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Tweeting about emergency: A semantic network analysis of government organizations' social media messaging during Hurricane Harvey☆

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ABSTRACT

While social media like Twitter have been increasingly adopted by public-sector organizations, it remains less explored as to how government and emergency management (EM) organizations use these platforms to communicate with the public in response to emerging natural disasters. Extending the Situational Crisis Communication Theory (SCCT) to the realm of social media, this study examines the emerging semantic networks from 67 government and EM organizations' official tweets during Hurricane Harvey over a three-week period. It identifies how multiple crisis response strategies—including instructing information, adjusting information, and bolstering—are constituted of different issues, actions, and organizational actors before, during, and immediately after the disaster event. Results suggest that government agencies use the strategy of instructing information predominantly before and during the disaster, whereas adjusting information and bolstering strategies are utilized more during post-disaster recovery. The study offers theoretical and practical implications of using a semantic network approach to studying organizational crisis responses.

1. Introduction

Organizational use of social media is on the rapid rise (e.g., Briones, Kuch, Liu, & Jin, 2011; Curtis et al., 2010; Lovejoy & Saxton, 2012; Nah & Saxton, 2013; Rybalko & Seltzer, 2010). In the public sector, government organizations are increasingly adopting social media like Twitter to disseminate information (Waters & Williams, 2011), build communication networks with the public (Khan, Yoon, & Park, 2014), and manage natural or social crises (Houston et al., 2015). For example, a survey showed that local government organizations held a highly receptive attitude towards using social media to help control, manage, and recover from crisis (Graham, Avery, & Park, 2015). Compared to the traditional mode of government-public communication, social media enhance government agencies' capacity to make announcements, mobilize resources, and manage public expectations (Veil, Buehner, & Palenchar, 2011). These functions become especially important during crises, when government agencies are expected to effectively respond to rising situations and stay connected with the public (Graham et al., 2015).

Government social media messages significantly shape public risk perception and emergency preparedness action (Freberg,

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2012). However, few existing studies focus on real-time social media content from the perspective of public-sector organizations. The current study uses a large-scale natural disaster, Hurricane Harvey, as a case to analyze government and EM organizations' official tweets across multiple stages of the disaster. Hurricane Harvey struck the Gulf Coast of Texas in August 2017 (National Hurricane Center, 2018), during which social media were actively used by government agencies to communicate with the public.

The current study contributes to the growing literature on government social media use for crisis management in two ways. First, combining semantic network analysis with the Situational Crisis Communication Theory (SCCT after), we demonstrate a semantic network approach of studying crisis response strategies in the realm of social media. SCCT predicts that organizations would employ different response strategies to manage public expectations and restore image during crisis (Coombs, 1995, 2007; Holladay, 2010). While various response strategies have been well studied through mass media discourse (e.g., Holladay, 2010; Kim & Liu, 2012), we argue that a semantic network approach is particularly suited to identifying strategies from emerging social media content. By mapping semantic-level connections among frequently occurring terms and investigating their associative meanings, the semantic network approach advocated here not only enables a more contextualized interpretation of organizational crisis responses, but also expands the unit of network analysis from organizational relationships (Yang & Taylor, 2015) to the discursive associations among salient issues, actions and social actors specific to the crisis situation.

Second, the current study extends the SCCT framework by examining how the same response strategy may reflect the changing emphasis of different actors and issues as a crisis evolves. SCCT suggests that organization-public communication should correspond to the changing priorities specific to each crisis stage (Coombs, 2007). Contributing to a multi-stage view of crisis management, we posit that government and emergency management (EM) organizations may emphasize certain issues and actions, and engage with different actors across multiple crisis stages on Twitter. We thus view organizational crisis communication as a dynamic issue framing process (Iyengar, 1990), and provide a semantic perspective to understand such a process. In doing so, we further explicate the theoretical connection between SCCT and issue framing, and broaden the methodological repertoire of SCCT from conducting content analysis (e.g., Kim & Liu, 2012), discourse analysis (e.g., Benoit, 1997), to machine-assisted semantic network analysis (Guo & McCombs, 2015; Schultz, Kleinnijenhuis, Oegema, Utz, & Van Atteveldt, 2012).

In the following, we first review the literature on government use of social media for crisis management, the SCCT framework, and crisis-related issue framing, based on which we develop the research question. The semantic network analysis of 67 government and EM organizations' official tweets identifies stage-specific variations in terms of which issues, actions, and actors frequently co-occur in government tweets.

2. Literature review

2.1. Strategic social media use for crisis management

Social media technologies provide several functions for crisis management. First, social media enable rapid message diffusion. Compared to websites, the primary communication platform of Web 1.0, social media are more efficient in broadcasting organizational updates through large-scale and decentralized networks (Lovejoy & Saxton, 2012). This feature has made social media a highly desirable platform for information dissemination during a crisis (Sutton et al., 2014), as evidenced by the 2008 Southern California wildfires (Sutton, Palen, & Shklovski, 2008), the 2011 earthquake in Japan (Cho, Jung, & Park, 2013), and Hurricane Sandy in 2012 (Hughes, St. Denis, Palen, & Anderson, 2014; Lai, 2017). During various types of crises, government organizations are expected to provide timely and credible information. A study by Freberg, Palenchar, and Veil (2013) found that the public frequently referred to government sources in their online discussion of crises, highlighting the critical role of governments as major information providers.

Second, social media enable community building through their connective features. For example, Twitter allows the public to directly interact with the focal organization via "mention" (i.e., include other users in the tweet) or "reply" (i.e., include user names at the beginning of a tweet) function. Saxton and Guo (2014) found that organizations would use Twitter's mention and reply features to send customized messages to selected stakeholders as a way to strengthen community relationships. Moreover, social media support the building of issue community or issue publics—that is, the publics surrounding a specific social event or crisis (Aldoory & Grunig, 2012; Kim, Ni, Kim, & Kim, 2012). For government organizations, these functions have the potential to improve transparency and trust when communicating with various publics (Avery et al., 2010; Hong, 2013).

The two functions of social media, information dissemination and community building, can be leveraged by government organizations for crisis management. During a crisis, government organizations are not only expected to provide instrumental information but also communicate support and solidarity to the public (Coombs & Holladay, 2010). Crafting the appropriate crisis response messages to match public expectations is at the core of effective crisis management, and it thus brings the strategic selection of crisis response strategies to the forefront, the subject detailed by the Situational Crisis Communication Theory.

2.2. Situational crisis communication theory and organizational response strategies

Developed by Coombs (1995, 2007), SCCT is a theoretical framework that explains the selection of response strategies by organizations in the event of a crisis, with crisis broadly defined as any eruptive situations such as terrorist attacks, health epidemics, corporate scandals, and so forth. Although the conceptual boundary between "crises" and "disasters" is drawn differently across various research traditions (for a detailed review, see Shaluf, Ahmadun, & Said, 2003), the SCCT framework conceptualizes natural disasters as one of ten types of crises, under the "victim cluster" where individual or organizational victims are at the center of crisis communication (Coombs, 2007, p. 168). SCCT offers a prescriptive approach that recommends organizations to match their

communication response strategies with both organizational goals (e.g., reputation maintenance, advocacy) and the distinctive nature of a specific crisis (Coombs & Holladay, 2002). The fundamental logic behind such a matching process comes from the attribution theory (Weiner, 1992,2006), which posits that depending on the type of a crisis, the organizations involved may be attributed with different levels of responsibility (for a detailed review of the theory, see Coombs & Holladay, 2010). To mitigate the negative consequences from responsibility attribution, organizations are motivated to engage in practices, such as apologies, to restore image and keep themselves accountable.

Although the goal to craft appropriate crisis responses is universal for all types of organizations, there are great differences between corporate and public-sector organizations with regard to their respective communication priorities. Whereas corporate actors are more concerned about reputation and image restoration (Kim, Avery, & Lariscy, 2011), public-sector organizations are expected to prioritize public interest by guarding the public from the physical or psychological harm of a crisis (Coombs, 2007; Holladay, 2010). Furthermore, public organizations' handling of crisis may be under greater public scrutiny (Liu, Horsley, & Levenshus, 2010). Compared to corporations, therefore, government organizations need to exhibit more frequent and transparent public communication, manage information needs from a multitude of diverse publics, and collaborate with cross-sector organizations on a regular basis (Kim & Liu, 2012; Liu & Horsley, 2007; Liu et al., 2010).

