Using value modeling to evaluate social media messages: The case of Hurricane Irene

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ARTICLE INFO

ABSTRACT

Emerging technologies, advances in social media, and new communication platforms have transformed how crisis communicators reach their audiences and partner agencies in a variety of situations. Not only do individuals and organizations communicate differently during a crisis, but they are also perceived very differently; social media platforms and messages add to the challenges involved in maintaining the overall reputation of brands and corporations. To better understand the new messaging system and its effects, the researchers analyzed social media crisis messages and messaging theory through various qualitative and quantitative value modeling techniques and generated a simple baseline model for what constitutes a "good" crisis message. Using data collected during Hurricane Irene, the researchers used this baseline model to rank effective and ineffective messages to determine whether the most followed/forwarded messages fit this model, and to identify a set of new best practices for crisis communicators and reputation management monitors using social media platforms.

1. Introduction

Emerging technologies, advances in social media, and new communication platforms have transformed how crisis communicators reach their audiences and partner agencies in a variety of situations (Freberg, 2012). Not only do individuals and organizations now communicate differently during a crisis because of emerging technologies, but they are also perceived very differently; social media platforms and messages add to the challenges involved in maintaining the overall reputation of brands and corporations (González-Herrero & Smith, 2008; Jin, Liu, & Austin, 2011).

Organizations invest time, money, and communication resources to identify and implement the latest forms of technology, including social media, which enables them to proactively monitor and prepare for potential crises. Crises, defined as significant, disruptive events that often feature a rapid onset (Coombs, 2007), can produce negative consequences for an organization's financial health and reputation. Social media can mitigate these consequences by offering daily monitoring of reputational indicators and crisis messages (Heath & Palenchar, 2009).

Social media also enable reputation managers to reach their key demographics quickly and efficiently, making it easier to establish a strong sense of credibility and reputation for a brand (Prentice & Huffman, 2008). This aspect of social media

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allows crisis management practitioners to develop and disseminate timely and consistent crisis messages across multiple social media platforms. The speed of information sharing across these platforms coupled with the organic creation of viral information (e.g., key terms and hashtags) offers crisis communicators new challenges and new uncertainties. Practitioners can look to previous research on best practices in emergency and crisis communication to inform strategic communication practices within social and mobile media platforms. Such research (Heath, Lee, & Ni, 2009; Dillard, Shen, & Vail, 2007) has shown that crisis and emergency messages are most effective when they feature a personal touch (i.e., personalized messages) and efficacy (i.e., providing individuals with action steps to take).

Existing literature in crisis communication offers many best practices but has yet to delve into what constitutes a "good" crisis message communicated through social media. Do emergency messages benefit from having a hashtag? What return do communicators receive from photos or hyperlinks? How does having a more conversational tone or a personal touch (e.g., use of text, voice, or video) contribute to the effectiveness of an emergency message?

The current research analyzed existing communication theory and practice to develop both a qualitative and quantitative value model of a "good" crisis message conveyed using social media platforms. Next, these models were applied as a proof of concept to social media crisis messages collected concerning Hurricane Irene, which impacted most of the East Coast of the United States in August 2011. A total of 2157 updates were collected between August 22 and September 1, 2011, from the social media monitoring site Social Mention (www.socialmention.com).

An initial analysis of these updates revealed a range of uncertainty in actions by emergency first responders. Government agencies involved in the response demonstrated inconsistent implementation of effective and consistent hashtags on Twitter. Second, unique challenges arose regarding the processes used by practitioners to monitor emerging risks and other emergency issues related to Hurricane Irene through social media.

Through the use of value modeling techniques and analysis of the Hurricane Irene data, the researchers offer a simple baseline model of what constitutes a "good" crisis message communicated through social media and a set of best practices for social media messages communicated during a natural disaster. These guidelines can be adapted for other scenarios to aid communicators in transmitting effective crisis communication and reputation management messages in a crisis.

1.1. Reputation management and crisis communications

Reputation management is a critical component of any strategic communication plan for organizations in both public and private sectors. A reputation in this case is conceptualized as "the collective representation of multiple constituencies' images of a company, built up over time and based on a company's identity programs, its performance, and how constituencies have perceived its behavior" (Argenti & Druckenmiller, 2004, p. 369). Reputation management in the private sector often focuses on consumer sales; the public sector focuses on credibility.

