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Utilization of Social Media in the East Japan Earthquake and Tsunami and its Effectiveness

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ABSTRACT

During the 2011 East Japan Earthquake and Tsunami, newly popular social media such as Twitter and Facebook served as a lifeline for directly affected individuals, a means of information sharing, and a way for people inside and outside Japan to volunteer and to provide information-based support to affected individuals. Social media was used to perform vital relief functions such as safety identification, displaced-persons locating, damage information provision, support for disabled individuals, volunteer organization, fund-raising, and moral support systems. This study discusses the potential for public, civil society, and government organizations to utilize social media in disaster preparedness and response.

Keyword: *Social media, social networking, disaster relief, disaster prevention, 2011 East Japan Earthquake and Tsunami*

1. BACKGROUND

In the simplest terms, social media is a set of applications and services that use the Internet to connect people. More specifically, social media is a communication medium, made possible by the Internet, which combines dynamic, collaborative Internet-based tools, social networks, computers, and, increasingly, mobile devices. It allows users to connect to each other, exchange information and collaborate. It consists of social networks such as Twitter and Facebook, which act as a means of connection between users, and websites and applications that allow users to cooperate and create content, such as the websites Wikipedia and YouTube. Its use has grown in recent years along with the development and increased use of the Internet and mobile devices, such as smartphones. In addition, social media is constantly being redefined because of the evolving nature and the rapid change of the technologies. Social media "employ mobile and web-based technologies to create highly interactive platforms via which individuals and communities share, co-create, discuss, and modify user-generated content" (Kietzmann, Hermkens, McCarthy & Silvestre, 2011, p.241). It has been described as having the characteristics of participation, openness, conversation, community and connectedness (Mayfield, 2008, p. 2).

The term "social media" came about with the creation of social networking websites such as MySpace and Facebook, but some tools, which are now considered to be part of social media, have been around for twenty years (Kaplan & Haenlein, 2010, p. 2). Social media has grown out of previous forms

of user-publication based web tools such as a discussion system called Usenet, which started in the late 1970's, and blogs later in the 1990's (Kaplan & Haenlein 2010). Social media is the content of Web 2.0, which is a term popularized by Tim O'Reilly of O'Reilly Media to describe the shift from an Internet made up of static web pages to a more complex and sophisticated one where users interact, collaborate, share information online and create content (O'Reilly, 2005).

Beginning around 2005, social media has grown in popularity to become a part of the daily lives of many people in recent years. Since the tools and content that make up social media are dispersed, it can be difficult to measure usage, but Facebook, the largest social network, which started in 2004, only became open to the public in late 2006 (Abram, 2006), as of September 2011, had 800 million active users, 50 percent of whom access the website daily (Facebook, 2011). Other social networks boast large numbers as well; Twitter, which functions in a very different way than Facebook and can be used with Short-Messaging Service (SMS) text messages through mobile phones, started in mid-2006 (Mashable, 2011) and has about 200 million users (Shiels, 2011). In addition, Google entered social networking with Google+ in June 2011 (Kaste, 2011), and as of October 14th, 2011, had 40 million users (Svelik, 2011).

Social media has great potential, but there are also issues for concern such as the potential for misinformation, the digital divide (the gap between users and non-users, usually related to economics or age), privacy, and identity theft. In order to understand and develop means of minimizing the negative impacts of these issues, further research is necessary. During the 2011 East Japan Earthquake and Tsunami, newly popular social media such as Twitter and Facebook acted as a lifeline for directly affected individuals, a means of information sharing, and a way for people inside and outside Japan to volunteer and to provide information-based support to those affected individuals. Social media was used to perform vital relief functions such as safety identification, displaced-persons locating, damage information provision, support for disabled individuals, volunteer organization, fundraising, and moral support systems as well as others. This paper analyzes the roles of social media in past disasters, and then analyzes the role it played in the 2011 East Japan earthquake and tsunami. Based on a survey on the users of the social media, the paper analyzes the potential role it played in the disaster and draws lessons on how its future role can be enhanced in disaster preparedness and response.

2. USE OF SOCIAL MEDIA IN RECENT DISASTERS

Social media has been used increasingly in disasters, both natural and man-made in recent years. The increase in use of the Internet and the increase in use of network-connected mobile devices have led to more people having access to social media. This increasingly larger group of individuals armed with instant access to the Internet means that when a disaster happens they are likely to use that avenue of communication because it is available to them at that moment. The way that the technology is used varies based on the type of disaster, location, situation, and resources available. Individuals who make use of social media in disasters are limited by the types of services, tools, and number of users that they have available to them at the moment when the disaster occurs. Due to the fact that the change to Web 2.0 is gradual and that new innovative web services develop over time, we can see a difference between the early use of social media in disasters and later, more sophisticated uses in the ways problems are approached.

