrum were participants who understood verifying certain information or mediating it across two agencies that handle disaster management as an action. For example, if a potential victim shared information about being held hostage, P7 described how he would ‘act’ upon it by trying to contact the victim back to get more information. On the other hand, some participants related actionability specifically to how it catalyzed or shaped their physical response. For example, P1 described information about damage to telecom infrastructure as actionable. His possible response included mobilizing resources, visiting the location, or ordering equipment. Thus, the need for his service or resource was an explicit factor that made information actionable.

4.2 Factors of Actionability

Responders often try to make sense of available information for comprehending the overall picture during a disaster and for shaping their emergency response (Matheus et al. 2003). Participants attributed several factors—like presence or absence of location of the event, availability of resources to address the concern etc.—that shape the action that they find appropriate to take. While information shapes action, different characteristics of that information impart the quality of being more or less actionable. During our research, participants explicitly called out several factors that affect actionability. Consider the following tweet:

They just showed a dude on a Jet Ski off of Battery Park in NYC... hey idiot there's a hurricane coming... #Sandy #wow

When asked to rate this message on a scale of no actionability to high actionability, P7 mentioned that he would look for details that enable him to locate and identify the person to guide a decision related to whether or not he should inform a police official about the person being in danger. The inability to fetch these details in real-time through social media (unlike a phone call) made it even more important for him to look for several factors in the message. In his words:

“Without the ability to get in touch with them and like validate that’s actual or to get little bit more information... if they had the geo-location, a time stamp, and if it was my responsibility to monitor... those things would help. That’s like the closest to an actionable thing.” - P7

This reply highlights several different considerations that responders make to determine the actionability of the information. It involves evaluating the information across multiple criteria related to their specific role, the format of tweets in general and this tweet specifically, and the broader nature of crisis-related information. We now describe the factors that responders noted as being part of their rapid decision process for whether and how to ‘act’ on a particular tweet or other information.

4.2.1 Responder’s Role Defines Degree of Actionability. The role of a responder is an important factor that affects actionability. P4, who has worn multiple hats in her career, put it succinctly when she responded: “depends on my role”. She elaborated that the notion of what is urgent information, and how one deals with it, differs across organizations and responder roles. This aligned with the responses of several interviews, for example:

“As a logistician, information regarding roads and access (is important, but) ...as a program officer, it would be information regarding the needs and what’s going on in these areas I have information about.” - P11

Information that is not suited to a responder's role or her authority may be ignored, absorbed as background knowledge, or used to catalyze an informational action. For example, one of the participants expressed how at times he may encounter information that is extremely important to act upon, but that he does not have the control to dispatch the required resources. This reduces the perceived actionability to non-actionability. However, a responder in that situation might resort to reaching out to other people in their network of responders to bring it to their notice. Some responders considered information that catalyzed such passing along actions as being actionable.

4.2.2 Timeliness and Speed of Response Impacts Actionability. Time—when the responders come to know about information compared to both when it was shared and when it needs to be acted upon—is important for determining whether something is relevant or irrelevant to one's responding role, or even at scale to one's organization. Responders sometimes inferred time rendering information non-actionable because either the information itself is no longer actionable, or because they already know about it through an alternate channel. For example:

"It's time sensitive. If I had seen this at 1PM, I could take action. If I see this at 5 PM, I have already failed." - P1

Time is also an important characteristic of how information flows to and through an organization. While some organizations are responsible for immediate reactive actions, others require slower and more reflective actions. As quoted by a participant:

"It's nice to know what a response (from UN) is, but the UN is about 4 weeks behind. I would call that ancient history. Other groups are much faster than the UN." - P5

Time also has a second meaning for the responders, which is dependent on the nature of the disaster event—*i.e.*, slow onset (*e.g.*, a storm, protest) or rapid onset (*e.g.*, earthquake, crime). The former usually contains information that could be useful to an organization involved in preparatory roles, while the latter informs organizations involved with reflective activities. Time can function as a necessary placeholder for organizing information to build up the complete perspective that impacts actionability—*e.g.*, consider the case of developing of an emergency:

