An Exploration of Collaboration over Time in Collective Crisis Response during the Haiti 2010 Earthquake

Research-in-progress

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Abstract

In 2010, Haiti was struck by the worst natural disaster in 200 years. The work of first responders was helped by micro-blogging services and crisis mapping systems that were deployed for rescue missions. These systems provided the capability to reshape the crisis response by facilitating collective response through citizen reports, visualization and interactive mapping by (1) enabling crisis information from the voluntary online public to be disseminated speedily, (2) offering new insights into events happening in near real-time, and (3) assisting humanitarian efforts related to community recovery from crises. In this research-in-progress paper, we focus on a participatory and collaborative crisis mapping system known as Ushahidi. We explore how the Ushahidi mapping system was utilized for collaboration in collective crisis response. Second, we suggest that two dimensions of the information quality framework are paramount in such crises: uncertainty reduction and urgency. This paper therefore is a step toward understanding the interplay of information quality measures (urgency reduction and uncertainty) in collective crisis response situations. We also suggest implications for emergency responders to better manage voluntary online citizens by reducing uncertainty at the right time.

Keywords: Collective Action, Haiti Earthquake, Information Quality, Information Urgency, Information Uncertainty
Introduction

Haiti was struck by a magnitude 7.0 earthquake on Jan 12, 2010. It displaced over 3 million people, killed nearly 300,000 people and destroyed critical national infrastructure. It was the worst natural disaster in the capital city of Haiti, Port-au-Prince, in 200 years. The response to such an earthquake was complex mainly for two reasons. First, due to immense destruction of national infrastructure, Haiti had to rely on external supports of foreign countries to recover from disasters. Second, most global emergency responders who spoke English could not understand the local Creole language.

Under such unplanned, unfamiliar, and unpredictable emergency situations, it was difficult for responders to communicate, share, evaluate and interpret situational information to make sense of their environment (Valecha et al. 2012) in terms of verifying location, severity, status of incidents. Such situations pose major challenges to collaborative problem solving in collective crisis response (McGuire & Silvia 2010; Waugh Jr. & Streib 2006).

Recently, social media services (e.g., Facebook, Twitter, YouTube, etc.) have demonstrated that they can be used as powerful emergency response systems to solve complex information problems in partnership with voluntary online citizens. In addition to those social media services, a new breed of crisis response systems in the form of crisis mapping systems are also becoming pivotal in facilitating a collective response and sense-making. For example, during the Haitian response, the interactive and participatory crisis-mapping solutions facilitated collective response by (1) receiving crisis reports from the local and global online citizens, (2) translating the local Creole language into English, (3) processing the unstructured text messages into structured format, (4) aggregating, geo-mapping, and visualizing the reported situational information in a near real-time speed. The system assisted emergency responders and the public to make sense of unfolding situations in order to make informed decisions regarding recovery efforts.

In this context, this research-in-progress paper focuses on a participatory and collaborative crisis mapping system called Ushahidi to answer our primary exploratory research question: how was the crisis mapping system (Ushahidi) utilized for collaboration in collective crisis response?

Our study has two contributions: First, we explicate how the Ushahidi mapping system was utilized for collaboration in collective crisis response. Second, we suggest two dimensions of the information quality framework that are paramount to collaboration: uncertainty reduction and urgency. These concepts of information quality as well as ‘collective intelligence’ will be utilized to explore crisis mapping. We believe our study will allow emergency responders to develop an understanding of the interplay of information quality measures in emergency situations (urgency and uncertainty) and will offer insights to design of participatory resilient and adaptive emergency response systems to solve complex crisis problems.

For this study, we collected data from Ushahidi’s (http://haiti.ushahidi.com) participatory and collaborative crisis mapping system that was deployed for the 2010 Haiti Earthquake. We also had detailed conversations with two key respondents who directed the crisis mapping efforts at Ushahidi, and coordinated the translation, geo-location mapping, and categorization of emergency messages during the 2010 Haiti Earthquake.

The study is organized as follows. In the next section, we review the background of crisis mapping and describe the Ushahidi platform. We then explore the Ushahidi project data on the 2010 Haiti Earthquake and conduct an analysis. Subsequently we draw upon the literature of collective behavior and information quality to indentify two critical dimensions that need to be considered in crisis response systems. Finally we end this study with the conclusion.