Experience shows that social media is sometimes the only functioning communication method in disasters (Acar and Murakami, 2011). In addition, the availability of these new tools and the need for information during crisis spawns new organizational methods to accomplish tasks, some that were not possible or imaginable before the availability of a specific tool and the need to communicate in that specific situation. When disasters happen, users of social media use it to fulfill a need, and sometimes that need requires that they use the social media that they have at hand in a way that was not previously imagined by the designer. Luckily, social media's eclectic and flexible nature lends itself to being "mashed up" and so these crises can create greater innovation.

When the coordinated suicide attacks in London, UK occurred on July 7th, 2005, it was arguably the first time that social media had been widely used in any kind of disaster. At the time, newly popular websites,

Wikipedia and Flickr, along with recently available photo-capable mobile phones became tools in the hands of witnesses of the attacks ("Cell Phones Capture," 2005). Photos taken by people on the scene were sent to others who using computers uploaded them to Flickr, a photo sharing website created the year before. In addition to the photos taken by people on the scene, the website showed images of news reports on television, as well as images expressing condolences to people affected by the attack.

Images were also sent by SMS from camera phones to the British Broadcasting Corporation (BBC) and were broadcasted around the world. Over 1,000 pictures and 20 videos of firsthand accounts were sent to the BBC in the hours following the disaster (Barnes & Carrell, 2005). The photos were used in the coverage of *The New York Times* (Cowell, 2005). This event popularized the idea of the "citizen reporter" (Huck, 2005), which is the idea that with new technologies such as blogs and camera-capable mobile phones average persons can become "reporters" helping to cover stories when they happen to be on the scene.

In October 2007, a little over a year after the microblogging website Twitter was created, wildfires that eventually burned over 400,000 acres and 1,500 homes broke out in southern California (Flaccus, 2007). Two San Diego residents began posting real-time, status updates on Twitter from multiple sources such as radio, television news, SMS, and other online sources on information, on evacuations, meeting points, supply locations and other information (Poulsen, 2007).

At the same time, the website of the local public radio station, KPBS, was brought down because of too much traffic, 36 times the normal amount, from individuals looking for information on the state of the wildfires (Poulsen, 2007). In addition, several of the radio station's towers were burned in the fire (Gibbs, 2007). The online editor of the website had been experimenting with Twitter and so employees of the radio station began to use Twitter to share information with residents. They also made a Google Map "mashup," which is a way that users of Google Maps service can take data from various sources and place it on the maps to interact with the data, with locations of shelters, supplies and danger zones (Poulsen, 2007).

In September 2009, during typhoon Ondoy, which caused the heaviest amount of rainfall in four decades and resulted in subsequent flooding that submerged 80% of Metro Manila, individuals inside and outside the disaster zone used Twitter and other social media tools to perform relief functions and "transformed themselves from content disseminators into active rescue and relief workers" (Morales, 2010, p. 23). Individuals used Twitter to give updates on their safety and the situation around them and later communication changed into collaborative action. This action took the form of making online spreadsheets where individuals could enter up-to-date information on the disaster situation, such as information on evacuation centers, emergency rescue numbers, drop-off websites for donation, and lists of people in need of relief, as well as the creation of an organization called Philippine Aid by Filipino bloggers in order to set up a PayPal account for online donations to help support disaster victims. The organization collected USD $12,500. Up until this point, no system for online donations existed and this drove the Philippines Red Cross to create a PayPal account for donations in response. A crisis map was also set up using Google Maps that showed distress calls in real time. The crisis map became an "invaluable resource" for relief workers in the field (Morales, 2010, p.23). Table 1 summarizes the role of social media in past disasters (Peary 2011).

On January 12th, 2010, a 7.0 magnitude earthquake hit Haiti's capital Port-au-Prince, in which the damage amounted to 220,000 deaths, over 300,000 injuries, 180,000 homes destroyed, 1.5 million people made homeless and 3.5 million affected ("Haiti Earthquake Facts," 2011). The use of social media in this recent disaster has been widely documented. When the disaster occurred, individuals from the non-profit company Ushahidi, which created "crisis-mapping" in response to post-election violence in Kenya, created a software platform to be used in Haiti and began to organize. They created a crisis-mapping system, and SMS-based, alternative 911, since none existed at the time, that uses information from the ground from Haitian people sent by SMS to a special number, 4636. SMS received by the team based in Boston, Massachusetts in the US, were aided by 12,000 Creole and French translators in 49 countries who were organized through a request sent out by the company through