Sustaining a credible reputation with a company's or organization's consumer base can "add value and increase cash flow and profits, result in increased sales, more credible advertisements, improve perceived product quality and produce higher consumer loyalty" (Caruana, Cohen, & Krentler, 2006, p. 429). Preserving a credible reputation is doubly important. A reputation can be greatly tarnished if an audience perceives a crisis response strategy to be ineffective. Companies that have an established and positive reputation are more likely to recover quickly after a major crisis (Ulmer, 2001).

A corporate reputation is based on four foundations: reliability, responsibility, credibility, and trustworthiness (Fombrun, 1996). These foundations can be challenged or discredited during a crisis, but a crisis can impact private and public sector corporations and organizations very differently. The public sector often prepares for and responds to natural hazards (earthquakes, tsunamis, landslides, etc.) in a way that demonstrates that the public sector organization is responsible for ensuring the safety of its citizens. The private sector faces more subtle crises such as transgressions, accidents, workplace violence, rumors, technical errors, and human errors, where responsibility is not seen as a positive factor (Coombs, 1995, 2007).

Regardless of the type of crisis, crisis communication research provides evidence that emergency messages ought to explain the event, explain who is in charge and what they are doing to mitigate harm, and what people can do to protect themselves (Sandman, 2006; Seeger, Sellnow, & Ulmer, 1998). Effective crisis communications occur when public relations professionals use their "efforts to strategically manage and frame public perceptions of an event so that harm is reduced for both the organization and stakeholders" (Reynolds & Seeger, 2005, p. 46).

1.2. Social media and crisis communications

Crisis communication refers to the provision of effective, efficient messages to relevant audiences during the course of a crisis process. Reynolds and Seeger (2005) state that crisis communication "seeks to explain the specific event, identify likely consequences and outcomes, and provide specific harm-reducing information to affected communities in an honest, candid, prompt, accurate, and complete manner" (p. 46). Crisis communication directs the course of a crisis process in a positive direction when done well or in a negative direction when done poorly.

Social media have been used by businesses and agencies to promote a more positive reputation (Prentice & Huffman, 2008), to provide an unfiltered view of consumer perceptions based on digital word-of-mouth communications (Marken, 2007), to produce a convergence of social and technological networks (Kleinberg, 2008), to engage in a virtual dialog with others online (Hsu, Ju, Yen, & Chang, 2007), and to establish social media influencers within specific communities based on perceived personality characteristics (Freberg, Graham, McGaughey, & Freberg, 2011). Social media and mobile technology

can benefit individual stakeholders during a highly tense situation like a crisis. These emerging technologies have allowed people to feel they have more control over the crisis as well as more connection to the community (Shklovski, Burke, Kiesler, & Kraut, 2010). Increased empowerment of the individual stakeholder leads to greater feelings of control over the situation and a willingness to help others in the community.

Emerging digital communication platforms such as social media are used to connect groups of people using mobile internet capabilities and social networking sites like Facebook and Google+, microblogs like Twitter, photosharing sites like Instagram and Pinterest, and video sharing sites like YouTube and Vimeo. All of these platforms produce engaging inter-actions, conversations that are enhanced with multimedia, and connections among individuals with real-time information directly through computers, tablets, or smartphones. Emergency and crisis communication professionals need to be pre-pared to engage in the dialog among their key stakeholders on the behalf of the organization or agency they represent (Bruns, Burgess, Crawford, & Shaw, 2012).

On digital platforms, the individual user can create and curate information in multiple contexts to be shared via one-to-one, one-to-many, or many-to-many communications. Individuals not only receive information through these platforms, but they can use technology to create their own content or forward content to others. By doing so, individuals can contribute directly to media by providing eyewitness perspectives through video, photos, or texted accounts of an event, often bypassing the professional reporters on the scene, and providing unfiltered views of what is happening in the world (Gordon, 2007).

Most recent research has explored the use of social media in crisis situations in general (Shklovski, Palen, & Sutton, 2008) and in specific crisis events including 9/11 (Midkoff & Bostain, 2002), Hurricane Katrina and the 2007 Virginia Tech Shootings (Liu, Palen, Sutton, Hughes, & Vieweg, 2008; Palen, 2009; Vieweg, Palen, Liu, Hughes, & Sutton, 2008), and the Egypt protests in 2011 (Starbird et al., 2012). Each of these crises stimulated discussion about the importance of understanding the application of these new communication technology tools for crisis and emergency communicators. Midkoff and Bostain (2002) pointed out that the terrorist attacks on 9/11 showed the need for more effective technological advancements in communicating emergency response messages in disaster situations. The 9/11 event stimulated increased focus and drive in the crisis communication literature looking at the implementation and crisis communication strategies involving new forms of technology in a crisis or disaster. Sutton, Palen, and Shklovski (2008) showed how community members who experienced the 2007 southern California wildfires sought information and used social media to contact friends and family. Sutton (2010) analyzed Twitter updates and conversations in regard to the TVA ash spill crisis, messages that often reached the public before the traditional media. Vieweg et al. (2008) looked at the possible risks for organizations that inadvertently provide inaccurate information to stakeholders in a time of crisis.