While public-sector organizations may employ a great variety of response strategies to manage a crisis (Kim & Liu, 2012), we choose to focus on three most relevant types in the current study—the strategy of instructing information, adjusting information, and bolstering. This focus is first determined by the distinct communication priorities of public-sector organizations. As discussed above, truthful and timely information disclosure fulfills the public-serving duties of government organizations, and this practice is most expected by the public in the event of a crisis. Second, the prominence of victims in natural disasters further requires organizations to communicate care and compassion (Coombs, 2007), making adjusting information and bolstering strategies of particular relevance too. It should be noted, however, the three strategies selected here by no means represent the full spectrum of response strategies employed by government agencies. In fact, secondary strategies like diminish, rebuild, and reinforce are often combined with the use of instructing and adjusting information (Kim & Liu, 2012). In the following, we discuss the three selected strategies in detail.

2.2.1. Instructing information

The responsibility to inform and guard the public against crisis-related harm makes the strategy of instructing information pivotal for government organizations. Instructing information refers to the practice of reporting crisis-related information, as motivated by the ethical expectations of organizations (Grunig & Dozier, 2003). It is also recommended that instructing information should precede any reputation-restoration strategies, such as apologies or justifications, for most organizations during a crisis (Coombs & Holladay, 2002). Coombs (1995) further identified three specific types of information of this kind: 1) the what, why, when, where, and how of information about a crisis; 2) the preventive or corrective actions to take in order to minimize harm; and 3) actions **already** taken by the responding organization. In a natural disaster, the strategy of instructing information is frequently used, and such messages may take the form of real-time disaster updates, rescue reports, travel advisories, and so on (Houston et al., 2015; Hughes et al., 2014).

2.2.2. Adjusting information

The strategy of adjusting information may come hand in hand with instructing information, and it is set to facilitate the coping of psychological stress and threat. The specific response strategies include: 1) reporting measures taken by the responding organization; 2) assuring the public about any corrective actions, and 3) expressing concerns for the victims (Coombs, 2007). Along this line, empirical research found that the strategy of adjusting information was often associated with the expression of emotions, such as compassion (e.g., Coombs, 1995), hope (e.g., Jin, Park, & Len-Ríos, 2010), and sympathy (e.g., Kim & Niederdeppe, 2013). The use of adjusting information strategy can be instrumental in sustaining hope for post-disaster recovery (Griffin-Padgett & Allison, 2010; Olsson, 2014).

2.2.3. Bolstering

The strategy of bolstering, including praising partners for their efforts and expressing sympathy towards the victims, is an important response strategy during natural disasters. The bolstering strategy is best used as "secondary" or supplementary strategy (Coombs, 2007), and it is more effective to be deployed during the recovery phase of a disaster. From the standpoint of community building, the bolstering strategy helps boost morale, communicate solidarity, and cultivate a sense of togetherness among victims and the broader community (Coombs, 2007). Government organizations may also strategically engage media and community members to bring back the positive collective identities and restore the sense of normality after the disaster (Olsson, 2014).

2.3. Crisis response strategies as semantic-level message framing

SCCT posits that organizational message framing is critical for attributing responsibility (e.g., framing a crisis as occurring naturally or due to human-errors) and shaping public perception of crisis management efficacy. Organizational use of different types of crisis response strategies, therefore, can be considered through the lens of strategic framing. The concept of strategic framing has been introduced to the field of public relations to examine how an organization deliberately constructs messages to evoke desired interpretations of issues (Schultz et al., 2012). A frame is defined as a schema of interpretations that allow the audience to identify, label, and make sense of social phenomena from news media or public life (Benford & Snow, 2000; Guo & McCombs, 2015). "Frame-builders," which can be news media or organizational actors, often deliberately construct messages in ways to make salient certain themes or attributes over others.

Existing research on the strategic framing of online organizational messages spans across corporate, nonprofit, and public sectors (e.g., Muralidharan, Rasmussen, Patterson, & Shin, 2011; Weberling, 2012). However, most of these studies categorized various frames through identifying a single theme from individual messages, rather than exploring how multiple themes and concepts may simultaneously emerge from an aggregated corpus of organizational messages. One exception is the study by Schultz et al. (2012). The authors investigated the associative frames used by BP during the notorious oil spill crisis by comparing the semantic network structure of direct organizational responses versus mediated messages. Expanding the notion of "meaning network," the authors argued that organizational crisis communication can be interpreted from the meaning of objects and concepts embedded in the overall meaning network, operationalized as the semantic networks of organizational messages (Schultz et al., 2012, p. 3).

Following this line of work, we conceptualize organizational crisis communication as a strategic framing process, where the inclusion (or exclusion) of certain issues, actions, and organizational actors signal desired meanings towards the public. Rather than categorizing organizational discourse as generic response strategies, we argue that the semantic-level meanings of these messages need to be scrutinized to allow for more nuanced interpretation. Specifically, it is important to identify salient issues, actions, and organizational actors that emerge from organizational discourse, as well as how these entities are juxtaposed with one another to form associative meanings. Doing so enables us to distinguish how even the same crisis response strategy may display different intentions and communication priorities from the focal organization.

Using a semantic network approach to examine crisis response strategies has two significant advantages. First, methodologically, semantic network analysis supplements existing SCCT research by extending the examination of response strategies from thematic categories to associative patterns among key issues, actions, and actors. Previous research of SCCT has much relied on qualitative methods such as discourse analysis (Benoit, 1997) and manual content analysis (e.g., Kim & Liu, 2012). For example, Kim and Liu (2012) content analyzed the response messages from 13 corporate and government organizations during the 2009 flu pandemic. They identified different crisis response patterns between corporations and governments by comparing how frequently each type of organizations employed crisis response strategies, including "denial," "diminish" and "reinforce" (p. 69). While traditional content analysis enables the comparison of response strategies across situations, it is still limited in that the coding scheme usually does not offer a close-up look at the semantic features of the messages, nor the association pattern among any emerging concepts.

Second, the semantic network approach enables more nuances to be identified when comparing the use of same response strategies across multiple crisis stages. For example, the same strategy of instructing information may focus on different aspects of a crisis or emphasize involvement of different actors. Such variations are likely driven by distinctive communication goals specific to each crisis stage. In the context of using social media for crisis management, Houston et al. (2015) identified different social media use goals across various stages of a natural disaster. In the pre-disaster stage, the communication goal deals primarily with delivering disaster preparedness and warning information, where government organizations such as city police and fire departments use social media to broadcast impending situations. At this stage, instructing information is likely to be the predominant type of strategy employed. During the disaster, the communication goals may shift from information delivery to more instrumental resource mobilization, such as requesting assistance, calling for volunteers and donations, and reporting real-time disaster response updates. At this stage, the strategy of instructing information is still widely present, but its emphasis shifts from informing to mobilizing. Therefore, it is important to distinguish different semantic-level meanings emerging from the same response strategy, as they are likely to vary as the crisis evolves.

Given the different communication goals as outlined above, we posit that the three most prominent response strategies for natural disasters—instructing information, adjusting information, and bolstering—are likely to be employed at varying degrees, and the specific issues, actions, and actors emphasized in each strategy may also evolve across stages. In the following, we detail semantic network analysis and ways of operationalizing response strategies.

2.3.1. Semantic operationalization of crisis response strategies

Semantic network analysis is an analytical approach focused on the co-occurrences (associative patterns), frequency, and clustering patterns among words from a variety of communication texts, such as organizational narratives, news content, and social media messages (Doerfel, 1998). The semantic network pattern helps identify salient concepts in terms of their frequency of usage and the interpretive context surrounding them (Doerfel & Barnett, 1999). Along with Schultz and et al.s' (2012) study, public relations scholars have utilized this analytical approach in fruitful ways. For example, Gilpin (2010) used semantic network analysis to identify the divergent sets of top key terms used by Whole Foods, a supermarket chain, to strategically construct its organizational image across multiple online communication channels.

In this study, we investigate the semantic representation of three key crisis response strategies as proposed by SCCT, namely, the strategy of instructing information, adjusting information, and bolstering. We operationalize each crisis response strategy not as a single or static theme conveyed by the individual message, but as contextualized meaning interpreted based on 1) the salient concepts and 2) the associations between salient concepts and their surrounding context based on an aggregated corpus of organizational discourse on Twitter. We present our research question in the following:

RQ1. How did government and EM organizations' social media strategies of instructing information, adjusting information, and bolstering manifest themselves at different stages of Hurricane Harvey?