Table 1. Overview of disasters in which social media was utilized

Disasters in which social media was used	Details on how social media was utilized in the disasters
The 7/7 Bombings in London	One of the first examples of social media use in a man-made disaster. Newly popular cell phone cameras were widely used. Flickr, a photo sharing site and Wikipedia were used to share news and information. This in turn popularized the ideas of the citizen reporter.
The 2007 San Diego Fires	Twitter was newly popular. Users in and outside the fire zones used Twitter through SMS. Information on safe locations and supplies was aggregated by outside users and used to make mashups with Google Maps. A large TV station relied on Twitter when its website crashed.
Typhoon Ondoy/Ketsana	Twitter was widely used. Online spreadsheets were used to share information on the disaster situation. PayPal was first used for online donations inspiring the Red Cross to adopt the practice. A crisis map was created with Google Maps and was described as "an invaluable resource" by relief workers.
The 2010 Haiti Earthquake	The Ushahidi crisis map platform was widely used, helping to create an ad-hoc 911 system. A total of 12,000 translators were recruited through Facebook, making for a 5 to 10 second turnaround time for incoming SMS messages. The map was used to track cholera outbreaks 6 months after the disaster. The system was widely used by relief organizations.
2010 Yushu Earthquake	A Twitter-clone site called Sina-Weibo was widely used to exchange information after the earthquake. Information is limited because of language limitations with Chinese.
Super-typhoon Megi	The Philippine Atmospheric Geophysical and Astronomical Services (PAGASA) launched a Twitter account just before the typhoon. Their tweets were broadcasted by conventional mass media. After a month, the organization had 28,000 followers. There are 20 typhoons a year in the Philippines and the organization says it is the most cost-efficient way of making announcements to the public.
2010 Eruptions of Mount Merapi	A community radio station created to respond to an ongoing lava flow began using Twitter to organize. They were able to send 700 volunteers to places that were not reached by government aid. The organization had 35,000 followers and would make requests for help for driving and cooking and receive mass amounts of support from the community. It demonstrates the possibility of reducing dependency on foreign aid for communities.
2010 Canterbury (Christchurch) Earthquake and 2011 June Christchurch earthquake	The government used Twitter to send a coordinated flow of recovery information to residents. An official hashtag keyword was instituted. Misinformation was also spread using Twitter during the disaster. A symposium after the disaster about social media in the disaster discussed creating an "Emergency 2.0 Wiki."
Hurricane Irene	The US Federal Emergency Management Association (FEMA) encouraged people to use SMS and social networks to keep in touch with family and friends instead of calling by phone so as not to jam networks.
2011 Virginia Earthquake	Twitter users in New York City and other locations saw tweets about the earthquake, which originated in Virginia state, up to 30 seconds before it was felt, showing that information moves faster through networks than the earthquakes themselves.

Facebook. With the help of the translators the team had a 5 to 10 second translation time for each of the 40,000 messages they received (PBS, 2011).

Through the crisis map the team can see, in general, which areas are facing particular kinds of problems, as well as respond to specific requests for supplies, medical aid or housing. The system was also used to track a cholera outbreak that began six months after the earthquake. By mapping SMS requesting medical help for cholera, the team could tell which areas are still affected by the cholera outbreak (PBS, 2011). The US State Department, recognizing the potential of the crisis-mapping system, organized with the Red Cross, the US Coast Guard, and Ushahidi. Then local radio was used, which 90% of Haitians use, to inform people that if they need help, they should text the 4636 number. In Haiti, 80% of people have mobile phones. There are no specific numbers on how many lives were saved, but the US state department claims lives were saved based on experiences such as the rescue of a woman giving birth in the middle of the street (PBS, 2011).

Since then, the Ushahidi platform has been used in disasters in Chile, Pakistan, and Japan, and the United Nations asked Ushahidi to make a team that can always be on call when a crisis hits. The team was first used when the uprising in Libya began in February 2011. Also during the crisis resulting from the earthquake, a new tool called the Transnational Information Sharing Cooperation (TISC), which grew out of a file sharing system for countries with a low level of infrastructure developed by the Pentagon called the All Partners Access Network (APAN), was released and utilized by the US military's Southern Command (Hodge, 2011). The tool was scheduled to be tested in a simulated hurricane in Haiti and the Dominican Republic around the time that the earthquake hit and so the tool went live to help in the earthquake relief. The tool is, in essence, a social network or "community" that becomes a hub for information sharing, made up of organizations and individuals, currently 1,700 in Haiti, related to the relief effort (Pierce, 2011). The network is an unstructured, online community of web portals set up by the organizations and uses wikis, forums, SMS, and email (Redmon, 2010).

3. USE OF SOCIAL MEDIA IN EAST JAPAN EARTHQUAKE AND TSUNAMI

Of the examples of social media during that disaster that were found online, Twitter appears to be the most important tool in exchanging information and helping people to connect. Twitter started in mid-2006 (Mashable, 2011) and had about 200 million users as of July 2011 (Shiels, 2011). When a user is followed, that person's status updates, or "tweets" will appear in chronological order in the timeline, the main portion of the website or application used. The timeline is made up of all the tweets that a person follows. Every time a user follows another user, the followed user's tweets will appear in the timeline of the user. The relationship between users can be one-way, meaning that the person followed does not have to follow the person who follows him or her, or the relationship can be two way. During the disaster, Twitter published a blog post in Japanese and English with an explanation of how to use Twitter during the disaster and the hashtags for different topics. Twitter also published a mobile phone website with the same information (http://twtr.jp/earthquake) "Touhoku chihou," 2011). This is significant because although only a portion of the population in Japan has smartphones, which can use applications for Twitter, nearly all mobile phones are Internet capable, so access to a mobile phone based Twitter website would make Twitter available to virtually anyone with a mobile phone, which is almost 115 million mobile phones for a population of 126 million.