Background

Collaboration

The area of collaboration has been extensively studied in fields of Systems Science and Computer Science. The literature in this field has focused primarily on multi-agency collaboration (Samba 2010; Chen et. al, 2007) and responder collaborative ability (Curra et al. 2009). However, academic work on crisis collaboration is scanty but growing (Valecha et al., 2013). Jarvenpaa & Ives (1994) and Hollingshead et al. (1993) have studied collaborative knowledge, resources, tasks, and technology for improving crisis

The literature in collaboration has deliberated the design of systems facilitating effective collaboration during crisis (Janssen et al. 2010). Even so, one of the most successful crisis emergency response systems is the crisis mapping system that has not been studied much, to date. In this paper, we examine collaboration in the context of crisis mapping systems.

**Crisis Mapping Systems**

Crisis mapping systems have gained popularity in solving critical information problems and have been known to deliver accurate and actionable information for both emergency responders and victims under crises. Using crisis mapping systems, online volunteers can receive crisis reports from onsite eyewitness, verify the veracity of the received report, and map it onto the Google Maps such that the system can visualize the aggregated crisis information as an interactive map.

One such system that has emerged as a successful crisis mapping system in the recent past has been Ushahidi system. This system was used during the Haitian earthquake to address information problems by providing situational information for emergency responders, victims, and online volunteers at a distance. In fact, this system has been so effective that it was appreciated by Administrator of the Federal Emergency Management Agency (FEMA), who reported that the crisis mapping of Haiti represented the most comprehensive and up-to-date information available to the humanitarian community.

**Ushahidi**

The Ushahidi platform has been successful in facilitating crisis communication under two conditions: (1) the information is timely, and (2) victims act as information providers. In this way, the information collection is immediate, and the victims are empowered to help themselves (Leson, 2012). The platform allows for information collection, visualization, and interactive mapping, and it is particularly geared towards users as producers of crowd-sourced data (information generated by the public). Examples of use of Ushahidi projects include the Haiti earthquake (2010), the Arab Spring in Egypt (2011), etc.

Thus the Ushahidi crisis mapping system was revolutionary in Haiti for the following reasons. It was not launched by professional first responders, humanitarian organizations on the ground, or search and rescue teams in Port-au-Prince in Haiti. Instead, it was launched 1,500 miles away from Haiti by a group of voluntary individuals with no emergency response experience. The situational information created and delivered by the voluntary online crowd was so comprehensive that many professional crisis responders relied on Ushahidi to perform their emergency response activities. In addition, because only actionable information was mapped onto the Ushahidi platform along with detailed comments, rescue teams could effectively collaborate among multiple-agents to solve crisis problems.

**Ushahidi Categories**

In this sub-section, we explicate the process by which Ushahidi worked during the disaster, based on our discussion with two experts in the field. People in Haiti texted their location, name and requests for aid (often in Creole language). Creole-speaking volunteers translated these messages to be logged in English. Furthermore, these messages were categorized and the geo-coordinates of the location were plotted. The structured data was then streamed to the main Ushahidi database where it was combined with other data

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1. According to our interview with the director of crisis mapping, International emergency response teams served by Ushahidi’s crisis information systems include US Coast Guard, Joint Task Force Command Center, Red Cross, US State Department, and US AID, etc.


3. This description is based on our interview with Patrick Meier, director of crisis mapping at Ushahidi at that time.
and streamed to different organizations on the ground like Red Cross and InSTEDD, who acted on it and passed it to appropriate people in Haiti.

Each text message was assessed by the volunteer non-local responders so that the severity level of incident could be classified, and the veracity of reports could be verified quickly. These volunteers classified the messages into 8 categories – emergency details, vital lines, public health, security threats, infrastructure damage, natural hazards, available services and other details – based on their learning from other Ushahidi deployments prior to Haiti. ‘Vitals’ and ‘Services’ categories were common categorizations used during the earthquake period. ‘Health’ and ‘Security’ categories developed fairly rapidly after the earthquake. The ‘Emergency’ category did not appear in the first week, and represented a slow-developing event. ‘Damage,’ ‘Hazard,’ and ‘Other’ categories were scarce in the data set. As a result, we selected five types of categories of incidents during the first week of response following Ushahidi deployment. (We decided to ignore the three categories for which there were only minimal instances, for our analysis).