1.3. Hurricane Irene case study (2011)

Hurricane Irene hit the East Coast of the United States during fall of 2011 and turned out to be one of the most destructive hurricanes in the last three decades ("Hurricane Irene," August 29, 2011). The last hurricane that produced this impact on the East Coast was 2005's Hurricane Wilma, which came ashore in Florida ("Hurricane Irene strengthens on path to Carolinas," August 23, 2011). The significance of this natural disaster prompted President Obama to make a formal statement to residents in the potentially impacted locations ("President Obama delivers a statement"):

> I cannot stress this highly enough: If you are in the projected path of this hurricane, take precautions now. The federal government has spent the better part of last week working . . . to see to it that we're prepared. All indications point to this being a historic hurricane.

In observing social media messages during the event, two key issues emerged. First, erroneous information, particularly regarding locations where people could obtain necessary items like food and shelter, was being disseminated at a rapid pace through Twitter and other social media platform sites during the hurricane. This misinformation caused unwarranted uncertainty, fear, and confusion in online community and social networks ("Social media lessons learned from Hurricane Irene," September 1, 2011). Crisis communicators should monitor their social media accounts to ensure that erroneous information is not provided via their accounts or by individuals commenting on their organization's social media posts.

The second issue highlighted during Hurricane Irene was the importance of crowdsourcing, or the power to ask individuals to help contribute and create information surrounding a topic or issue in a centralized location. In particular, the authors monitored the sites Kyoo (www.kyoo.com) and Esri (www.esri.com) to see how individuals were sharing information across various social media platforms. These social media and geolocation monitoring services presented different snapshots of what was being discussed, shared, and commented on by users regarding this particular natural disaster. Kyoo is a social media aggregator that pulls data from multiple sources into one dashboard. Esri allows geographically referenced data to be analyzed quickly and easily.

1.4. Qualitative and quantitative value modeling

The sheer breadth and depth of information available in social media make it necessary for both crisis professionals and crisis communicators to identify the best messages to monitor and to know what elements to communicate in a message so that it will be heard. While effective criteria currently exist, they are not organized in an algorithm that can aid crisis professionals in executing their task. To attack this problem, this research applied problem definition and requirements

analysis techniques used in systems engineering. Systems engineering has been defined as "selecting the path to follow from among many possible courses" (Kossiakoff, Sweet, Seymour, & Biemer, 2011, p. 3). Systems engineering modeling techniques include functional and requirements analysis, qualitative value modeling, and quantitative value modeling.

Functional requirements analysis is the discipline within systems engineering that gathers information regarding a system, identifies the overall function/purpose, and then breaks it into subfunctions. In this manner, the analyst attempts to ascertain exactly what the requirements are that are placed on the system. The term "function" is defined through the process as "a characteristic task, action, or activity that must be performed to achieve a desired outcome" (Parnell, Driscoll, & Henderson, 2011, p. 315). The overall function is the overarching end purpose of the system, and the subfunctions consist of all the contributing tasks. Although this process seems fairly straightforward, identifying the appropriate subfunctions is absolutely necessary or critical components of the model will be left out and could greatly bias future data analyses (Parnell et al., 2011).

While systems analysts create both qualitative and quantitative value models, the qualitative value model "is the most important because it reflects the key stakeholder values regarding the [system]" (Parnell et al., 2011, p. 327). A good qualitative value model is one that is as complete as possible without introducing redundancy. To develop a qualitative value model, the analyst must use information developed in initial functional analysis to assign objectives and value measures to the model. The objectives identify the optimal value for a particular function and show what the ideal system should produce in the corresponding category. Value measures provide a scale that allows the researcher to rate alternatives against the ideal system. These methods of measurement can be drawn from preexisting scales, can be assessed through data analysis, or can be assigned subjectively (Parnell et al., 2011). A mixture of these techniques has been used in this model.

A quantitative value model is the next step in the process. It turns the qualitative value model into a measure to show how well "candidate solutions" to the problem meet what the stakeholder is looking for, in this case how well collected crisis messages measure up to what the literature and subject matter experts say they should do in order to be considered "good" crisis messages (Parnell et al., 2011). In the current research, various crisis communications are tested against the model and its value measures to see whether the ratings drawn from the literature and subject matter experts are sufficient to correctly classify messages that were widely spread and followed throughout the crisis situation.