"We get a lot of situations where you see a potential emergency response. So you pay very close attention to it, how it's going to develop and whether it's going to require a response... because it's all important information unless, until you get to the conclusion that, okay, you know, thankfully it wasn't too serious, and it didn't have any, you know, negative damage on the services, telecom services. Or, let us say if it is becoming worse and worse, and we need to act fast, so this is important that you are on alert." - P1

When it comes to information of a reflective nature, time governs urgency. Responders face situations in which there is only limited time to be physically there at the place of impact. In such situations, deciding whether to act or not is a matter of judging urgency; responders cannot wait for more information to emerge for getting a complete picture.

4.2.3 Location Improves Chances of Acting on Information. Another factor that takes a toll on the decision-making ability of a responder is the location of the potential disaster. For deploying resources, for verifying the account of events as described on some information channel, and for confirming jurisdiction of a disaster event, information about the location is crucial. During the interview rate-a-tweet task, messages without any mention of location made several participant responders think of them as non-actionable.

"It's not actionable because it does not give me anything that tells me where it is. Location matters!" - P4

Responders often have limited jurisdiction over disaster events occurring in a nearby region. Information about the location of a disaster event places it either within a responder's geographic range of operability and helps her assess its actionability, or allows her to redirect the information to a co-located responder authority. Information about the location of a disaster thus increases the chances of it being acted upon. A responder suggested how being located outside the operable region of a disaster event can impart actionability in instances when direct impact of the disaster has deprived a co-located responder of his capacity to take an action:

"Well it's actually more actionable with us in Seattle than with us in Portland - because if we are all in Portland we are all feeling the Earthquake together." - P12

4.2.4 Information Source Affects Credibility.

"Source is the most important thing, it depends on whether it was relevant to what I knew or did not know or that time. It would be highly dependent on the situation." - P11

We found through our study that the impact of an information source upon actionability is a function of the responder's role, time when he is informed, and his knowledge of existing situation. Responders often mentioned need for verification if they came across an unknown or doubtful source.

"I judge (tweet actionability) based on experience and knowing sources I could go to verify information. Or looking at source of tweet (e.g. something came from Mayor's office)." - P6

Source became a highlight of discussion during rate-a-tweet for its actionability task in the later half of the study, when we included the source names along with the tweet messages. Police responders asserted that the verified badge with a blue checkmark certainly made a difference.

"I'm not going to listen to a whole lot from <@somerandomguy>" - P10

Although source governs actionability, similar sources did not receive the same treatment at the hands of responders. While responders expressed mistrust in information from unknown public sources, they found the same unknown public sources useful for triangulating information. Thus, context of use moderated the credibility judgment of a source.

4.2.5 *Context Offers a More Complete Picture.* Responders evaluate the requirement specific to the situation and adjust their response accordingly. Scale of the disaster is one such parameter that shapes the requirement and (hence) the response. While some of the disaster events can be of a smaller nature and need a simple corrective action, some events may require massive planning, deployment, and execution. Participants also shape their response based on the context of the disaster, e.g., police response if it were a robbery, or fire truck for incidents involving fire. Thus, the context defines a somewhat tiered response (P5) depending on what resources are necessary to ensure the responders can fix the situation. The context of a disaster situation is also driven by the responder's capacity and the (limited) available resources. Responders borrow heavily from their past experience and utilize their knowledge to assess the requirement.

"Weather phenomenon are usually known. We need to be able to respond to the unknown stuff. Based on what we know is likely, we will take action." - P8

A responder (P12) walked us through the process of how he would assess actionability related to concerns about sanitation and drinking water by evaluating the context. Information about such issues would be important during times of Sandy; however, if there were a Cholera outbreak, it would be a part of a larger incident about which public authorities will be aware. Apart from background knowledge of what is happening, and past experience of dealing with similar situations, other factors that enrich the context include whom is the action meant for (e.g., abled or disabled),

and what kind of action may be essential (e.g., remote or physical). Contextual information allows for a better judgment, and therefore invokes more responsible actions from the responders.