3. Method

3.1. Study context

In August 2017, the Category 4 storm (the second highest category), Hurricane Harvey, struck the Gulf Coast of Texas and particularly the metropolitan area of Houston. The hurricane formed as a tropical storm on August 17, 2017, and made landfall near Rockport, Texas on August 25 at its peak intensity. Over the next seven days, Harvey brought strong winds and record-level rainfall to Southwest Texas, directly causing a large-scale flooding that paralyzed major highways and airports, and submerged thousands of residential housings. The hurricane was one of the most destructive natural disasters that severely impacted a large-scale community in the United States. It was estimated to cause $125 billion in damage and at least 88 deaths, with cost inflicted second only to the 2005 Hurricane Katrina (National Hurricane Center, 2018).

3.2. Data collection

During the rapid progression of the disaster, city, county governments and EM organizations at local, state, and federal levels were involved in disaster control and relief efforts. To identify all active government organizations on Twitter throughout the course of the disaster, this study performed the following procedures. First, the authors used the disaster declaration map released by the Federal Emergency Management Agency (FEMA, 2017)[1] to locate all government organizations operating in the disaster-impacted regions. This step generated a total of 74 government organizations, including 26 city governments (e.g., City of Corpus Christi), four county governments (e.g., Bexas county), one state government (Texas), three federal agencies (Federal Emergency Management Agency, The U.S. Department of Education and U.S. Department of Labor), 25 first responder organizations (e.g., city/county police departments, fire departments, and weather services), and 15 Offices of Emergency Management (OEMs). Second, the authors manually checked each organization for its presence on Twitter and identified a total of 67 active Twitter accounts.

To capture the three stages of the disaster, August 21 through August 24, 2017 was categorized as the pre-disaster stage. Note that although the tropical storm was formed on August 17, it did not enter public and media agenda until August 21, 2017. The time between the landfall of Harvey on August 25 and September 1, 2017 was categorized as the during-disaster stage. September 2 till September 8, 2017, the week after the major rainfall and flooding, was categorized as the post-disaster stage.

Via Twitter's public API, a customized Python script (available upon request) was written to collect tweets sent by the 67 organizations. The time frame was set between August 21 and September 8, 2017, producing a total of 15,086 tweets, which consisted of 8672 original tweets (neither retweets nor Twitter mentions) forming the text corpus for the subsequent semantic network analysis. During the pre-disaster stage, 61 of 67 Twitter accounts were active, contributing to a total of 1849 tweets (998 original tweets). During the disaster, the tweet volume increased substantially to 10,991 tweets by 65 accounts (6309 original tweets). At the post-disaster stage, 2246 tweets (1365 original tweets) were posted by 61 accounts.

3.3. Data analysis

We divided the data into three time points (pre-disaster, during, and post-disaster) and conducted semantic network analysis separately. Leximancer (https://info.leximancer.com/), a text analytics tool, was used for semantic network analysis. Leximancer analyzes the presence and frequency of concepts by extracting a collection of terms (or words) representing each concept, and a concept is thus constituted of an individual word or a constellation of words that appear together in the text (Doerfel, 1998). For example, the concept "thank" may contain the words "thank," "dedication," and "thankfully." Words/phrases relevant to the concept are weighted based on how frequently they occur in sentences containing the concept. Typical stop-words, the words that do not contribute to the meaning of the text, were removed from the analysis, which generally include: articles, prepositions, conjunctions, and transitive verbs (e.g., a, I, you, and, during, including, via). The analysis first produced a list of most frequently used concepts, and then the co-occurrence network matrix containing all concepts. In such a matrix, the value of each cell indicates the number of times two concepts appear together in a single text segment (in this case, two sentences per block). In other words, two concepts are connected based on their pattern of co-occurrence. Clusters are then developed based on the analysis of this co-occurrence matrix (Smith & Humphreys, 2006), which are visualized as overlapping circles on the semantic network map. Note that the size of the concept node on the map reflects the co-occurrence count, meaning that the larger the node, the more connected with other concepts, and the more central this concept is.

For our study, we first used the frequency counts to identify the concepts that appeared most frequently in organizational tweets at each disaster stage, followed by the semantic network maps to present the interconnections among concepts and the themes that emerged.

[1] The map was retrieved from https://gis.fema.gov/maps/dec_4332.pdf.

Table 1
The top 30 most frequently-occurring concepts from government and EM organizations' tweets.

Pre-disaster			During Disaster			Post-Disaster		
Concepts	Count	Relevance	Concepts	Count	Relevance	Concepts	Count	Relevance
Harvey	299	100%	Harvey	1729	100%	Harvey	248	100%
tropical storm	162	54%	water	999	58%	flood	136	55%
Texas	128	43%	tornado warning	936	54%	info	102	41%
Nwshouston	108	39%	**Nwshouston**	761	44%	water	94	38%
flooding	104	36%	**houwx**	717	41%	need	91	37%
NWS	86	35%	flooding	652	38%	home	87	35%
expected	85	29%	status	606	35%	Texas	84	34%
weather	81	28%	rain	597	35%	**Sylvesterturner**	83	33%
update	78	27%	areas	516	30%	working	83	33%
txwx	70	26%	update	513	30%	debris	82	33%
forecast	68	23%	possible	510	29%	Houston	73	29%
hurricane	66	23%	aviso	478	28%	Hurricane	72	29%
issued	66	22%	tornado	431	25%	**houstonpolice**	70	28%
rainfall	62	22%	hasta	428	25%	thank	68	27%
heavy	61	21%	heavy	410	24%	**Fema**	65	26%
monitor	58	20%	**txwx**	392	23%	area	63	25%
prepared	56	19%	stay	381	22%	assistance	60	24%
rain	54	19%	safe	336	19%	check	60	24%
possible	51	18%	continue	332	19%	open	59	24%
plan	51	17%	**Sylvesterturner**	287	17%	tips	52	21%
NHC	49	17%	Houston	277	16%	today	52	21%
latest	49	16%	**Readyharris**	273	16%	evacuation	50	20%
area	49	16%	issued	270	16%	storm	50	20%
sure	45	16%	**NWS**	261	15%	latest	47	19%
school	45	15%	info	266	15%	continue	46	19%
time	44	15%	shelter	253	15%	recovery	44	18%
today	44	15%	today	232	13%	visit	43	17%
winds	42	15%	need	223	13%	**Artacevedo**	42	17%
coast	40	14%	rainfall	217	13%	Houstonstrong	42	17%
weekend	40	13%	open	214	12%	officers	42	17%

Note: Count refers to the total number of occurrences of a concept, and relevance is calculated as the percentage frequency of text segments (i.e., two sentences in this case) coded with that concept, relative to the frequency of the most frequent concept. It is to identify a concept's relative salience in terms of frequency of occurrence. See https://www.leximancer.com/faq/display_and_output.html. The bold concepts are individual or organizational Twitter accounts.

4. Results

4.1. Concepts comparison across disaster stages

Table 1 presents the top 30 concepts ranked by the frequency of occurrences across the three stages of Hurricane Harvey. Concepts like "Harvey," "water," "flood," "tornado," and "storm" consistently ranked the top of the list throughout the disaster, naturally because the crisis was hurricane-related. When comparing the type of concepts across each stage, the pre-disaster stage was characterized by a greater number of time- and location-sensitive information about hurricane forecasting, and the top organizational actors mentioned in the tweets were primarily weather forecast agencies such as the National Weather Service at Houston (@Nwshouston), and the National Hurricane Center (@NHC). Meanwhile, concepts related to specific instructions, represented by the action terms such as "shelter," "evacuation," and "stay", occurred more frequently during the disaster than pre-disaster stage. Finally, the top concepts used at the post-disaster stage were characterized by: 1) verbs and nouns that indicated action mobilization, such as "need," "assistance," "recovery"; and 2) concepts like "thank," "Houstonstrong," and "home" that are intended to praise collaboration partners and evoke collective community identity.