Although having yet to take off in Japan, Facebook is the largest social network in the world and, as such, it played a great role in communication after the disaster. Many people around the world learned about the disaster through Facebook and used Facebook to express their support as well as donate to the relief effort. The social network also played a large role in helping friends and family of directly affected individuals get in touch with their loved ones. Facebook and its group functionality were also used by many organizations and spontaneous volunteers to help with the relief effort in terms of direct support and informational support. It provided the means of communication for the groups to function. In addition, due to the fact that Facebook is very popular outside Japan, many foreign residents rely on Facebook for

communication with friends and family back in their countries of origin, and so when the disaster occurred it became the most logical method for communication. There are countless articles and comments in mass media surrounding the event about how Facebook became a lifeline in the disaster. Facebook, as an organization, also helped out in the disaster by providing a centralized page for disaster information called Disaster Relief. As of October 2011, the page was being followed, "liked," by over 680,000 people. For users in Japan, Facebook also put information on blackouts and train service above users' News Feeds, the first page users see when they log into Facebook.

Mixi, as a company, also took action to help in the disaster. At the log in page of the website after the disaster, large images with links to Google Person Finder were placed as well as messages asking users to conserve energy. Mixi also provided a blog post with a list of all the communities related to the disaster and links to other websites and services. The list had four categories: general, affected person's support information, regional and "other." The groups had very high membership numbers because Mixi prohibited the making of new groups during the disaster ("Jishin – Mikushi," 2011). This was probably to make sure that more than one group for the same topic was not made, which often happens with Mixi communities. This style of approach is unique amongst the examples of social networks.

As previously stated, SMS is not used widely in Japan. Mobile service providers have an internal messaging system for use between users of the same service provider. At the time of the disaster, and in the case of Softbank, this messaging system was SMS, so Softbank users could use SMS to communicate with individuals using Softbank and others abroad. For communication between different mobile service providers, mobile email addresses are used. Twitter, which is arguably the most helpful form of social media in disasters, uses SMS, except for inside Japan for the previously mentioned reason, but it does not use email. Therefore, users of Twitter in Japan for mobile use must rely on applications such as those used by smartphones or mobile web browser to view Twitter's mobile web page. Applications and mobile web pages use significantly more data than individual SMS messages, and so this could create an unnecessary burden on networks in disasters, which would mean that less vital disaster information would be able to get through. This could delay communication at vital times. The major mobile carriers in Japan, Docomo, KDDI, SoftBank Mobile and eAccess (Emobile), announced that inter-carrier SMS would begin in Japan starting July 13th, 2011. This date is after March, 11th, 2011 and so inter-carrier SMS was not used during the disaster. Given this development, if Twitter provides a local SMS number for Japan, SMS and Twitter could be used together in the case of another disaster, which would be beneficial because of its low data use.

There are also topic specific wiki websites related to the disaster. One such example is the website Olive (https://websites.google.com/website/oliveinenglish/), a wiki specifically made for design-oriented solutions to the problems created by the disaster. The website is in Japanese, Korean, Chinese, and English and has directions for various solutions for disaster related problems, such as how to make a mask out of a shirt or how to make an aluminum can stove. Some Wiki pages have an extremely large amount of information in Japanese and English related to the disaster such as information on the details of the earthquake, tsunami and nuclear accident, disaster prevention, electricity, tsunami warnings, hospitals, shelters, people finding, etc.

Smartphones, which are mobile phones that can use applications like a computer, such as the iPhone and Android platform phones, have recently become popular in Japan. Many of the phones rely on mobile Internet data to function. During the disaster, applications that run on the iPhone and Android platform phones and interface with Twitter Facebook and other websites were used by smartphone users. In many cases, the mobile phone lines were jammed because of an excess of calls, but individuals with smartphones were able to use 3G mobile Internet data and these applications to obtain and share information, which suggests that these applications and devices can be extremely helpful in disasters.

Maps such as Google Maps and Google Earth are powerful tools in disasters when combined with other information. Sinsai.info was a website built during the disaster that uses the Ushahidi platform, a crisis-mapping platform described in the section about the 2010 Haiti earthquake. The website overlays data gathered from individuals throughout the affected area, the country, and the world using social media,

email, mobile phone email, SMS and other forms of communication. The website can show information on where to find shelter, which areas have lost electricity, evacuation locations etc. This type of information gathering is called "crisis-mapping" and would not be possible without mapping services such as Google Maps and Open Maps. Table 2 summarizes the use of social media in the case of the 2011 East Japan Earthquake and Tsunami (Peary 2011).