4.3 Processes Governing Actionability

4.3.1 Verification is a Critical Concern for Actionability. Participant responders repeatedly cited verification of information as a major factor in determining actionability. Emergency responders have a shared understanding that a single report of information is insufficient for decision-making. Instead, responders rely upon triangulation—getting the same information from multiple sources and channels—to establish credibility of reports:

“Information might also get emailed because maybe the person outside sends an email via phone to the person here and they put it in. Or they could call it in. So, information comes from multiple places in the system overall. So there is some kind of built in redundancy.” - P6

Responders challenge the credibility of information due to its source (e.g., posts from unofficial accounts), or the channel it comes from (e.g., social media is viewed as less credible than 911). Some organizations have protocols for only incorporating information mediated through certain channels. For example, one participant described an instance when they had to vet the information from a trusted source as it came had through an informal channel (personal text) and not an official communication channel.

Information mediated through social media is often novel and warrants verification. Responders often make use of active and passive triangulation to discern credibility. Responders going to a power company to get more information about power situation if they see a tweet mentioning it (P3) is an example of active triangulation. In passive triangulation, responders use multiple sources to validate information.

“If there are more than one observations, there is a high probability of it being a fact. If there are 5 people saying it snowed, then well it snowed!” - P5

Information of questionable authenticity may rarely trigger any action involving resources. Therefore, responders gather more feedback for ascertaining an accurate understanding of the situation.

4.3.2 Feedback Supports Adjusting the Context of an Action. The first piece of information about a disaster often offers a partial picture of the situation involved; responders need feedback upon this partial knowledge to help contrive the fuller picture. Responders mainly consider feedback at two different levels during operations. First level involves getting real-time feedback through a source like 911 that supports real-time communication and get most of the ‘what, when, where, which, why’ answers to facilitate a complete contextual picture. It involves talking to people to know what needs to be done—is it something that could be handled through a distance (e.g., instruction to put more pressure on fire alarm), or we need to dispatch resources?

A second level of feedback happens when an actionable plan is set in motion and supporting or contrasting information is brought to knowledge, e.g., knowledge about an action by another organization; this feedback helps a responder adjust his course of action to augment what already has been done.

“You need to decipher what’s good, who are key partners and players, and who is doing what to avoid overlap. It is only later that you start to identify who is doing what, set up meetings with the right people, and coordinate.” - P1

Course of an action is also negotiated depending on the role and resourcefulness. Responders can be constantly aware of the changing dynamics of a disaster through such need assessment and coordinated feedback, and thereby trigger appropriate actions.

4.3.3 Assessing Quality and Relevance of Information Promotes Better Decision-Making. The need to prioritize possible actions often leads to a tension with the required urgency of response. Therefore, each responder follows a unique understanding of what pieces of data and subjective threshold of quality are required to adequately decide actionability:

“That’s why when you call 911 they ask you where you are, who is involved and who is not involved... to get off on goose chases based on suspect description. We don’t have a chance to know that it is bad information until we go down to find it. The strangest information breaks the cases.” - P9

P9’s response reveals the need for specificity and quality of information to avoid loss of time and valuable resources. Though the content being looked at for might differ among responders, a common theme was the emphasis on factual information that helps identify the location, trickles in at suitable time to act, is mediated through trusted source and channel, and is contextually specific.

5 SURVEY FINDINGS: IS THIS TWEET ACTIONABLE?

To gather more information on the different kinds of ‘action’ that humanitarian and emergency responders consider regarding online disaster-related information, we conducted an online survey with a diverse group of humanitarian and emergency responders. We received 93 participant responses (with varying levels of completion) and analyzed a total of 27 responses (all the responses that were at least 75% complete). Researchers considered meaningful responses to text-based questions towards confirming the validity of these responses.