1.5. Justification of research

Information systems continue to evolve at a rapid pace and as a result, ongoing evaluation and investigation of the tools and systems is needed. Understanding the uses of emerging technologies—including social media—in a crisis allows crisis communicators to disseminate emergency messages effectively. Not only is it important to determine the most efficient way to communicate crisis messages via social media, but it is also crucial to identify any reputational risks within messages. Determining a formula to assist in the monitoring and creation of crisis messages is one of the top priorities for reputation and crisis managers for the 21st century.

Research into the implications of emerging technologies such as social media for crisis communication is transdisciplinary, linking various disciplines such as systems engineering, computer science, health communication and weather risk communication. To stay current, communication and public relations academic communities need to review these findings and integrate the relevant literature into the theoretical and applied perspectives of crisis communication practices. Methods used in previous social media and crisis literature reviews include interviews (Palenchar & Freberg, 2011), experiments with a specific population such as undergraduate students (Austin, Liu, & Jin, 2012) or consumer panels (Freberg, 2012), or social media monitoring and crisis informatics (Palen et al., 2010; Sutton, 2010). Approaching social media and crisis communication from a joint public relations and systems engineering approach will provide additional methods for observing and determining the most effective online crisis messages.

RQ1: What are the main attributes constituting a "good" crisis message communicated via social media?
RQ2: What are the best practices for effectively communicating via social media in a crisis situation?

2. Method

2.1. Data acquisition and coding

Social mention (www.socialmention.com) was used to collect updates appearing on social media platforms from August 22, 2011 to September 1, 2011 using the search terms "hurricane irene," "hurricane irene safety," "hurricane irene mold," and "hurricane irene food safety." Social mention is a "social media search and analysis platform that aggregates user generated content" from more than 100 social media sites, including Twitter, Facebook, FriendFeed, YouTube, Digg, and Google (Cianciullo, 2012). Data were collected by downloading the updates twice a day at 8 am and 8 pm EST. A total of 2157 updates were collected, 1550 of which were collected under the search terms "hurricane irene" and 458 of which were collected for "hurricane irene safety." The remaining updates were collected under other variants.
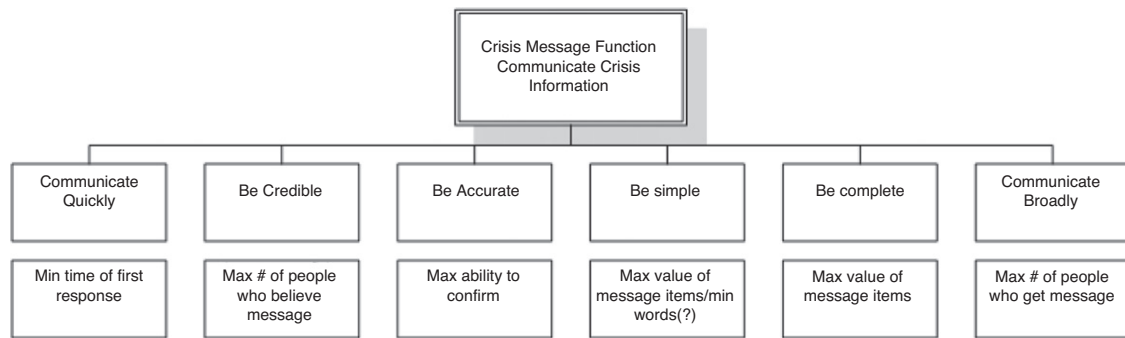
Fig. 1. The research literature on crisis messages formed the basis of a hierarchical model composed of functions, subfunctions, and qualitative value measures.

2.2. Application of qualitative and quantitative value modeling

The researchers reviewed the existing crisis communication literature to determine the primary function of a "good" crisis message. Ultimately, the end purpose of a crisis message is to communicate crisis information. This goal can be broken into subfunctions. The identified subfunctions are as follows:

F.01 Communicate Quickly
F.02 Be Credible
F.03 Be Accurate
F.04 Be Simple
F.05 Be Complete
F.06 Communicate Broadly

The systems engineering process known as value modeling takes these functions and uses them to create a qualitative value model called a functional hierarchy. A qualitative value model is a model that deconstructs a system into functions and subfunctions that are of value to the stakeholder, in this case the crisis communicator or monitor (Parnell et al., 2011). A functional hierarchy provides ways these functions can be measured, categorized, and ranked. Using this methodology, the next step was to determine how the communications system, the crisis message, achieves a successful rating in the performance of these functions. In qualitative value analysis, measures are created that are phrased in the form of objectives with a maximum or minimum value assigned to them that indicates an optimal result (Parnell et al., 2011).