4. USER SURVEY AND ANALYSIS OF RESULTS

This study was performed by reviewing social media use in disasters, with specific focus on the East Japan Earthquake and Tsunami of March 11, 2011 (Peary 2011, Peary, Shaw and Takeuchi 2011). An extensive quantitative online questionnaire survey was undertaken. Based on a literature review, the following factors were identified to measure the experiences of users of social media during disaster: *information, motivation, problems, evaluation*, and *expectation.* In addition, based on the documented experiences of social media use in past disasters, the following categories of users of social media during disaster were identified: *non-user, non-sender, basic sender, volunteer sender*, and *manager sender*. To analyze the results of the online questionnaire survey, a framework for analysis was created. The framework consists of user roles, factors (general areas to be understood, such as motivation), parameters (specific questions

Table 2. Summary table of services and software used and their characteristics

Services and software used	Characteristics
Social Networks	Act as network between tools. Vary greatly by type.
Twitter	Popular in Japan. Highly public. Concise and fast information is easily shareable and user driven. High level of anonymity. One-way relationships possible. Character amount limits. Had problems with rumors.
Facebook	Popular amongst foreign community. Less public. Not so popular in Japan. Low level of anonymity. More likely to have personal friends. Resending shared information not always straight forward. It has groups, and is good for group networking.
Mixi	Popular in Japan. Japanese language only. Sharing information is less fluid. New group creation related to the disaster was locked to centralize info. Directed users to Google Person Finder.
Email	Main text-based type of communication for cell phones in Japan. Sharing of information possible, but more difficult than on social networks. Tracking the origin of information is difficult because it is not public. Accounts of chain mails with incorrect information widespread.
SMS	Cell phone based. At the time in Japan, not for cross-network use so use was minimal. Used widely outside Japan to collect donations. Highly valuable in disasters in general. Character amount limits.
Wikis	Crowd-sourced. Information rich. Accessible by even low level users. Collaboration usually is by higher level users. Commonly used as Info list. Innovative.
Webpages or blogs	Commonly used. Common for info lists, but usually created by one person, differing from wikis. Information shared in social media links to them.
Smartphone applications	Must have smartphone to utilize. Offers GPS functionality. Mobile. High flexibility. Not commonly used by lower level users.
Maps	When aggregating other information, easily useable to understand a complex situation using crisis-mapping. Requires a computer to use easily. Usable on smartphones but somewhat difficult.

that fall under the factors), and indicators (specific aggregated answers of question response sets). Reflecting the framework for analysis, the questionnaire was structured to measure the factors of motivation, problems, evaluation and expectation by user role. The following figure is a graphical representation of the theoretical and functional structure of the online questionnaire survey that combines these factors and the user roles mentioned here (See Fig. 1).

The survey was made available for response on a webpage designed specifically for the survey over a one-month period from September 13th to October 13th, 2011. In order to generate a specified response, the survey was distributed to groups and individuals identified as having utilized social media in the disaster. Following this, general appeals were made through the social networks Twitter and Facebook by contacting users who had shared information related to the disaster. The survey was made available to all regardless of location or use of social media in the disaster. The webpage for the survey was visited 1,538 times and there were 206 responses to the survey (156 in Japanese and 50 in English). Table 3 shows the attributes (language, age and sex) of the respondents.

There were individuals who shared information with family or friends, others who worked within groups or organizations, and yet others who designed or created or managed these groups. After comparing and categorizing all the collected examples, three types of senders were also identified: *basic sender* (sending on an individual basis), *volunteer sender* (sending through cooperation with others), *manager sender* (sending while leading a group volunteer senders). The term *non-sender* is used to differentiate receivers who did not become senders from other senders.

Therefore, every individual that utilized social media has a receiver-sender relationship, such as receiver-basic sender, receiver-manager sender, or receiver-non-sender. Throughout this thesis, the term