**Methodology**

Collaboration in crisis has been explored in the literature in many different ways. Samba (2010) has employed case studies to identify issues under collaborative response. Curra et al. (2009) have utilized qualitative interview techniques to explore factors that deter responder’s collaborative ability. Valecha et al. (2012) have exploited qualitative design in the form of responder interviews, derivations from literature on collaboration and incident reports to explore collaborative interactions during crisis. Drawing from these collaboration studies to understand the role of new mapping technologies in collaboration, we adopt an exploratory comparative approach based on the inductive research method of iterative triangulation (Lewis, 1998), cycling between analyses of data gathered from the crisis response platform, literature reviews and conversations with key respondents. In this paper, we focus on collaboration as interaction of crisis mappers and second responders who communicate through the use of threads and posts.

**Data Collection**

For this research, we selected incidents that were reported through Ushahidi platform during the 2010 Haiti earthquake. An Ushahidi incident can have multiple categories (as discussed above) assigned to it since the platform can report multiple conditions as witnessed by the reporter. For each collective response report, there was one thread of text with one or multiple posts of collaborative activity texts, from responders (or the general public) on-scene. Those threads with just one post indicate less collaborative activity as compared to threads with multiple posts. The data cases (threads) with multiple posts are much fewer than those with single posts. (This results in violation of normal distribution for the collaboration variable). So we choose to consider collaboration as a dichotomous high/low variable as opposed to a continuous variable. The collaboration was coded as a binary variable: (1) high, for reports with multiple posts or (2) low, for reports with only a thread with a single post. Table 1 summarizes the basic descriptive statistics of the data set.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Freq</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Collaboration</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>566</td>
<td>73%</td>
</tr>
<tr>
<td>High</td>
<td>215</td>
<td>27%</td>
</tr>
<tr>
<td><strong>Category</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency</td>
<td>36</td>
<td>5%</td>
</tr>
<tr>
<td>Vitals</td>
<td>645</td>
<td>83%</td>
</tr>
<tr>
<td>Health</td>
<td>83</td>
<td>11%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Thread</th>
<th>Percent</th>
<th>Post</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>16</td>
<td>2%</td>
<td>23</td>
<td>1.97%</td>
</tr>
<tr>
<td>Day 2</td>
<td>15</td>
<td>1.9%</td>
<td>27</td>
<td>2.32%</td>
</tr>
<tr>
<td>Day 3</td>
<td>55</td>
<td>7%</td>
<td>84</td>
<td>7.20%</td>
</tr>
<tr>
<td>Day 4</td>
<td>50</td>
<td>6.4%</td>
<td>96</td>
<td>8.23%</td>
</tr>
<tr>
<td>Day 5</td>
<td>152</td>
<td>19.5%</td>
<td>252</td>
<td>21.61%</td>
</tr>
<tr>
<td>Day 6</td>
<td>178</td>
<td>22.8%</td>
<td>245</td>
<td>21.01%</td>
</tr>
</tbody>
</table>

While there are several thousand of threads and posts in Ushahidi, we focused on only those threads and posts where there was evidence of (textual) collaboration helping in the collective response.
Collaboration over Time

We used the Ushahidi platform to obtain the incident reports (of five categories) in a week's period ranging from January 17, 2010 to January 23, 2010. We found 781 incident reports. Each report had multiple number of posts associated with it, indicating that there were collaborations with regard to that information. The 781 reports provided us with a dataset of 1166 threads/posts. These 781 incidents with 1164 threads/posts were selected matching the above categories exactly in our specified time period. We classified the data into seven buckets, each for one day of the week. Table 2 shows statistics of the reports and posts in these buckets.

Exploring Collaboration over Time

We encountered 16 reports on the first day, and 23 corresponding threads/posts; 15 reports on the second day, and 27 corresponding threads/posts. Immediately after the first two days, there is a spurt, with 55 reports yielding 84 threads/posts on day 3, and 50 reports yielding 96 threads/posts on day 4. A second spurt is observed on day 5 and day 6 with 152 reports yielding 252 threads/posts and 178 reports yielding 245 threads/posts. On the seventh day, there is yet another spurt with 315 reports resulting in 439 threads/posts.