Figure 1 indicates the distribution of the participant responses (horizontal axis) for whether they would take any action for the respective tweet (vertical axis). In that Figure, each horizontal row shows how a single tweet was judged—as whether it would be actionable or not—by the 27 different participants. If responders all agreed that something was actionable (or not), it would be appear as a solid line. As we expected, the graph shows considerable variability in how different responders view the actionability of different tweets. In other words, what is actionable for one responder is not necessarily actionable for another. Participants are grouped together by their primary “responder role”, which we inferred from their responses. Though there were some clear trends within responder type (e.g., the digital volunteers were somewhat consistent in their determinations), the Figure shows that actionability judgments even varied within responder type.

Figure 2 offers a similar view of the sector-wise distribution of participant responders who perceived the tweets to be actionable. It demonstrates that different tweets can be relevant to responders from different sectors of work. For example, Tweet 8 is not at all relevant to emergency food aid and disaster prevention responding roles, while responders in the reconstruction relief and rehabilitation sector will not act on tweet 18.

We also compared the tweets that participants perceived as useful with the tweets where they indicated willingness to act. Survey analysis indicated that ‘actionable’ information as perceived by responders is different from ‘useful’ information. We found that the information that could be useful, and hence important to be (situationally) aware about, is not necessarily actionable. For example, 8 out of 54 (13.5%) responders found some tweets very useful but not actionable.

Out of the 486 tweet instances, participants expressed their intent to act upon 42% of the tweet instances. They perceived some of the tweets to be more actionable than others. At some instances the action comprised of sharing the information, while at others it involved diverting actual resources to reach out to the location of the impact to handle the situation. Figure 3 offers additional

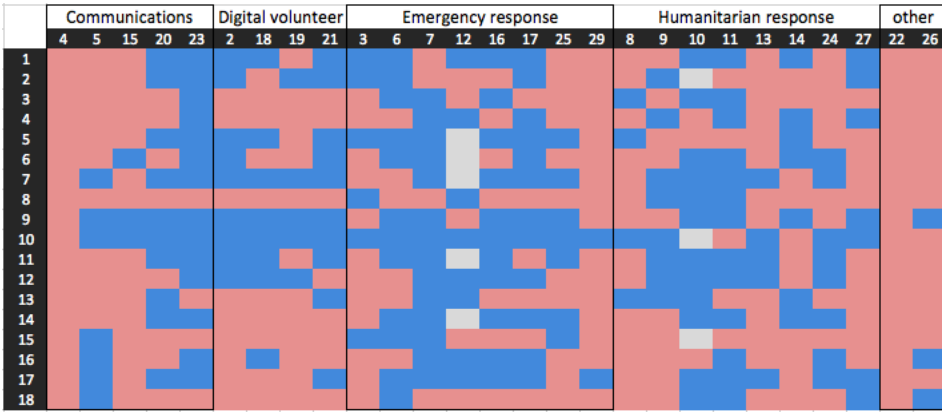


Fig. 1. Participant responses (horizontal axis) to each tweet (vertical axis) if they found it actionable or not. Red cells correspond to no participant action, while blue cells correspond to tweets which a participant would act upon. The gray cells indicate missing participant responses. Participants are clustered into four primary roles along the horizontal axis.