4.2. Semantic network comparison across disaster stages

In addition to analyzing concept frequency, we examined the interconnections among concepts and major themes at each disaster stage. While concepts represent meanings associated with constituent terms, themes are defined as clusters of concepts more closely connected with one another through co-occurrences in tweets (Smith & Humphreys, 2006). Fig. 1 through Fig. 3 present the semantic networks of both concepts (individual dots inside the gray bubbles) and themes (the gray bubbles) that emerge from each stage. The visual presentation of the semantic networks thus enables a bird's eye view of the data, illustrating the content of main themes as well as we the associative meanings among their constituent concepts (Poser, Guenther, & Orlitzky, 2012).

Overlapping yet different sets of themes were identified from each disaster stage. At the pre-disaster stage (see Fig. 1), five major themes emerged and respectively indicated: 1) general weather updates from the National Weather Service (the bubble on the bottom

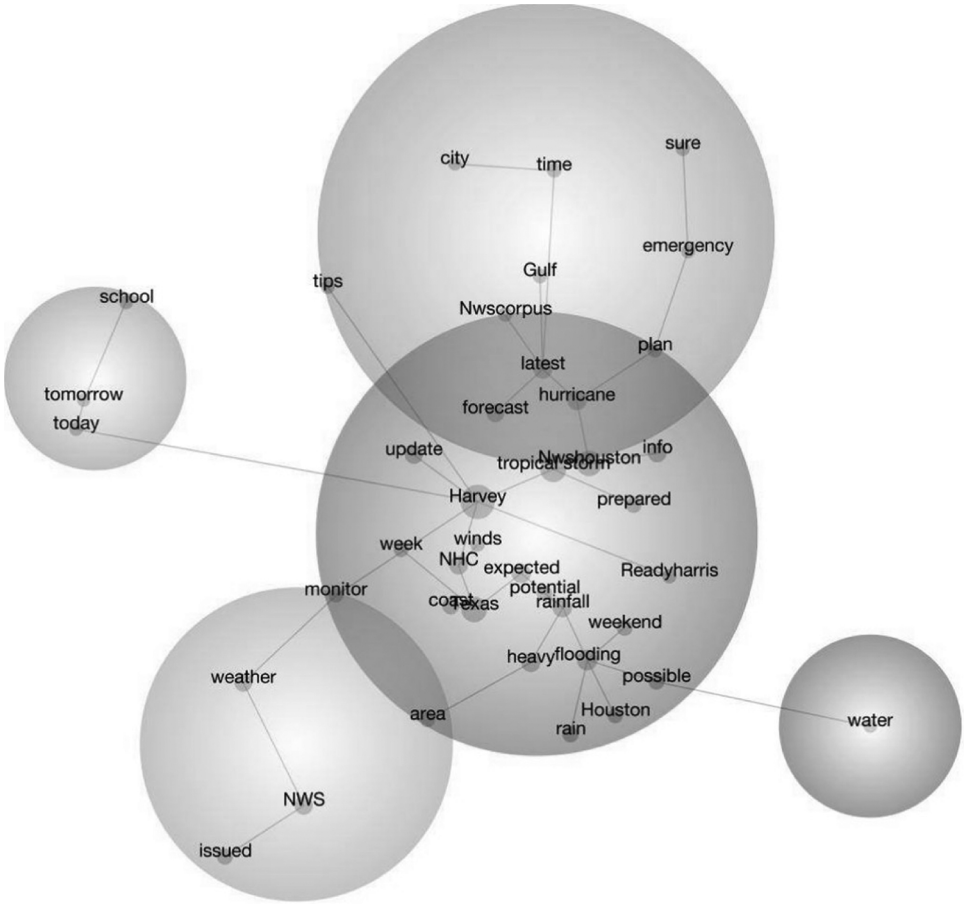

Fig. 1. The semantic network from 67 Harvey-affected government and EM organizations' tweets, a week before Hurricane Harvey.

left); 2) location-specific emergency plans (the bubble on the top center); 3) hurricane-specific forecast and prevention information (the bubble in the center); 4) updates of system functions (the bubble on the top left); and 5) water (the bubble on the bottom right). The last two themes pointed out the duties of government organizations to update the public about the operation of school systems, as well as the nature and possible consequences of this impending disaster (i.e., "water"). Note that "school" was mentioned often because hurricane occurred right before the start of the school year.

Together, all five themes represented the information instruction strategy, but in diverse forms. Specifically, theme two, four, and five informed the public of the "what", "when", and "where" about the disaster, whereas theme three, the most densely connected theme, consisted of hurricane-specific disaster updates from weather forecast agencies—illustrated by concepts such as "tropical storms," "winds," "rainfall", and "flooding"—and disaster prevention information from government organizations as shown by concepts like "prepared" and "plan." In addition, tweets at this stage clearly revealed "who" of the disaster—that is, actors that actively involved in pre-disaster planning. The National Hurricane Center (@NHC), the Harris County Office of Homeland Security and Emergency Management (OHSEM, @Readyharris), and the National Weather Service in Houston (@Nwshouston) were most active actors at this stage.

As the disaster unfolded (see Fig. 2), the content of major themes shifted in the following ways. First, while the same number of themes were identified ($N = 5$), the boundary of each theme became more fluid as more concepts were shared between themes. This indicated that as the disaster rapidly progressed, various government agencies tended to emphasize a similar set of issues, actions, and actors. Second, three types of messages emerged from the during-disaster phase: 1) the strategy focused on reporting various updates from relevant actors (e.g., @NHC, @Nwshouston, @NWS, @HSCO, @Hscotexas, reflected in the bubble on the bottom center), indicating direct or indirect involvement of these actors in rescue operations; 2) the strategy of instructing citizens what to do, constituted by a set of action-oriented concepts such as "shelter," "stay," "evacuation," "working," "rescue," and "use" (the bubbles on the bottom right and top center); and 3) the stagey of status updates about the disaster itself and another tornado warning (the bubbles on the top left and bottom left). These themes reflected the use of multiple strategies concurrently, which was contrary to the pre-disaster stage when only instructing information strategy was used. For example, concepts like "stay" and "safe" frequently appeared to convey care and compassion, representing the use of adjusting information strategy; and the concept "thank," despite still at the periphery of the semantic network, indicated the growing use of bolstering strategy. In addition, prominent actors at this stage differed from the previous one. For example, although news and information sources like NHC, NWS, and Nwshouston

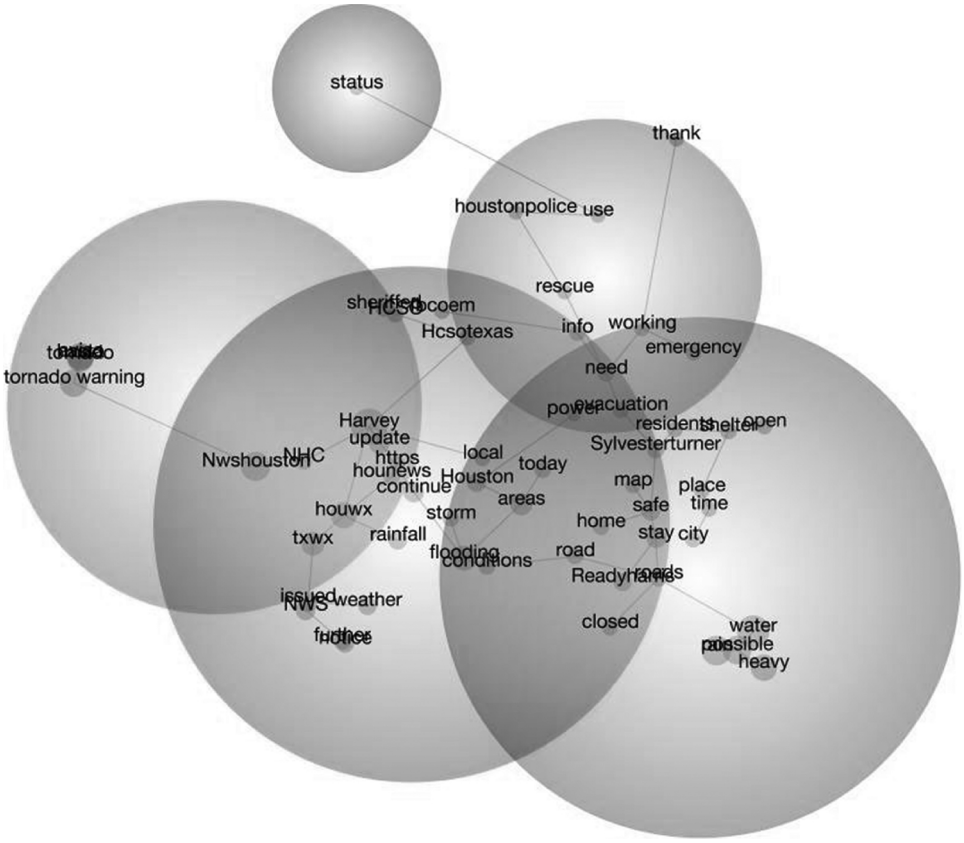

Fig. 2. The semantic network from 67 Harvey-affected government and EM organizations' tweets during Hurricane Harvey.

remained visible, Mayor of Houston (@Sylvesterturner) and first responder organizations, including the Fort Bend County Office of Emergency Management (@fbcoem), the Harris County OHSEM (@Readyharris), and the Houston Police (@houstonpolice), gained significant visibility compared to the pre-disaster stage.