Fig. 1 shows the overall functional hierarchy of the system with function, subfunctions, and qualitative value measures created based on scale items from the literature. The identified objectives allowed the researchers to begin establishing a system for measuring the success of these crisis messages against the model. In order to best develop the measurement system, the researchers assigned a value question to each of the objectives that, if answered, showed just how well the messages performed in the category of that objective. Using existing literature, the researchers constructed the objectives and value questions for the crisis message model. When there was not an existing scale in the literature to measure effectiveness, the researchers created a subjective scale.

To test the model, the researchers limited the number of values tested to eight items instead of testing all seventeen value measures. As the crisis model was constructed for the general definition of a crisis, almost every value measure in FO2 Be Credible applies to corporate reputation and attribution of responsibility. This facet of the model was not pursued in this case study. The value measures and value questions used in this study are as follows: VM02_5 Traditional media outlet, VM03_1 Presence of topical keywords, VM03_2 Real time monitoring links, graphics, etc., VM04_1 Conversational voice, VM05_1 Info about safety given, VM05_2 Info about sources of relief, VM05_3 Secondary messages in a different medium, VM06_1 Presence of a hashtag, and VM06_2 Presence of a URL. Using these value measures, the researchers assigned values to the collected Hurricane Irene data to determine whether the top messages identified by Social Mention as "messages that matter" (www.socialmention.com) fit the value model as "good" crisis messages.

3. Results and discussion

3.1. Descriptive statistics

Only a few updates were collected during the first day of collection ($N=27$), but the number of important updates grew as the hurricane approached the East Coast ($N=495$). The social media updates collected about Hurricane Irene came from multiple sources such as Twitter, Facebook, Digg, YouTube, Yahoo! News, Google News, Reddit, and Flickr. The most frequently used social media platform was Digg ($N=295$) followed by Twitter ($N=231$) and then Stumbleupon ($N=207$).

CBS was the most cited traditional media outlet ($N = 21$). The top expert mentions via Twitter included the following Twitter accounts: @breakingnews ($N = 39$), @cfnews13 ($N = 37$), and @atlanticwatch ($N = 43$). The top keywords (besides hashtags) were collected, and water ($N = 65$) was most frequently mentioned, followed by "damage," "storm," "creates," "flood," "spill," "septic," "chemical," and "pesticides."

Of the updates collected from Social Mention, the researchers limited the data to the first 48 hours, or what was deemed a reasonable response time for all the necessary functions of a crisis messaging strategy. This criterion resulted in 480 updates analyzed through the pilot model and rankings developed for this research. The highest score was given to an update that incorporated all of the components for an effective or "good" crisis message based on the literature and scale items created for the quantitative value model.

All of the top updates except two referenced Twitter usernames (e.g., @username) in their update as well as hashtags related to Hurricane Irene. Links were also present. Similarities were present in the scores of effective messages not only in terms of the totals, but also in the ratings of individual attributes. Based on the scores and rankings of each update, this table presents the breakdown of the characteristics that were given to each attribute.

3.2. Proof-of-concept value model test for crisis messages in social media

The proof-of-concept model for this study presented various characteristics and attributes for crisis communicators to take into consideration with their crisis messages when communicating over social media. One interesting finding was that there appeared to be traditional hashtags being used consistently, though there was variation on the hashtags based on location (i.e., North Carolina had #ncirene and Maryland had #mdirene). While these variations are useful for those aware of the hashtags, it is not apparent whether the variations were effectively communicated across media platforms or agencies. Oddly, though all of the top updates presented in this study were from Twitter, only four of the top ten used a hashtag. Hashtags (topical keywords; Starbird & Palen, 2011; Suh, Hong, Pirolli, & Chi, 2010) are useful to incorporate strategically into a crisis communications plan not only for others to use in monitoring what others are saying, but to ensure that those impacted in the crisis situation are able to follow what others are reporting; the improper use or improper dissemination of hashtags may have impacted the wider dissemination of what could have been very high scoring messages.