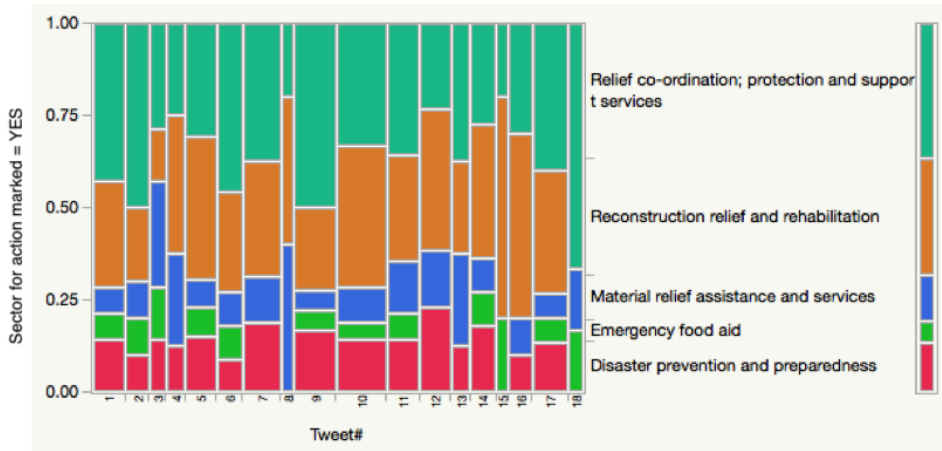


Fig. 2. Each column represents a unique tweet, while its width represents the number of responders who found the tweet actionable. The vertical axis represents the spread of responders across different sectors when the number of positive responses for actionability towards a tweet is normalized.

insight into participant responses reflecting what different pieces of information could improve the actionability of a tweet depending on whether responders found the previous information non-actionable or actionable. If non-actionable, responders searched for alternate sources for triangulation. However if already actionable, they typically seek more information about the original source; contextual information including pictures and videos also became more relevant.

6 DISCUSSION

6.1 Pivoting to Actionability as an Organizing Concept

Though social media represents a potential valuable resource for humanitarian and emergency responders, formal responders have struggled to incorporate these new data sources into their

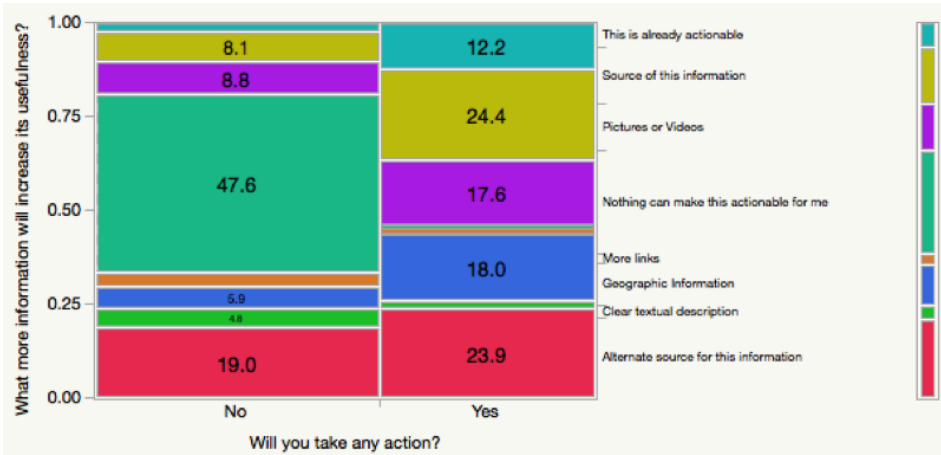


Fig. 3. Depending on the perceived actionability of a tweet (horizontal axis), different pieces of information could be helpful to improve the actionability (vertical axis).

work. Researchers have identified numerous challenges—from information overload, to fear of misinformation, to training—that have contributed to the gap between possibility and actuality (e.g., [9, 22, 36]). One persistent focus within the field of crisis informatics has been on building systems to help responders filter, process, and visualize social media data shared during crisis events, e.g., [13, 15, 17, 24]. Though these systems address some of the identified issues—e.g., information overload—they have not been widely adopted by responders in the field. When we talked to emergency responders, few relied on systems such as these in their work. Most were still looking at social media data—when they looked at it all—through publicly available client applications.