The post-disaster stage showed greater variations in terms of the specific concepts characterizing each theme. The theme of community building (the bubble on the bottom left), which reflected the use of bolstering strategy, became a salient one at this stage. This meant that compared to the during-disaster stage, the bolstering strategy was used by a greater number of organizations in the sample. The community building theme was characterized by concepts likes "Houstonstrong," "thank," and "support", all of which were connected to first responder organizations, including the Houston Police (@houstonpolice) and its chief officer Art Acevedo (@Artacevedo). Meanwhile, the strategy of instructing information was characterized by 1) a theme concerning the news coverage of the city of Port Arthur (the small bubble on the left); 2) a theme where Mayor Turner issued a curfew due to continued storm and debris situation (the bubble on the top); 3) and the largest theme solicitating citizen contribution to help disaster recovery, as well as reporting relief efforts from agencies like FEMA and the Harris County OHSEM (the largest bubble in the middle). The instructing information strategy at this stage was particularly characterized by the growing emphasis on citizen mobilization and cooperation (illustrated by concepts like "helping," "need," "supplies"), whereas disaster-related updates (shown by concepts like "storm" and "water") became rather peripheral compared to the previous two stages. The changing semantic structure of the instructing information strategy therefore indicated that the communication goals had shift from informing community about the disaster to mobilizing resources for disaster recovery. Finally, federal agencies like FEMA (@fema) emerged as an active actor, whereas far fewer local EM agencies remained in the semantic network at this stage (except for @Readyharris), likely due to the conclusion of immediate disaster relief operations.

A closer examination of each theme across three stages also pointed to the divergence of the "shouting-out" practice—that is, the practice of explicitly referencing or calling out certain individuals or organizations in the tweets. Such a practice was generally more visible in the semantic networks of during and post-disaster stages than at the pre-disaster stage. For example, Mayor of Houston, Sylvester Turner's Twitter account (@Sylvesertuner) frequently co-occurred with concepts like "evacuation," "shelter," and "curfew," among others. So were the organizational Twitter accounts of the Houston Police (@houstonpolice), the Harris County Sheriff's Office (@Hcsosheriffed), NHC, and the Fort Bend County Office of Emergency Management (@fbcoem). At the post-disaster stage, organizational accounts such as FEMA (@fema) and the Harris County OHSEM (@Readyharris) were heavily referenced in the largest theme, whereas first responder organizations like the Houston Police (@houstonpolice) and its officers were praised in the community building theme to express solidarity and support.

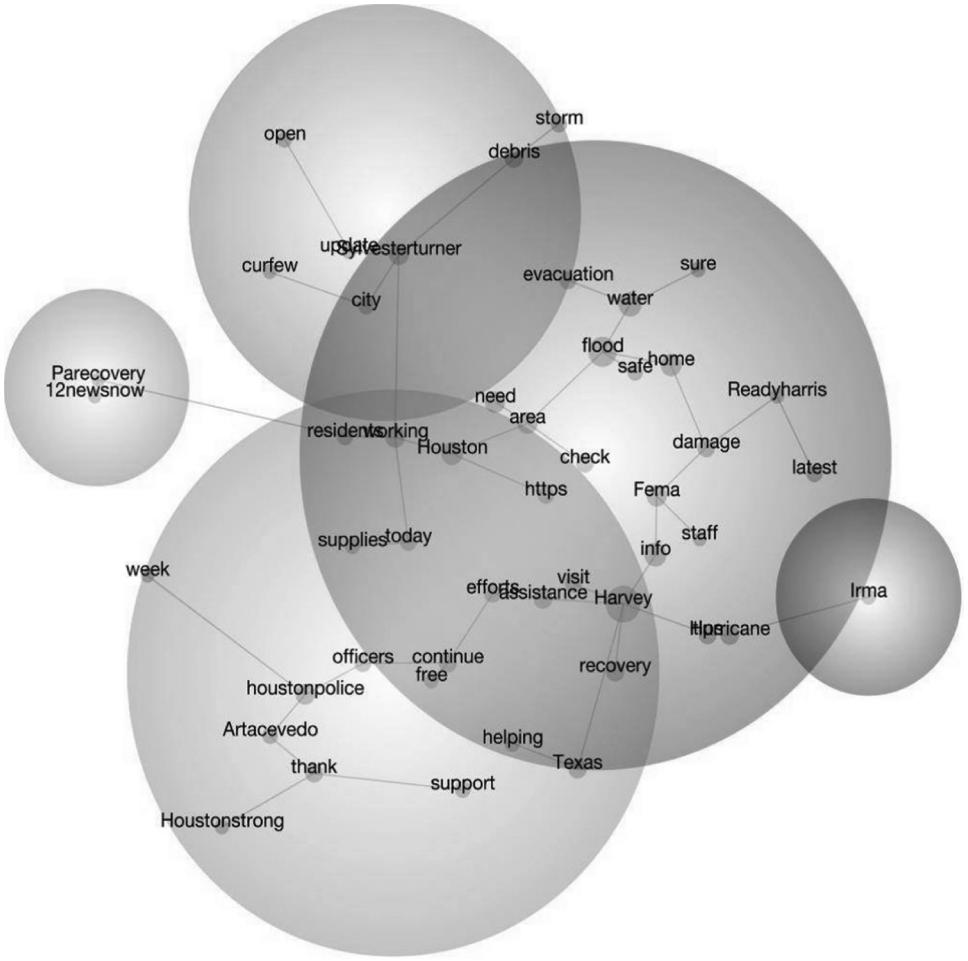

Fig. 3. The semantic network from 67 Harvey-affected government and EM organizations' tweets, a week after Hurricane Harvey.

5. Discussion

The semantic network analysis has identified distinctive patterns in terms of how key concepts and themes emerge from government and EM organizations' social media messages, and how the three crisis response strategies—instructing information, adjusting information, and bolstering—manifest themselves in different associative concept maps. Across the three disaster stages, crisis response strategies diverge by emphasizing different issues, actions, and actors. Such stage-based differences may well reflect the evolving communication priorities that ultimately shape the content of these social media messages. In the following, we summarize key findings from the semantic network analysis, and discuss theoretical and practical implications for the SCCT framework.

5.1. Stage-based variations of issues, actions, and actors in crisis responses

First, the results suggest that the frequency at which each response strategy is used, as well as the ways in which these strategies are constituted differ across stages. Specifically, pre-disaster communication is characterized entirely by information instruction, where issues emphasized included disaster-related weather information, warnings, and preventive measures the public should take. During the disaster, although instructing information strategy is still present, we find that the emphasis has shifted from disaster-related information updates to (1) direct mobilization of action and (2) updating actions taken by first responder organizations. Meanwhile, bolstering strategy only begins to emerge at this stage, and it is secondary to the instructing information strategy in terms of usage frequency. At the post-disaster stage, bolstering evolves to become a primary strategy, where government and EM organizations engage in practices such as praising partners, expressing solidarity, and boosting community morale.

Second, we find that government and EM organizations actively engage other official Twitter accounts in their crisis responses, but the type of individual and organizational actors engaged vary greatly by crisis stage. Before the disaster, the most visible actors mentioned in government tweets are disaster information provision organizations such as the national and regional offices of the National Weather Service and the National Hurricane Center. Although regional EMOs are also mentioned at the pre-disaster stage,

they are at a more peripheral position thus generally less salient than information provision organizations. However, as the disaster progresses, first responder organizations like regional EMOs and police offices, grow more central and visible in the semantic network.