Following the catastrophe, as time elapsed, more incidents were reported. With the complexity of the situation, emergency responders faced daunting challenges in gaining situational updates. Collaboration can help in these situations in forming sense of the emergency. Thus, we expect that as time increases, number of collaborative threads/posts increase. More than 80% of the threads/posts occur towards the end. In order to test if time is associated with collaboration for the different categories, we perform the analysis of collaboration over time below.

This analysis of collaboration over time contributes to our research in the following ways: First it describes a trend of collaboration, a generalization of which is useful in suggesting critical time periods for collaborating within each category. Second, it identifies inflexion points, if any, which denotes when collaboration within each category is noteworthy. Finally, it also identifies the difference in high and low collaboration trends, which provides implications about how crisis mappers and second responders (public) collaborate together to gather information on various categories in different time periods.

Analysis of Collaboration over Time

The time and collaboration relation was tested as follows. Collaboration—the dependent variable in this study—took the form of a categorical variable with two categories. A binary logistic regression procedure was used (Hosmer and Lemeshow, 2000) to test the model. The objective was to predict whether level of collaboration could be predicted with time, and whether there was cutoff point beyond which level collaboration decreased, for different categories. We expected an inverse U curve. We used SPSS software to run the logistic regression analysis. The following equation represents our logistic regression model:

\[ \ln [\text{Collaboration}] = \alpha + \beta_1 \text{Time} + \beta_2 \text{Time}^2 + e \]

This model was tested across five types of categories (emergency, vitals, health, security and services).

The results of the model testing are reported in Table 3. We report the following statistics: individual regression coefficient \( \beta \) and significance, standard error of \( \beta \), Wald chi-square statistics, odds ratio, 95% confidence interval of odds ratio, model chi-square statistic, and overall correct classification.

The Wald statistic (b/SEb) was used to test whether the predictor variable made a significant contribution to the prediction of the dependent variable. The odds ratio indicates the change in the odds due to a one-unit change in the predictor variable; the 95% confidence intervals for this ratio were also reported. In our analysis, high level of collaboration was coded as 1, and low level of collaboration was coded as 0. If both limits of the 95% confidence interval for the odds ratio are greater than 1, then it is possible to conclude that a one-unit increase in the predictor variable will lead to an increase in the likelihood of the higher levels of collaboration. If both limits of the interval are less than 1, then it is possible to conclude that a
one-unit increase in the predictor variable will lead to an increase in the likelihood of the lower levels of collaboration.

To test whether the predictors of the model make a difference in predicting the dependent variable, a model chi-square statistic was also reported. A statistically significant model chi-square statistic denotes that the predictors make a significant difference as compared to the base model. The overall correct classification indicates the percentage of correct prediction made by the model.

**Results**

The results for the overall population presented in Table 3 show that three of the five models provide a good fit for the data (demonstrated by the significant chi-square test).

Time is associated with collaboration for the vitals and services category. However, for emergency, health and security category, the results were not significant. The association implies that for increase in time in vitals and services category, higher level of collaboration is 1.91 and 3.50 times likely. In addition, for increase in time beyond a certain inflexion point in vitals and services category, lower level of collaboration is 1.13 and 1.22 times likely.

![Figure 1. Comparison of Collaboration over Time for various Categories](image)