One potential weakness in existing solutions is that they do not adapt to specific responders’ needs. Many of the systems proposed and studied in this area have used the concept of situational awareness to guide their designs [26]. This initial organizing concept, introduced within the crisis informatics context by Vieweg et al. [39], has profoundly shaped research and design around this problem. It has been operationalized at multiple levels—e.g., from labeling individual tweets as situational updates or not [30, 39] to producing geographically-bounded visual representations of tweets for supporting emergency responders work [15]. In a sweeping literature review of the crisis informatics field, Reuter et al. [26] devotes a significant section to enumerating a long list of systems built to process social media data into representations that support situational awareness. That work also notes that integrating these systems into the practices of actual emergency responders has been difficult [26]. Though this issue of adoption is multi-faceted, one factor may be a weakness inherent to this guiding concept of situational awareness—or perhaps more precisely, how this concept has been operationalized within the crisis informatics field to support a responder-neutral view of the relevance of social media posts.

In this work, we explore the utility of examining this problem through the complementary lens of actionability. Though existing studies in this area loosely invoke the term [5, 18], our work is the first to focus in on the term, unpack what it means, contrast it with other guiding concepts, and use it as a framework for reconceptualizing the problem of processing social media data. Other researchers are starting to think about and develop systems that account for differences in informational needs [24], hinting towards the utility of a more nuanced and “personalized”

approach to filtering information. Our work provides actionability as an organizing concept to guide that work—similar to and perhaps in tandem with how the concept of situational awareness has guided this work up until now.

Many of the responders we talked to are already thinking about information through an actionability lens. Though not all of the interview participants used the term actionable, all had mechanisms for thinking about how they prioritized information around what was “good” and what could be “acted upon now”. Though some emergency managers and participants with leadership experience in humanitarian response talked about needing a global view of the data (akin to situational awareness), our interviews and surveys demonstrated that different responders saw value in different kinds of information, and that this value varied across other dimensions such as time, location, and scale of the event. These findings suggest some utility, as we think about the informational needs of responders, in approaching the crisis data filtering and processing challenge through the lens of actionability.

6.2 Actionability Varies Across Role, Contextual Factors, and Format

In this paper, we highlight that different responders make different judgments about whether or not a certain type of information is actionable. Our findings confirm that whether a specific piece of information warrants an action or not is highly governed by factors like the role of the responder, the time when a responder comes across the information, location of the disaster in relation to their region of operations and other contextual factors in the evolving situation (*e.g.*, which agency is in charge of what, which varies across events). Analysis of the interviews and survey responses, conducted with diverse responders in both the humanitarian and emergency response domains, supported our initial assumption that responder role is a major factor in shaping the actionability of information shared on social media. However, there were other contextual factors that contribute.

One of these is location, including both the location of the disaster and the location of the information shared about the disaster. The relation between that location and the responder’s areas of jurisdiction determine whether and how actionable a piece of information is, as well as the appropriate action. For example, a tweet about impact in a region near but outside their jurisdiction may invoke the “action” of passing that information on to someone within that region, while the same tweet about a location within their area may invoke a physical response. In several instances, participants resorted to sharing information with more appropriate authorities (due to role or location mismatch) to improve its chances of getting acted upon. Additionally, tweets without location information were often judged as “not actionable”, so one aspect of location had to do with the format of the tweet. Time is another factor that plays a critical role in determining the actionability of information; response is shaped not only by the ongoing phase of disaster, but also by how recently the incident (in the social media post) occurred. The timeliness of knowledge about information combined with the suitability of that information to responder role together shape the action that will be taken—and the urgency around it.

Additionally, aligned with the focus of previous research in this area [2], responders explained that they have to take into consideration the perceived credibility of the source of information—especially with social media content. A single social media post from an unknown source is often not considered actionable on its own, but responders want to have this information and perhaps use it to triangulate with other information, at which point the corroborated information might become actionable. And finally, the broader context of the situation—including its severity and scale, area of impact, geographic features of the affected area, ability of different responders to access the area, etc.—are all important factors as well, especially in the context of humanitarian response where the organization’s role might change from event to event depending upon need.