The top social media updates presented by Social Mention received high scores for having links to more information and a focus on safety. Most of the updates had a strong score in voice, which reflects the sharing of up-to-date information across social media platforms to empower others to take action (Shklovski et al., 2010). Eight of the top ten updates had a link associated with the update. The use of links to graphics, photos, and videos within the social media update is critical to providing more detailed information than can be reported in limited-character posts, and has been reported in the literature as a key characteristic for effective crisis communications (Taylor & Perry, 2005).

The fact that Twitter was one of the primary resources for information related to this particular crisis is interesting. Previous research has discussed the role of Twitter as a platform for sharing updates and breaking news to audiences in real-time (Sutton, 2010) and found that during the TVA Ash Spill crisis, Twitter message often reached the public before the traditional media. Other cases in which Twitter was a primary crisis communication tool include the 2007 California wildfires, the 2008 Mumbai massacre, the 2009 crash of US Airways Flight 1549, the 2010 Haiti earthquake (Veil, Buehner, & Palenchar, 2011), and the 2011 Japanese tsunami (Freberg, 2011).

Information about safety (Hughes et al., 2008) along with secondary messages in a different medium such as videos, links (Suh et al., 2010), and photos (Schultz, Utz, & Gortiz, 2011) are considered to be necessary components of a crisis message. The updates that received the highest scores included these characteristics.

Social media are about having a dynamic and ongoing conversation that is real, and several updates scored very high in the category of transparent and real voice, which the literature cites as a best practice (Diga & Kelleher, 2009). Official sources were recognized in the traditional media, social media, and weather community within the top updates. This finding implies that one best practice would be to mention an established source within the realm of the crisis.

3.3. Best practices for crisis communicators

With these points taken into consideration, the researchers have identified several best practices that extend some previous best practices discussed in social media and crisis communications (Veil et al., 2011) including:

- *Integrating multimedia and links into updates:* Individuals want not only textual information appearing in social media updates related to a crisis, but also a visual context of the information or a reference to another credible source.
- *Proper use of hashtags and tagged keywords:* Organizations and agencies need to be strategic in monitoring and assigning hashtags for specific events so that others may monitor, follow, and respond. Proper training in this practice for crisis communications professionals using social media needs to be explored. Project EPIC from the University of Colorado has initiated this type of research with its "Tweak the Tweet" application to use in disasters. Further exploration into the application of this principle to platforms besides Twitter is needed.
- *Balance between official and conversational updates:* Most of the updates collected from Social Mention focused on addressing breaking news about Hurricane Irene, but they were framed to be more conversational than official in tone compared to

traditional media. The more conversational updates were more successful than those in an official tone of voice, so tone should be an area of consideration for crisis communications professionals operating in social media.

There were several limitations to this study. First, the researchers only collected the data coming from one social media monitoring site. This social media monitoring platform only collected from certain platforms and not all of the social media platforms were available to monitor. The researchers did not research the specific links that were used to share video, pictures, and information sheets regarding the hurricane, and no scale was developed to rank the quality of the link included in the update. Further analysis needs to consider the influence of additional information presented in link format.

Future research into this area can include exploring the same proof-of-concept model for various crisis situations. Corporate scandals, occupy or social movements, product malfunctions or accidents, or even industry crises can be explored with this model. Further research incorporating more of the reputation management component could add subfunctions and objectives pertaining to the credibility of the spokesperson, tone of the message, and timing and location of the update.

4. Conclusion

As technology increases and mobile technologies become integrated into daily social and business practices, these tools and specializations need to become a focus of discussion and research within crisis communications. Understanding what constitutes a "good" crisis message appearing on social media should be incorporated into crisis and risk communication training, education, and simulation exercises for practitioners and researchers. Even though social media is becoming more mainstream in society and communications practices, not everyone involved in the crisis communications or the stakeholders within specific communities know or understand social media.

More integrated research is needed within reputation management bridging various disciplines such as systems engineering, computer science, and computer engineering. The strategic communications academic community could then review the resulting findings and integrate this literature into the theoretical and applied perspectives of crisis communication and reputation management practices. Further research particularly in the area of data analysis and visualization research needs to be explored to determine the specific metrics and evaluation tools to measure engagement and conversations emerging from social and mobile platforms (Bruns et al., 2012).

Acknowledgments

References

Argenti, P. A., & Druckenmiller, B. (2004). Reputation and the corporate brand. *Corporate Reputation Review*, 6(4), 368–374.