**Table 3. Logistic Regression Results for Collaboration in the context of Five Categories**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Test Statistics</th>
<th>Regression Model # 1: Emergency</th>
<th>Regression Model # 2: Vitals</th>
<th>Regression Model # 3: Health</th>
<th>Regression Model # 4: Security</th>
<th>Regression Model # 5: Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>β</td>
<td>0.657</td>
<td>0.648</td>
<td>0.487</td>
<td>1.113</td>
<td>1.251</td>
</tr>
<tr>
<td></td>
<td>SEβ</td>
<td>0.900</td>
<td>0.275</td>
<td>0.597</td>
<td>0.762</td>
<td>0.540</td>
</tr>
<tr>
<td></td>
<td>Wald’s χ²</td>
<td>0.533</td>
<td>5.531</td>
<td>0.665</td>
<td>2.135</td>
<td>5.380</td>
</tr>
<tr>
<td></td>
<td>Odds ratio</td>
<td>1.928</td>
<td>1.912*</td>
<td>1.628</td>
<td>3.044</td>
<td>3.495*</td>
</tr>
<tr>
<td></td>
<td>95% CI</td>
<td>0.331–11.242</td>
<td>1.114–3.280</td>
<td>0.505–5.246</td>
<td>0.684–13.551</td>
<td>1.214–10.063</td>
</tr>
<tr>
<td>Square Time</td>
<td>β</td>
<td>−0.115</td>
<td>−0.121</td>
<td>−0.138</td>
<td>−0.143</td>
<td>−0.196</td>
</tr>
<tr>
<td></td>
<td>SEβ</td>
<td>0.120</td>
<td>0.035</td>
<td>0.081</td>
<td>0.102</td>
<td>0.070</td>
</tr>
<tr>
<td></td>
<td>Wald’s χ²</td>
<td>0.927</td>
<td>11.861</td>
<td>2.901</td>
<td>1.970</td>
<td>7.731</td>
</tr>
<tr>
<td></td>
<td>Odds ratio</td>
<td>0.891</td>
<td>0.886**</td>
<td>0.871</td>
<td>0.867</td>
<td>0.822**</td>
</tr>
<tr>
<td></td>
<td>95% CI</td>
<td>0.705–1.127</td>
<td>0.827–0.949</td>
<td>0.743–1.021</td>
<td>0.710–1.058</td>
<td>0.716–0.944</td>
</tr>
<tr>
<td>χ²</td>
<td></td>
<td>1.706</td>
<td>32.472**</td>
<td>14.656**</td>
<td>2.619</td>
<td>12.070**</td>
</tr>
<tr>
<td>Correct classification</td>
<td>58.3%</td>
<td>74.4%</td>
<td>69.9%</td>
<td>61.8%</td>
<td>69.6%</td>
<td></td>
</tr>
</tbody>
</table>

* p < 0.05; ** p < 0.01.
The initial time period following a catastrophe is very important for emergency responders. However, because of time crunch, the level of collaboration in the initial time period is much lower. For vitals and services category, on the fifth day, 25% and 45% of all high level collaboration is observed in order to reduce uncertainty about food and water shortage, and service distribution respectively. This is summarized in Figure 1.

**Two Dimensions of Crisis Response**

In this section, we review collective behavior literature and focus on information quality problems in the collective scenario. We focus on two dimensions of information quality, information uncertainty and urgency that need to be tackled for good crisis response operations.

**Collective Behavior**

Allport and Postman (1947) point out that “our minds protest against chaos” (p. 37). This statement in part epitomizes the condition for the emergence of collective sense-making process as an instance of collective crisis behavior. It suggests that if reliable information is unavailable to make sense of the uncertain situation, then people gather together to ask, share, evaluate, and interpret situational information. In this regard, unplanned, unfamiliar, and unpredictable crisis situations (e.g., natural disasters, terrorist attacks etc.) create optimal conditions to bring about collective behavior. For example, as the Haiti earthquake in 2010 has shown, a large number of grass root level collective behaviors had been spontaneously improvised because the unexpected disaster quickly incapacitated national infrastructures (e.g. power systems, communication systems, streets etc.) and it rendered inoperative the routinized day-to-day social action (Kendra and Wachtendorf 2013). In that regard, it is not surprising that recent extreme events have always accompanied techno-social collective behaviors (such as tweeting, retweeting, facebooking, wiki writing, picture uploading etc.) to look for, exchange, disseminate, and make sense of crisis situations.

For the collaborative emergency response management, crisis literature offers two important implications. First, “collective behavior is different from routine social behavior” in that the former spontaneously arises when the stable routine for the latter goes wrong (McPhail 1991, p. 99). This insight helps to understand the condition of and anticipate the emergence of collective behavior. Second, collective behavior under crises can be seen as a collective effort to make sense of uncertain situation such that they can manage and/or buffer impending threats that are posed by unexpected extreme event.

**Information Problems**

From the emergency responders’ perspective, too many inquiries and reports, many of which are not accurate or reliable, hamper emergency response teams in efficiently delivering relevant and trustworthy information to the right responders at the right time (Bharosa et al. 2008; Bharosa et al. 2010). From the perspective of the victims in the disaster stricken community, as they suffer from the lack of local information relevant to their specific situations, they exhibit collective information seeking and exchanging behaviors using their own social networks and resources at hand in their community (Mileti and Darlington 1997; Shibutani 1966; Wenger et al. 1975).