6.3 Designing Social Media Processing Systems around Actionability

When we look at the utility of social media through the lens of actionability, it becomes evident that individual responders have very different informational needs, which change both across and during events as conditions change and roles evolve. Our work suggests that attending to the variation in how a responder determines what is ‘actionable’ could be a productive step forward in improving the utility of solutions delivered by intelligent computational methods and techniques. Systems that meet and adapt to the specific needs of the individuals and groups may represent the next “step” in supporting integration of social media content into humanitarian and emergency responding practices—building upon and perhaps complementing systems that follow the “common operating picture” approach. The original situational awareness framing pushed us to filter relevant information from irrelevant information and helped guide the categorizations of social media posts according to different types of impacts (*e.g.*, damage, human injury, evacuation notices). Now, the actionability framing pushes us to consider further filtering and prioritizing—to figure out what type of information is needed by a specific responder at a specific time.

Consider the example of tweet 14 from Figure 1. This tweet mentioned about the possibility of a militant group gathering for a counter-protest. While this information is not at all actionable for digital volunteers, several emergency responders reported that it would catalyze an action for them. If a social system could learn this difference across responder groups, it could direct fewer tweets like tweet 14 to digital volunteers, and more tweets like tweet 14 to emergency response teams. Although we don’t have enough data to draw specific conclusions about differences across roles, our included observations highlight that there are apparent variations both within and between responder roles. Responder feedback could help teach and guide a system towards giving that set of responders the kinds of information they need, and reducing their cognitive burden by removing other information from their view—perhaps by delaying it or passing it on to another group.

Researchers have proposed machine learning-based techniques to extract brief, self-contained information items relevant to disaster response [13]. Our work suggests that, similar to human-in-the-loop systems that are used to train and calibrate machine learning solutions, a machine learning system could incorporate a responder-in-the-loop solution to help a specific responder or group of responders filter, process, and take action from the information flowing through social media. Ideally, this system would adapt over time, both within and between events, by providing limited feedback about the utility of the information that the system is sending—and grow increasingly efficient at getting a specific responder or team of responders the right information at the right time in the right form. Exploring this problem through a focus on “actionability”, our research identifies several factors that could be used to guide the features and feedback systems for the next generation of prototypes for social media processing in the crisis response context. For example, our work suggests that feedback systems should be as non-intrusive as possible, perhaps by incorporating a discard button for particular social media posts that allows responders to mark why the information is not useful, *e.g.*, it’s the wrong time (not now, too late, maybe later), outside their location, beyond their role, or missing some critical piece of information.

Our findings are limited by the scale and “snowball” nature of this initial study. To capture a deeper understanding of how the perceived meaning of actionability varies across responders, researchers should gather information from emergency and humanitarian responders more diverse in their demographics (including country of origin and language), experience, and domain of operations. For example, are there any commonalities or differences by “primary” role of a responder, does seniority of a responder significantly impact what she classifies as actionable, etc. Actionability is therefore an important information quality that needs to be explored further in future research—so

we might usefully harness available information, including social media posts, towards informing crisis response.

7 CONCLUSION

Researchers in the field of crisis informatics have been working for more than a decade to realize the potential and address the challenges of using social media data to inform emergency and humanitarian response. Up until now, the concept of situational awareness has guided much of this work towards responder-neutral solutions. Though these solutions support the goal of a “common operating picture” that can be useful to guiding response from a high level and coordinating actions across groups, they have some weaknesses when it comes to considering the immediate needs of specific responders. Our work explores a shift in this underlying paradigm to one of “actionability”, with the idea that different responders may need different information. While the original situational awareness framing pushed us to filter out relevant information and helped guide the categorizations of social media posts according to different types of impacts (e.g., damage, human injury, evacuation notices), our proposed actionability framing pushes us to consider further filtering and prioritizing—to figure out what types of information are needed by a specific responder at a specific time. Here, we demonstrate that different responders make different judgments about whether or not a piece of information is actionable, and we reveal several factors and processes that shape these judgments. We believe that such a lens of actionability can lead to new, improved, responder-in-the-loop solutions—that adapt to the needs of specific responders.

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