Austin, L., Liu, B. F., & Yin, J. (2012). How audiences seek out crisis information: Exploring the social-mediated crisis communication model. *Journal of Applied Communication Research*, 40(2), 188–207. http://dx.doi.org/10.1080/00909882.2012.654498

Bruns, A., Burgess, J., Crawford, K., & Shaw, F. (2012). #qldfloods and @QPSMedia: Crisis communication on Twitter in the 2011 South East Queensland Flood. *ARC center of excellence for creative industries & innovation (CCI) media ecologies project*. Retrieved from http://snurb.info/files/2012/qldfloods and QPS Media.pdf, January.

Caruana, A., Cohen, C., & Krentler, K. A. (2006). Corporate reputation and shareholders' intentions: An attitudinal perspective. *Journal of Brand Management*, 13(6), 429–440.

Cianciullo, J. (2012). About socialmention. Retrieved from http://socialmention.com/about/

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.

Coombs, W. T. (2007). *Ongoing crisis communication: Planning, managing, and responding* (2nd ed.). Thousand Oaks, CA: Sage.

Diga, M., & Kelleher, T. (2009). Social media use, perceptions of decision-making power, and public relations roles. *Public Relations Review*, 35, 440–442.

Dillard, J. P., Shen, L., & Vail, R. G. (2007). Does perceived message effectiveness cause persuasion or vice versa? 17 consistent answers. *Human Communication Research*, 33, 467–488.

Fombrun, C. J. (1996). *Reputation: Realizing value from the corporate image*. Cambridge, MA: Harvard Business School Press.

Freberg, K. (2011). NCFPD Brief Report on the Japanese Tsunami. Retrieved from http://www.ncfpd.umn.edu/Ncfpd/assets/File/NCFPD_Brief_Report_Japan_Social_Media.pdf

Freberg, K., Graham (Saling), K., McGaughey, K., & Freberg, L. (2011). Who are the social media influencers? A study of public perceptions of personality. *Public Relations Review*, 37(1), 90–92.

Freberg, K. (2012). Intention to comply with crisis messages communicated via social media. *Public Relations Review*, 38(3), 416–421.

González-Herrero, A., & Smith, S. (2008). Crisis communications management on the web: How internet-based technologies are changing the way public relations professionals handle business crises. *Journal of Contingencies & Crisis Management*, 16, 143–153. http://dx.doi.org/10.1111/j.1468-5973.2008.00543.x

Gordon, J. (2007). The mobile phone and the public sphere: Mobile phone usage in three critical situations. *Convergence*, 13, 307–319.

Heath, R. L., & Palenchar, M. J. (2009). *Strategic issues management: Organizations and public policy challenges* (2nd ed.). Thousand Oaks, CA: Sage.

Heath, R. L., Lee, J., & Ni, L. (2009). Crisis and risk approaches to emergency management planning and communication: The role of similarity and sensitivity. *Journal of Public Relations Research*, 21(2), 123–141.

Hsu, M.-H., Ju, T. L., Yen, C.-H., & Chang, C.-M. (2007). Knowledge sharing behavior in virtual communities: The relationship between trust, self-efficacy, and outcome expectation. *International Journal of Human-Computer Studies*, 65(2), 153–169.

Hughes, A. L., Palen, L., Sutton, J., Liu, S. B., & Vieweg, S. (2008). Site-seeing in disaster: An examination of online social convergence. In *Proceedings of the 5th International ISCRAM Conference* Washington, DC, USA,

Hurricane Irene strengthens on path to Carolinas (2011). Retrieved from http://www.usatoday.com/weather/storms/hurricanes/story/2011-08-23/Hurricane-Irene-strengthens-on-path-to-Carolinas/50106650/1, August 23.

Hurricane Irene. (2011). Retrieved from http://www.boston.com/bigpicture/2011/08/hurricane_irene.html, August 29.

Jin, Y., Liu, B. F., & Austin, L. L. (2011). Examining the role of social media in effective crisis management: The effects of crisis origin, information form, and source on publics' crisis responses. *Communication Research*, *20*(5), 1–21.

Kleinberg, J. (2008). The convergence of social and technological networks. *Communications of the ACM*, *51*(11), 66–72.

Kossiakoff, A., Sweet, W. N., Seymour, S., & Biemer, S. M. (2011). *Systems engineering principles and practice*. New York: Wiley.

Liu, S., Palen, L., Sutton, J., Hughes, A., & Vieweg, S. (2008). In search of the bigger picture: The emergent role of on-line photo-sharing in times of disaster. In *paper presented at the Proceedings of the 5th International ISCRAM Conference* Washington, DC,

Marken, G. A. (2007). Social media. . . The hunted can become the hunter. *Public Relations Quarterly*, *52*(4), 9–12.