These information problems have been a challenging issue in emergency response management. Often, first responders have to deal with incomplete and unreliable information under time pressure (Carver and Turoff 2007). In addition, a different sense of urgency and high levels of interdependent tasks complicate collective sense-making, information sharing, and efficient coordination between multiple agents and among the affected community, hindering inter-organizational or inter-agent teamwork (Lee et al. 2011 ; Majchrzak et al. 2007). Also, these complex and uncertain information problems hinder emergency response personnel and disaster stricken community members from reaching a common understanding of uncertain situations to solve problems (Chen et al. 2009; Singh et al. 2009).

**Information Quality**

In considering information in a crisis response that is based on the concepts of collective crisis response, we adapt the information quality framework (Wand and Wang, 1996; Wang and Strong, 1996; Huang et
al., 1999; Helfert et al., 2009) to consider two information quality measures derived from interaction within collectivities, namely information uncertainty and information urgency (McPhail, 1991). Information uncertainty results from a scenario wherein people do not know what to report. Unanticipated events, disrupted social structures, value conflicts, or system use create situations where people may have varying levels of experience with information amplifies the problem of uncertainty in information. Similarly, information urgency is a characteristic of the state of the information needed to pursue actions. It is representative of the current states of the situation. In the context of emergency response, urgency is one of the most important components of information quality. The initial hours following the disaster are the most important for emergency responders. Every single minute counts, since that is when lives will be saved and lost (Li & Rao, 2010).

We argue that crisis mapping is a mechanism to reduce uncertainty in information. Thus whenever there is greater uncertainty reduction needed, there will be a larger amount of collaboration on the platform. As in all decision-making processes, a more complete picture of the situation allows for reducing uncertainty in it. The power of collective collaboration allows crisis mapping to provide a superior overview of the situation, quickly and with a lesser degree of uncertainty. Similar to a wiki, while a single entry provides but a small sliver of the overall picture, multiple entries on the platform together can provide a grand overview. In crisis response, the need to have uncertainty reduction is confounded by the issue of urgency. When there are large scale disasters, such as in the case of Haiti, immediate and certain information about a situation could help in providing efficient crisis response and mitigating disasters (Li & Rao, 2010). We suggest that proxy measures to capture the above two are as follows: urgency can be measured using the variable \( \text{time} \), since it is quite likely that highly urgent information needs occur at the earliest time and vice-versa. Further we suggest that uncertainty reduction can be measured using the variable of \( \text{collaboration} \) (Oh et al. (2011)). This is because highly uncertain information (reduction) calls for higher levels of collaboration. In crisis response situations, it is the interplay between \textit{information urgency} and \textit{information uncertainty reduction} that need to be considered for effective collective response systems.

Conclusions

The crisis map users have a timeframe of interest. Crisis map users need to collaborate together to gather information as \textit{certainly} as possible. In emergency response systems, we should be taking advantage of both the \textit{immediacy} and \textit{collectivity} provided by the mapping in getting information out to the masses.

The initial time period following a catastrophe is very important for emergency responders. However, because of time crunch, the level of collaboration is much lower. On the fourth day, 25% of all high level collaboration is observed for emergency category. Similarly, on the fifth day, 25%, 30%, 35% and 45% of high levels of collaboration is observed for vital and services category respectively.

Our findings suggest that the interplay between urgency and uncertainty reduction is a significant issue for vital and services categories, which implies that each category should be responded to individually with consideration to this interplay. These findings can play an important role in improving the crisis response by enabling the use of micro-blogging systems in the initial phase of response (when urgent response is paramount) (Li & Rao, 2010), and the use of crisis mapping systems in the later phase of response (when information is uncertain). Finally, when urgency is not a concern, even mainstream media can be useful. An easily utilized communication channel may broadcast information as quickly as twitter and as collectively as with Ushahidi. Based on these findings, our work contributes towards understanding capability of information technologies during disasters, in that we believe incorporation of micro-blog and crisis-map in existing use of main-stream media for crisis response can dramatically help improve the information quality in terms of urgency and uncertainty reduction for emergency response system.

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