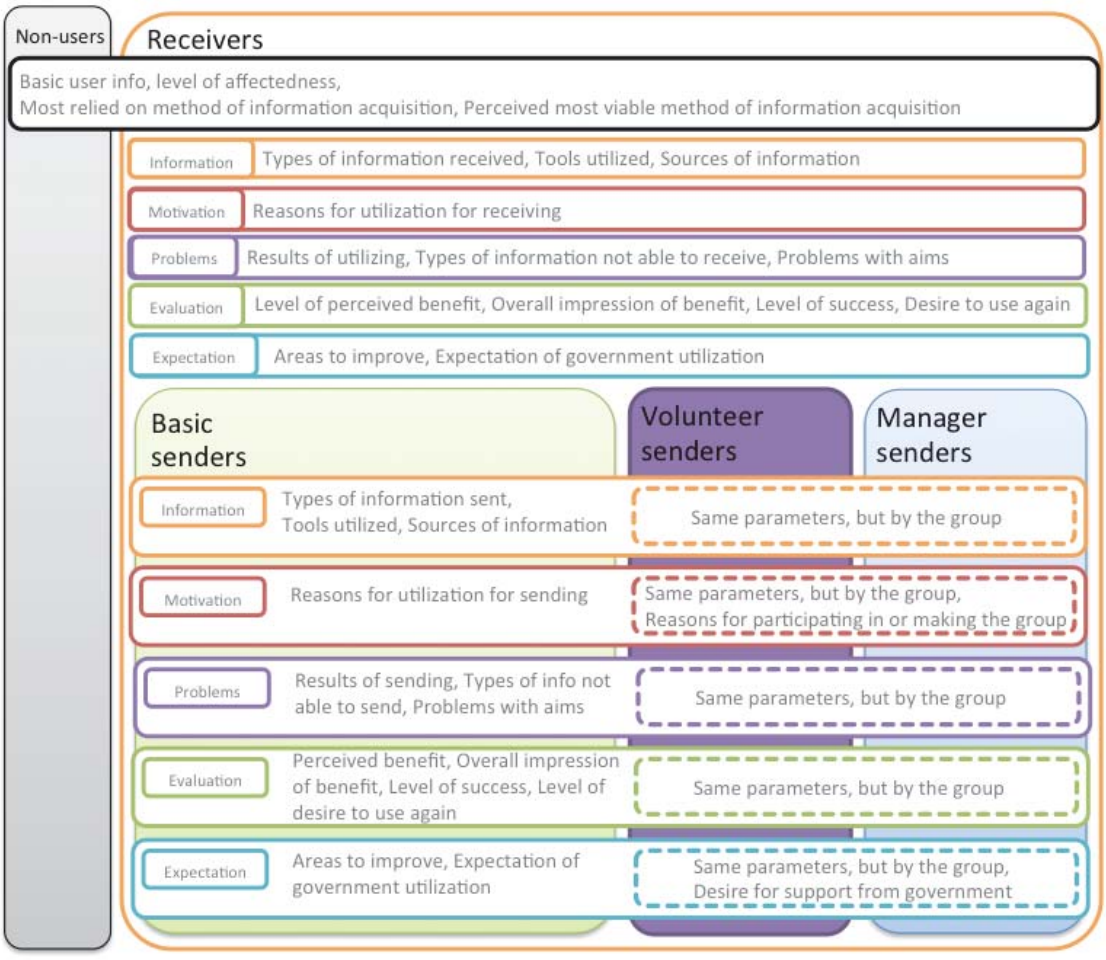

Figure 1. Theoretical structure of the online questionnaire survey

Table 3. Attributes of respondents

	TOTAL	Language		Age Group			Sex	
		Japanese	English	18-35	36-55	>56	Male	Female
Manager	5	5	0	1	4	0	4	1
Volunteer sender	32	23	9	11	19	2	15	17
Basic sender	100	76	24	49	49	2	53	47
Non seder	25	21	4	14	10	1	12	13
Non user	44	31	13	16	22	6	19	25
Total	206	156	50	91	104	11	103	103

receiver includes all sender types, as senders also first receive information. The following concept diagram describes these relationships (See Fig. 2). All roles are in reference to the use of social media *during the disaster*. (i.e., the term non-user refers to *a person who did not utilize social media during the disaster* not *a person who does not use social media in general*). Reflecting the framework for analysis, the questionnaire was structured to measure the factors of motivation, problems, evaluation and expectation by user role. The following figure is a graphical representation of the theoretical and functional structure of the online questionnaire survey that combines these factors and the user roles mentioned here.

Respondents were primarily between the ages of 26 to 45. There were no respondents below the age of 18. Individuals over the age of 45 made up 19% of respondents. Data on gender by user role shows that the division between the sexes is nearly equal. Respondents were asked for their location during the disaster. For analysis, areas were divided into affected areas (Tohoku region and Kanto region), other areas in Japan and outside Japan. A large majority of respondents, 88%, were in Japan at the time of the disaster. Around 55% of respondents were in areas affected by one of the three disasters, Kanto and Tohoku, during the disaster. Respondents were asked to identify their level of affectedness. Thirty percent of respondents were not affected. Of the remaining 70%, 18% were indirectly affected to a low level, 23% were indirectly affected to a high level, and 29% were directly affected.

Manager senders found social media to be the most reliable source of information during the disaster, as well as volunteer senders (See Figure 3). For these two groups, the Internet also makes up a very large portion of the most relied on source of information during the disaster. For basic senders, the Internet, followed by social media were the most reliable, with the two combined making up the vast majority, which is the same for the other groups that share information. Basic senders also rely on TV to a large degree. Groups that do not share information have a larger variety of sources that are viewed as the most reliable. For non-senders, social media, the Internet, and TV have nearly equal amounts, although social media and the Internet combined make up over 50%. Non-users relied on TV the most, followed by

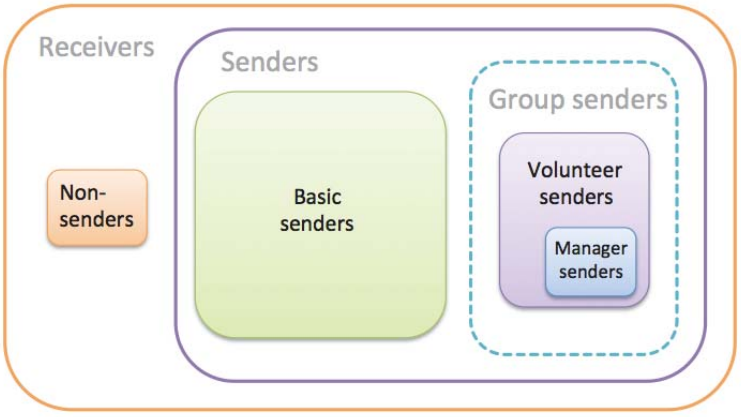

Figure 2. Concept diagram of relationship of types of users of social media use in the 2011 East Japan Earthquake and Tsunami