Midkoff, S. F., & Bostain, C. W. (2002). Rapidly-deployable broadband wireless networks for disaster and emergency response. In *paper presented at the The First IEEE Workshop on Disaster Recovery Networks (DIREN '02)* New York City, NY.

Palen, L. (2009). Keeping up with the future of human-computer interaction: The many masters of scholarship, social action work, and rapid technological change. In *paper presented at the Human Computer Interaction Consortium 2009* Winter Park, CO.

Palen, L., Anderson, K. M., Mark, G., Martin, J., Sicker, D., Palmer, M., & Grunwald, D. (2010). A vision for technology-mediated support for public participation and assistance in mass emergencies and disasters. *Proceedings of ACM-BCS Visions of Computer Science*, 1–12.

Palenchar, M. J., & Freberg, K. (2011). Conceptualizing social media and mobile technologies in risk and crisis communication practices. In *paper presented at the annual meeting of the International Communication Association, preconference workshop entitled Seamlessly mobile? Mobile communications @ a crossroads* Boston, MA,. May.

Parnell, G. S., Driscoll, P. J., & Henderson, D. L. (2011). *Decision making in systems engineering and management*. Hoboken, NJ: John Wiley & Sons.

Prentice, S., & Huffman, E. (2008). Social media's new role in emergency management. Retrieved from http://www.inl.gov/technicalpublications/Documents/3931947.pdf, March.

President Obama delivers a statement on Hurricane Irene (2011). Retrieved from http://www.whitehouse.gov/photos-and-video/video/2011/08/26/president-obama-delivers-statement-hurricane-irene#transcript, August 26.

Reynolds, B., & Seeger, M. W. (2005). Crisis and emergency risk communication as an integrative model. *Journal of Health Communication*, *10*, 43–55.

Sandman, P. M. (2006). Crisis communication best practices: Some quibbles and additions. *Journal of Applied Communication Research*, *34*(3), 257–262.

Seeger, M. W., Sellnow, T. L., & Ulmer, R. R. (1998). Communication, organization, and crisis. In M. Roloff (Ed.), *Communication yearbook* (pp. 230–275). Thousand Oaks, CA: Sage.

Schultz, F., Utz, S., & Goritz, A. (2011). Is the medium the message? Perceptions of and reactions to crisis communication via twitter, blogs, and traditional media outlets. *Public Relations Review*, *37*, 20–27.

Shklovski, I., Burke, M., Kiesler, S., & Kraut, R. (2010). Technology adoption and use in the aftermath of Hurricane Katrina in New Orleans. *American Behavioral Scientist*, *53*, 1228–1246.

Shklovski, I., Palen, L., & Sutton, J. (2008). Finding community through information and communication technology during disaster events. In *paper presented at the ACM Conference on Computer Support Cooperative Work* San Diego, CA,. November

Starbird, K., & Palen, L. (2011). *"Voluntweeters": Organizing by digital volunteers in times of crisis*. Vancouver, Canada: CHI 2011.

Starbird, K., Muzny, G., & Palen, L. (2012). Learning from the crowd: Collaborative filtering techniques for identifying on-the-ground Twitterers during mass disruption. In *Proceedings of the 9th International ISCRAM Conference* Vancouver, Canada.

Suh, B., Hong, L., Pirolli, P., & Chi, E. H. (2010). Want to be retweeted? Large scale analytics on factors impacting retweet in Twitter network. In *IEEE Intl Conference on Social Computing, IEEE* (pp. 177–184).

Sutton, J. N. (2010). Twittering Tennessee: Distributed networks and collaboration following a technological disaster. In *Paper presented at the 7th International ISCRAM Conference* Seattle, WA.

Sutton, J., Palen, L., & Shklovski, I. (2008). Backchannels on the front lines: Emergent use of social media in the 2007 Southern California Fires. In *paper presented at the Information Systems for Crisis Response and Management Conference* Washington, DC.

Taylor, M., & Perry, D. (2005). Diffusion of traditional and new media tactics in crisis communication. *Public Relations Review*, *31*, 209–217.

Ulmer, R. R. (2001). Effective crisis management through established stakeholder relationships: Malden Mills as a case study. *Management Communication Quarterly*, *14*(4), 590–615.

Veil, S., 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.

Vieweg, S., Palen, L., Liu, S., Hughes, A., & Sutton, J. (2008). Collective intelligence in disaster: An examination of the phenomenon in the aftermath of the 2007 Virginia Tech Shootings. In *paper presented at the Information Systems for Crisis Response and Management Conference* Washington, DC.