Among the most actively engaged Twitter accounts, it is worth noting that public figures emerge as a unique type. In our case, the Twitter account of Houston Mayor, Sylvester Turner, and the Chief of Houston Police, Art Acevedo, are highly visible both during and after the hurricane. The crisis management literature points out the importance of engaging key organizational and community leaders in order to facilitate disaster relief and improve community preparedness (Gamboa-Maldonado, Marshak, Sinclair, Montgomery, & Dyjack, 2012). The frequent mentions of public figures in government tweets helps create a sense of openness and personalness on behalf of government organizations, which can be especially instrumental in building trust, gaining public cooperation, and managing post-disaster distress (Bruning, 2000; Bruning & Ledingham, 1999).

5.2. Strategic framing in crisis response strategies

We argue that government crisis communication can be understood as a strategic framing process, and our findings identify two ways in which such a process is manifested. First, government agencies associate themselves more frequently with "doing" than "apologizing" type of response strategies. They employ the strategy of instructing information to proactively communicate various actions taken to protect the public interest, and use adjusting information and bolstering strategies to offer care and boost community morale at different stages of the disaster. Meanwhile, strategies like apology or denial are rarely used. It is clear from the semantic network analysis that government Twitter content focuses more on handling crisis situations than making any responsibility claims. This tendency is consistent with what SCCT predicts. As natural disasters are less subject to blame attribution compared to human-error induced crises such as corporate scandals (Coombs, 2007), government organizations may be acutely aware of such situational difference thus selecting crisis responses accordingly.

The second way in which strategic framing is executed is by framing prominent public figures, such as Houston mayor Sylvester Turner, as responsive, assertive, and action-driven. Organizational leaders, such as the CEO of a company, play an important role in crisis management, and they often act as "spokesperson" to represent organizational stance and action (Lucero, Kwang, & Pang, 2009). In the current case, government and EM organizations capitalize on the strength of leaders through strategic framing. For example, during the disaster, "stay" was the concept that most frequently occurred together with the mention of the mayor, whereas after the disaster, similar action-oriented concepts included "curfew," "update," and "working." This finding reflects an emerging "leading by actions" frame. At the initial stage of Hurricane Harvey, media has cast doubt on local governments' disaster preparedness effort, and especially questioned Houston Mayor's decision to not evacuate before the hurricane made landfall (e.g., King, 2017). These government tweets, first and foremost, combat the opposing media frame by emphasizing actions taken. The current study thus suggests that with social media, government organizations may have greater control over how leadership is framed, as social media afford direct communication between government and the public. Prior to the prevalent adoption of social media, such as during Hurricane Katrina in 2005, mass media remained as the primary actor portraying authority and leadership (Littlefield & Quenette, 2007). The fact that leadership figures already frequently appear in government social media messages suggests that public-sector organizations may already start leveraging such opportunities.

5.3. Implications for crisis communication research and SCCT

The current study makes several contributions to the SCCT framework. Most notably, it takes a semantic network approach to simultaneously examine issues, actions, and actors that emerge from organizational crisis responses. The semantic network approach represents one of several ways of theorizing network relationships, as scholars have begun to introduce the network approach to study various public relations phenomena, ranging from understanding mediated organization-public relations on social media (e.g., Himelboim, Golan, Moon, & Suto, 2014), unfolding shared meaning network from public relations messages (e.g., Saffer, 2016), to utilizing network strategies for activist issues management (e.g., Sommerfeldt & Yang, 2017). In the current study, we focus on the network relations at the semantic level, and our analysis offers a bird's eye view to investigate how multiple concepts and themes are interconnected to constitute response strategies, and how such connections evolve with the crisis situation. As our findings indicate, although the strategy of instructing information is used throughout the course of the disaster, the specific types of information and actors emphasized in messages do vary across stages. Findings from our study thus indicate that the execution of crisis responses should extend beyond selecting appropriate generic responses. Rather, crisis managers should attend to the network of meanings that emerge from associative concepts in order to proactively manage a crisis.

The current study also extends the scope of SCCT to the realm of public-sector organizations and their social media messages. As social media afford various connective functions, we observe that government agencies start to leverage such capacity to engage with other individual and organizational actors. Specifically, the action of mentioning other Twitter users is highly present in government crisis communication on social media. This reinforces the network approach that organizational crisis response is situated in a web of relevant issues, actions, and actors. By mentioning other actors in social media messages, organizations essentially signal to the public the involvement (or lack of involvement), affiliation, or value judgment of other actors. On a practical note, this thus implies that other than crafting crisis response strategies appropriate for a given situation (the primary focus of SCCT), response strategies may also need to speak to the multiple actors involved in the communication context.

However, the current study challenges one of the assumptions of SCCT, which contends that image repair and restoration is of utmost importance to organizations (Coombs, 2007; Kim et al., 2011), and therefore, the response strategies would particularly

prioritize blame mitigation. In the current study, we did not identify any explicit blame mitigation strategies such as denial or apologies, partly because the nature of the crisis was a natural disaster. Nevertheless, we speculate that this may also deal with the unique expectations placed on government and first responder organizations. As Liu and Horsley (2007) suggest, government organizations are expected to demonstrate greater concern to public goods than their own reputation. Therefore, government organizations are less likely to assign blames, especially when the cause of the disaster is natural or not easily identifiable. The emphasis on public goods was manifested by the main themes of tweets being instructing citizens how to take preventive measures, providing information for shelter access, and expressing good will and positive assessment of the disaster management progress.

Methodologically, the current study demonstrates the value of using a semantic network approach to analyzing crisis response messages in the form of associative concept networks. In current SCCT studies, the majority of content analysis methodologies focused on the occurrence of certain message genres or themes (e.g., Kim & Liu, 2012). The current study, on the other hand, utilized a novel approach that focuses both on the *occurrence* and *associative structure* of key concepts emerging from social media messages. Therefore, it enables a closer-up interpretation of crisis response strategies and identifies the aggregate-level patterns that emerge organically from the large corpus of social media data. With social media increasingly adopted by government organizations, communication with the public will increasingly be mediated by networked media platforms. Marrying a network approach with the existing SCCT framework thus offers new ways for public relations scholars to collect, analyze, and interpret digital trace data produced by organizations of interest.

Finally, the study integrates the concept of message framing in examining different crisis response strategies. While SCCT prescribes a set of response strategies for organizations to employ depending on the crisis type, such as attack, denial, or justification (Coombs, 2007; Coombs & Holladay, 2002), the theory itself does not specify how crisis managers may craft messages to make salient of certain concepts than others. According to the framing literature, the same type of crisis response strategies, such as apologies, may be framed differently when various concepts are emphasized in the message (Bowen & Zheng, 2015). By examining the associative patterns among concepts in the message, the current study thus proposes a network approach to analyzing crisis response strategies, allowing SCCT to offer a more nuanced analysis of organization-public communication.

5.4. Limitations and directions for future research

There are several limitations in the current study. Using a single disaster as a case, current findings may not be generalized to other cases of natural disasters, nor the wide spectrum of crisis types. The combination of crisis response strategies used on social media, therefore, is likely to vary in other crisis situations. And depending on different characteristics of the crisis, as well as the presence of multiple "publics" (Bruning & Ledingham, 1999, p. 158), instead of a single public for an organization, the crisis response strategies may exhibit greater sophistication than what was observed in the current study. Along this direction, future research may conduct multiple case studies to compare and contrast how the same government organizations may strategically select different response strategies via social media.

Moreover, public data are not included in this study. This limits our ability to assess the scope of reach as well as the actual impact of government social media messages. For example, it is not clear to what extent citizens would follow, trust, and engage with government agencies' Twitter accounts during disaster. The ways in which government and EM organizations' selective framing influences public risk perception and preparedness (Freberg, 2012) would be an important topic worth further investigation.

The current study only examined a single social media platform, Twitter. While multiple forms of social media are used by government organizations, it is likely that the unique characteristics of each platform may lead to the divergence of crisis-related messages in terms of their semantic structures. In fact, empirical work has started to suggest that organizations may pick and choose different social media platforms depending on their communication goals. For example, Lai (2017) examined the social media usage pattern among a group of disaster relief organizations in the aftermath of Hurricane Sandy and found that contingent on the stage of the crisis and the affordance of specific technology platforms, response organizations relied on multiple social media platforms differently. It would be worthwhile for future research to systematically investigate whether and how multiple social media platforms may associate with different patterns of message framing and the selection of various crisis response strategies.