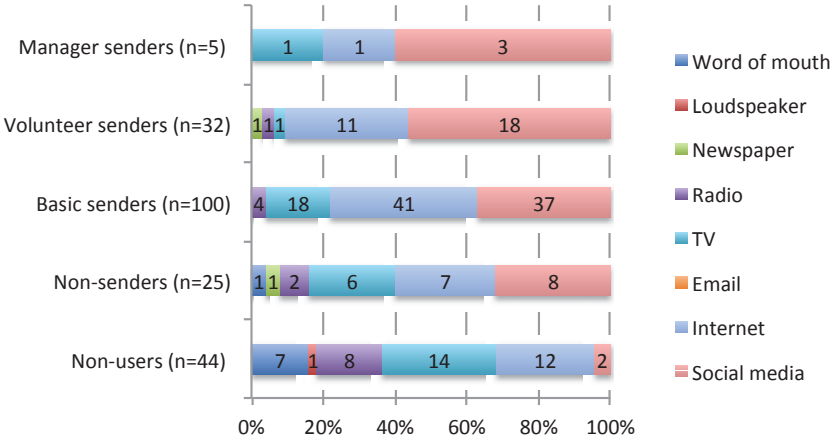

Figure 3. Most reliable source of information during the disaster

the Internet, radio and then word of mouth. A small percentage of non-users found social media to be the most reliable source of information during the disaster. This might be because the users did not personally use it themselves, but perceived it as such through the observed use of others. The results show that the user groups that have a higher level of participation, such as manager senders, are more likely to find social media or the Internet to be the most reliable source of information during the disaster. Interestingly, email, which many people use with mobile phones, as opposed to SMS, was not chosen at all.

Basic senders and volunteer senders have similar patterns in receiving information. General information comprises the largest group followed by infrastructure and then safety information. Non-senders mostly received information related to safety followed by general information and then infrastructure. Interestingly, they received almost no information on special needs or necessities. Non-senders do not have a need for this information. Since they chose safety information first, but almost no information on necessities, it might follow that they, after confirming that they are not threatened, did not feel the need to receive more information or to share information. Manager senders received special needs information the most followed by general information, infrastructure information, and necessities. Due to the fact that manager senders operated a group that shared information during the disaster, it is likely that their awareness about the needs of others, the individuals they are attempting to support, is high, and explains why they have such high rates of received information about special needs, infrastructure, and necessities. Individuals who share information, as opposed to those who do not, seek out information that may not be applicable to themselves at higher rates with the intention of sharing that information (Figure 4). Answers were multiple choice and the specific options have been aggregated into the groups, general (general information related to the disaster), safety (information related to making oneself safe during the disaster), special (information for individuals with special needs in the disaster such as deaf individuals or individuals who are not proficient in Japanese), necessities (information on food, water, shelter, etc.), and infrastructure (information on power outages, public transportation, etc.). The graph represents the percentage of individuals in each group that received that specific type of information.

There are vast amounts of research materials available on the role of media and information sources during disaster. However, in this paper, discussion is restricted to the use of social media and its role in information gathering during a disaster. Acar and Murakami (2011) conducted a survey with Twitter two weeks after the earthquake, tracking status updates of individuals in the affected area. The aim of the survey was to understand the benefits of social networks for individuals directly affected by the disaster and others who were not affected but using Twitter to find news. The research found that directly affected individuals' status updates tended to be related to "their unsafe and uncertain situation" and that individuals in remote areas used Twitter to let others know that they were safe. They also found that status updates in the disas-

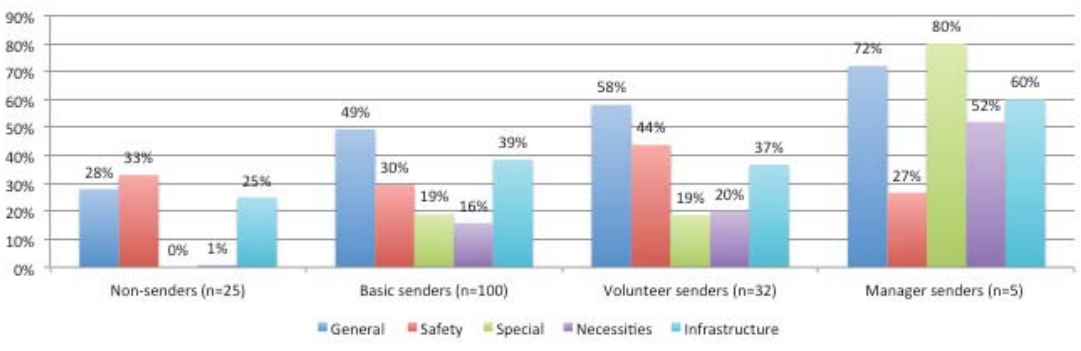

Figure 4. Types of information received during the disaster (multiple choice)

ter hit areas were warnings, help requests, and reports about the situation and that official local authority Twitter accounts, which were set up after the disaster, were particularly useful because the information was well followed and re-tweeted extensively, especially in the case of tsunami warnings. The research also found that there were many re-tweets that were inaccurate information as well as that there were many calls for help that were hoaxes or misplaced. In addition, users were concerned by these types of misinformation, but there were not enough status updates from the government and mass media to combat the misinformation.