As mass media remain important for crisis management, media coverage has been a fruitful avenue for scholars to examine organizational crisis response strategies and their effects (e.g., Coombs & Holladay, 2009; Holladay, 2010). While the current study only focuses on social media, future research may compare the response strategies employed by the same organization across different media channels. Media relations do not become obsolete, and social media are more likely to serve as complementary, rather than exclusive channels for organizations to manage crisis.

Finally, while semantic network analysis offers unique insights into government organizations' message framing on social media, other research methods, such as informant interviews, may be combined to better understand the intentions behind the composition of social media messages. The internal organizational structure, such as whether the government organization has in-house public relations professionals, or whether the messages posted on social media truly reflect the organizations' strategic intention and communication goals, may offer more nuanced interpretations of the current findings. Future research is encouraged to take a multi-method approach that better connects organizational-level motivations with content-level interpretations.

6. Conclusion

The current study investigates how government and EM organizations used Twitter to communicate with the public across different stages of Hurricane Harvey. It extends the SCCT framework by employing a semantic network approach to understand

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message framing and how crisis response strategies are used differently across various crisis stages. With more social media platforms integrated into government organizations' crisis communication repertoire, it becomes increasingly important for public-sector communication officials to become social media-literate. Findings from this study advance the literatures on government use of social media for crisis management. Going forward, it is important for government organizations to not only maintain active social media presence throughout a crisis. Of equal importance is the mindful selection and execution of social media messages that are sensitive to crisis context, event cycle, and targeted audience.

References

Aldoory, L., & Grunig, J. E. (2012). The rise and fall of hot-issue publics: Relationships that develop from media coverage of events and crises. *International Journal of Strategic Communication, 6*(1), 93–108. https://doi.org/10.1080/1553118X.2011.634866.

Avery, E., Lariscy, R., Amador, E., Ickowitz, T., Primm, C., & Taylor, A. (2010). Diffusion of social media among public relations practitioners in health departments across various community population sizes. *Journal of Public Relations Research, 22*(3), 336–358. https://doi.org/10.1080/10627261003614427.

Benford, R. D., & Snow, D. A. (2000). Framing processes and social movements: An overview and assessment. *Annual Review of Sociology, 26*(1), 611–639. https://doi.org/10.1146/annurev.soc.26.1.611.

Benoit, W. L. (1997). Image repair discourse and crisis communication. *Public Relations Review, 23*(2), 177–186. https://doi.org/10.1016/S0363-8111(97)90023-0.

Bowen, S. A., & Zheng, Y. (2015). Auto recall crisis, framing, and ethical response: Toyota's missteps. *Public Relations Review, 41*(1), 40–49. https://doi.org/10.1016/j.pubrev.2014.10.017.

Briones, R. L., Kuch, B., Liu, B. F., & Jin, Y. (2011). Keeping up with the digital age: How the American Red Cross uses social media to build relationships. *Public Relations Review, 37*(1), 37–43. https://doi.org/10.1016/j.pubrev.2010.12.006.

Bruning, S. D. (2000). Examining the role that personal, professional, and community relationships play in respondent relationship recognition and intended behavior. *Communication Quarterly, 48*(4), 437–448. https://doi.org/10.1080/01463370009385608.

Bruning, S. D., & Ledingham, J. A. (1999). Relationships between organizations and publics: Development of a multi-dimensional organization-public relationship scale. *Public Relations Review, 25*(2), 157–170. https://doi.org/10.1016/S0363-8111(99)80160-X.

Cho, S. E., Jung, K., & Park, H. W. (2013). Social media use during Japan's 2011 earthquake: How Twitter transforms the locus of crisis communication. *Media International Australia, 149*(1), 28–40. https://doi.org/10.1177/1329878X1314900105.

Coombs, W. T. (1995). Choosing the right words: The development of guidelines for the selection of the "appropriate" crisis-response strategies. *Management Communication Quarterly, 8*(4), 447–476. https://doi.org/10.1177/0893318995008004003.

Coombs, W. T. (2007). Protecting organization reputations during a crisis: The development and application of situational crisis communication theory. *Corporate Reputation Review, 10*(3), 163–176. https://doi.org/10.1057/palgrave.crr.1550049.

Coombs, W. T., & Holladay, S. J. (2002). Helping crisis managers protect reputational assets: Initial tests of the situational crisis communication theory. *Management Communication Quarterly, 16*(2), 165–186. https://doi.org/10.1177/089331802237233.

Coombs, W. T., & Holladay, S. J. (2009). Further explorations of post-crisis communication: Effects of media and response strategies on perceptions and intentions. *Public Relations Review, 35*(1), 1–6. https://doi.org/10.1016/j.pubrev.2008.09.011.

Coombs, W. T., & Holladay, S. J. (2010). *The handbook of crisis communication.* Malden, MA: Wiley-Blackwell.

Curtis, L., Edwards, C., Fraser, K. L., Gudelsky, S., Holmquist, J., Thornton, K., et al. (2010). Adoption of social media for public relations by nonprofit organizations. *Public Relations Review, 36*(1), 90–92. https://doi.org/10.1016/j.pubrev.2009.10.003.

Doerfel, M. L. (1998). What constitutes semantic network analysis? A comparison of research and methodologies. *Connections, 21*(2), 16–26.

Doerfel, M. L., & Barnett, G. A. (1999). A semantic network analysis of the International Communication Association. *Human Communication Research, 25*(4), 589–603. https://doi.org/10.1111/j.1468-2958.1999.tb00463.x.

FEMA-4322-DR, Texas Disaster Declaration as of 10/11/2017. Retrieved November 10, 2017, from https://gis.fema.gov/maps/dec_4332.pdf.

Freberg, K. (2012). Intention to comply with crisis messages communicated via social media. *Public Relations Review, 38*(3), 416–421. https://doi.org/10.1016/j.pubrev.2012.01.008.

Freberg, K., Palenchar, M. J., & Veil, S. R. (2013). Managing and sharing H1N1 crisis information using social media bookmarking services. *Public Relations Review, 39*(3), 178–184. https://doi.org/10.1016/j.pubrev.2013.02.007.

Gamboa-Maldonado, T., Marshak, H. H., Sinclair, R., Montgomery, S., & Dyjack, D. T. (2012). Building capacity for community disaster preparedness: A call for collaboration between public environmental health and emergency preparedness and response programs. *Journal of Environmental Health, 75*(2), 24–29.

Gilpin, D. (2010). Organizational image construction in a fragmented online media environment. *Journal of Public Relations Research, 22*(3), 265–287. https://doi.org/10.1080/10627261003614393.

Graham, M. W., Avery, E. J., & Park, S. (2015). The role of social media in local government crisis communications. *Public Relations Review, 41*(3), 386–394. https://doi.org/10.1016/j.pubrev.2015.02.001.

Griffin-Padgett, D. R., & Allison, D. (2010). Making a case for restorative rhetoric: Mayor Rudolph Giuliani & Mayor Ray Nagin's response to disaster. *Communication Monographs, 77*(3), 376–392. https://doi.org/10.1080/03637751.2010.502536.

Grunig, J. E., & Dozier, D. M. (2003). *Excellent public relations and effective organizations: A study of communication management in three countries.* New York: Routledge.

Guo, L., & McCombs, M. E. (2015). *The power of information networks: New directions for agenda setting, Vol. 8.* Chicago: Routledge.

Himelboim, I., Golan, G. J., Moon, B. B., & Suto, R. J. (2014). A social networks approach to public relations on Twitter: Social mediators and mediated public relations. *Journal of Public Relations Research, 26*(4), 359–379. https://doi.org/10.1080/1062726X.2014.908724.

Holladay, S. J. (2010). Are they practicing what we are preaching? An investigation of crisis communication strategies in the media coverage of chemical incidents. In Coombs W. T, & S. J. Holladay (Eds.). *The handbook of crisis communication* (pp. 159–180). Malden, MA: Wiley-Blackwell.

Hong, H. (2013). Government websites and social media's influence on government-public relationships. *Public Relations Review, 39*(4), 346–356. https://doi.org/10.1016/j.pubrev.2013.07.007.

Houston, J. B., Hawthorne, J., Perreault, M. F., Park, E. H., Goldstein Hode, M., Halliwell, M. R., et al. (2015). Social media and disasters: A functional framework for social media use in disaster planning, response, and research. *Disasters, 39*(1), 1–22. https://doi.org/10.1111/disa.12092.

Hughes, A. L., St. Denis, L. A., Palen, L., & Anderson, K. M. (2014). Online public communications by police & fire services during the 2012 Hurricane Sandy. April *Proceedings of the 32nd annual ACM conference on human factors in computing systems*.

Iyengar, S. (1990). Framing responsibility for political issues: The case of poverty. *Political Behavior, 12*(1), 19–40.

Jin, Y., Park, S. A., & Len-Ríos, M. E. (2010). Strategic communication of hope and anger: A case of Duke University's conflict management with multiple publics. *Public Relations Review, 36*(1), 63–65. https://doi.org/10.1016/j.pubrev.2009.08.015.

Khan, G. F., Yoon, H. Y., & Park, H. W. (2014). Social media communication strategies of government agencies: Twitter use in Korea and the USA. *Asian Journal of Communication, 24*(1), 60–78. https://doi.org/10.1080/01292986.2013.851723.

Kim, S., Avery, E. J., & Lariscy, R. W. (2011). Reputation repair at the expense of providing instructing and adjusting information following crises. *International Journal of Strategic Communication, 5*(3), 183–199. https://doi.org/10.1080/1553118X.2011.566903.

Kim, H. K., & Niederdeppe, J. (2013). The role of emotional response during an H1N1 influenza pandemic on a college campus. *Journal of Public Relations Research, 25*(1), 30–50. https://doi.org/10.1080/1062726X.2013.739100.

Kim, J. N., Ni, L., Kim, S. H., & Kim, J. R. (2012). What makes people hot? Applying the situational theory of problem solving to hot-issue publics. *Journal of Public Relations Research, 24*(2), 144–164. https://doi.org/10.1080/1062726X.2012.626133.

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Kim, S., & Liu, B. F. (2012). Are all crises opportunities? A comparison of how corporate and government organizations responded to the 2009 flu pandemic. *Journal of Public Relations Research, 24*(1), 69–85. https://doi.org/10.1080/1062726X.2012.626136.

King, B. (2017). *Houston's mayor was right to not evacuate.* August 28 Retrieved fromNew York Timeshttps://www.nytimes.com/2017/08/28/opinion/harvey-flooding-mayor-evacuation.html.

Lai, C.-H. (2017). A study of emergent organizing and technological affordances after a natural disaster. *Online Information Review, 41*(4), 507–523. https://doi.org/10.1108/OIR-10-2015-0343.

Littlefield, R. S., & Quenette, A. M. (2007). Crisis leadership and Hurricane Katrina: The portrayal of authority by the media in natural disasters. *Journal of Applied Communication Research, 35*(1), 26–47. https://doi.org/10.1080/00909880601065664.

Liu, B. F., & Horsley, J. S. (2007). The government communication decision wheel: Toward a public relations model for the public sector. *Journal of Public Relations Research, 19*(4), 377–393. https://doi.org/10.1080/10627260701402473.

Liu, B. F., Horsley, J. S., & Levenshus, A. B. (2010). Government and corporate communication practices: Do the differences matter? *Journal of Applied Communication Research, 38*, 189–213. https://doi.org/10.1080/00909881003639528.

Lovejoy, K., & Saxton, G. D. (2012). Information, community, and action: How nonprofit organizations use social media. *Journal of Computer-Mediated Communication, 17*(3), 337–353. https://doi.org/10.1111/j.1083-6101.2012.01576.x.

Lucero, M., Kwang, A. T. T., & Pang, A. (2009). Crisis leadership: when should the CEO step up? *Corporate Communications: An International Journal, 14*(3), 234–248. https://doi.org/10.1108/13563280910980032.

Muralidharan, S., Rasmussen, L., Patterson, D., & Shin, J. H. (2011). Hope for Haiti: An analysis of Facebook and Twitter usage during the earthquake relief efforts. *Public Relations Review, 37*(2), 175–177. https://doi.org/10.1016/j.pubrev.2011.01.010.

Nah, S., & Saxton, G. D. (2013). Modeling the adoption and use of social media by nonprofit organizations. *New Media & Society, 15*(2), 294–313. https://doi.org/10.1177/1461444812452411.

National Hurricane Center (May 2018). National Hurricane Center Tropical Cyclone Report: Hurricane Harvey. Retrieved from: https://www.nhc.noaa.gov/data/tcr/AL092017_Harvey.pdf.

Olsson, E. K. (2014). Crisis communication in public organisations: Dimensions of crisis communication revisited. *Journal of Contingencies and Crisis Management, 22*(2), 113–125. https://doi.org/10.1111/1468-5973.12047.

Poser, C., Guenther, E., & Orlitzky, M. (2012). Shades of green: Using computer-aided qualitative data analysis to explore different aspects of corporate environmental performance. *Journal of Management Control, 22*(4), 413–450. https://doi.org/10.1007/s00187-011-0147-2.

Rybalko, S., & Seltzer, T. (2010). Dialogic communication in 140 characters or less: How Fortune 500 companies engage stakeholders using Twitter. *Public Relations Review, 36*(4), 336–341. https://doi.org/10.1016/j.pubrev.2010.08.004.

Saffer, A. J. (2016). A message-focused measurement of the communication dimension of social capital: Revealing shared meaning in a network of relationships. *Journal of Public Relations Research, 28*(3–4), 170–192. https://doi.org/10.1080/1062726X.2016.1228065.

Saxton, G. D., & Guo, C. (2014). Online stakeholder targeting and the acquisition of social media capital. *International Journal of Nonprofit and Voluntary Sector Marketing, 19*(4), 286–300. https://doi.org/10.1002/nvsm.1504.

Schultz, F., Kleinnijenhuis, J., Oegema, D., Utz, S., & Van Atteveldt, W. (2012). Strategic framing in the BP crisis: A semantic network analysis of associative frames. *Public Relations Review, 38*(1), 97–107. https://doi.org/10.1016/j.pubrev.2011.08.003.

Shaluf, I. M., Ahmadun, F. L. R., & Said, A. M. (2003). A review of disaster and crisis. *Disaster Prevention and Management: An International Journal, 12*(1), 24–32. https://doi.org/10.1108/09653560310463829.

Smith, A. E., & Humphreys, M. S. (2006). Evaluation of unsupervised semantic mapping of natural language with Leximancer concept mapping. *Behavior Research Methods, 38*(2), 262–279. https://doi.org/10.3758/BF03192778.

Sommerfeldt, E. J., & Yang, A. (2017). Relationship networks as strategic issues management: An issue-stage framework of social movement organization network strategies. *Public Relations Review, 43*(4), 829–839. https://doi.org/10.1016/j.pubrev.2017.06.012.

Sutton, J. N., Palen, L., & Shklovski, I. (2008). Backchannels on the front lines: Emergency uses of social media in the 2007 Southern California Wildfires. *Proceedings of the 5th International ISCRAM Conference*.

Sutton, J., Spiro, E. S., Johnson, B., Fitzhugh, S., Gibson, B., & Butts, C. T. (2014). Warning tweets: Serial transmission of messages during the warning phase of a disaster event. *Information, Communication & Society, 17*(6), 765–787. https://doi.org/10.1080/1369118X.2013.862561.

Veil, S. R., Buehner, T., & Palenchar, M. J. (2011). A work-in-process literature review: Incorporating social media in risk and crisis communication. *Journal of Contingencies and Crisis Management, 19*(2), 110–122. https://doi.org/10.1111/j.1468-5973.2011.00639.x.

Waters, R. D., & Williams, J. M. (2011). Squawking, tweeting, cooing, and hooting: Analyzing the communication patterns of government agencies on Twitter. *Journal of Public Affairs, 11*(4), 353–363. https://doi.org/10.1002/pa.385.

Weberling, B. (2012). Framing breast cancer: Building an agenda through online advocacy and fundraising. *Public Relations Review, 38*(1), 108–115. https://doi.org/10.1016/j.pubrev.2011.08.009.

Weiner, B. (1992). *Human motivation: Metaphors, theories, and research.* Newbury Park, CA: Sage.

Weiner, B. (2006). *Social motivation, justice, and the moral emotions: An attributional approach.* New York: Psychology Press.

Yang, A., & Taylor, M. (2015). Looking over, looking out, and moving forward: Positioning public relations in theorizing organizational network ecologies. *Communication Theory, 25*(1), 91–115. https://doi.org/10.1111/comt.12049.