In another research study related to the disaster and social media, the Mobile Marketing Data Lab (MMD Lab, 2011) conducted a survey over the Internet over a five-day period from April, 22nd to the 29th, 2011, with 1,891 individuals on the use of social media in the disaster on mobile devices. The survey consisted of a series of questions about the usage of the social networks Twitter, Facebook, and Mixi, asking whether individuals used the networks before or started to use them after the disaster and if the networks were helpful during the disaster. The responses show that 63.9% of Twitter users said that information obtained through Twitter was helpful, with 34.7% of Facebook users saying information from Facebook was helpful and 26.0% of Mixi users saying information from Mixi was helpful. Responses also show that users thought that each social network was not helpful for anything at the following rates: 30.7% for Twitter, 49.4% for Facebook, and 57.9% for Mixi. Similar research was also carried out by Hirotada (2012), who pointed out several issues with the use of the Internet, social media and other mass media during disasters, especially focusing on the nuclear meltdown.

Respondents were asked what tools they utilized in receiving information (See Figure 5). Non-senders rely on primarily social networks and web pages as well as mobile devices to some extent. Basic senders also rely on social networks and webpages primarily, with video sites and email to a lower extent. While volunteer senders also rely on social networks and webpages to higher, and nearly similar rates, other tools seem to be all around the same levels. Manager senders rely on web pages, social networks, and email to the same degree, followed by mobile devices, and then video and crowd-sourced sites. Senders share using a greater variety of tools when compared with non-senders. Group senders use crowd-sourced sites

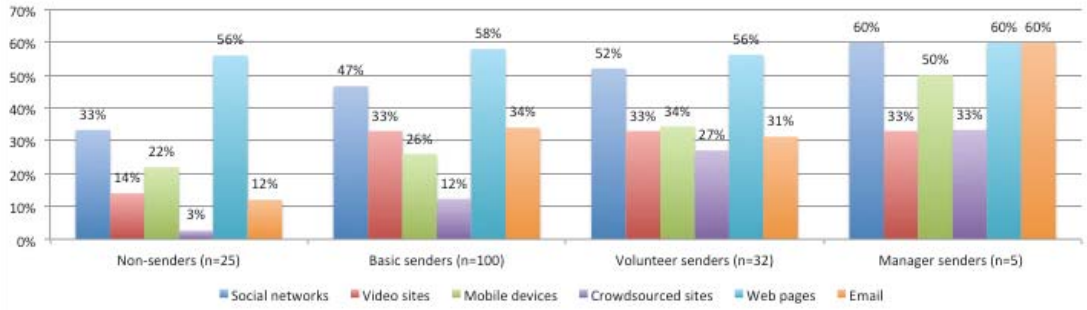

Figure 5. Types of tools related to social media utilized during the disaster (multiple choice)

more than basic senders.

A series of questions on users' motivations for using social media during the disaster were asked of each user role group. Reasons for using were aggregated into technological barrier (to using some other form of communication), ability barrier (some sort of disability drove users to utilize social media, such as non-Japanese speakers not being able to understand information being shared on TV), convenience, quality of information, prior experience, mass sending ability, desire to help, and encouraged by someone (See Figure 6). Non-senders cited convenience most often followed by quality of information. Basic senders cited convenience the most often followed by mass sending ability, quality of information, and then desire to help. Major reasons for volunteer senders followed the same order. Manager senders cited prior experience and mass sending ability followed by desire to help, with convenience being relatively high also. Senders have a relatively high level of prior experience, which might explain why they are more likely to share. Manager senders have a high level of prior experience also, so their prior experience would explain why they have a higher level of participation. Desire to help is high among senders and low among non-senders.

Respondents were asked a series of questions related to problems experienced in receiving and sending information through social media during the disaster. Respondents were asked to identify specific problems they experienced during the disaster and responses were aggregated into problems related to trustworthiness of information, utilization related to skill, failure in the goals of utilization (i.e., users were not able to accomplish what they were trying to do with the technology), and lack of electricity due to power failure (See Figure 7). The most common problems amongst all the groups were related to the trustworthiness of information.

Responses following the framework measuring the factors were used to analyze the results based on location. Location is specified as the areas affected by the disaster, the Tohoku and Kanto regions, other areas in Japan besides these two areas, and outside Japan. See Fig. 8 for responses to the most relied on source of information during the disaster. Although the number of respondents was small (n=31), respondents in the Tohoku region, affected by the earthquake

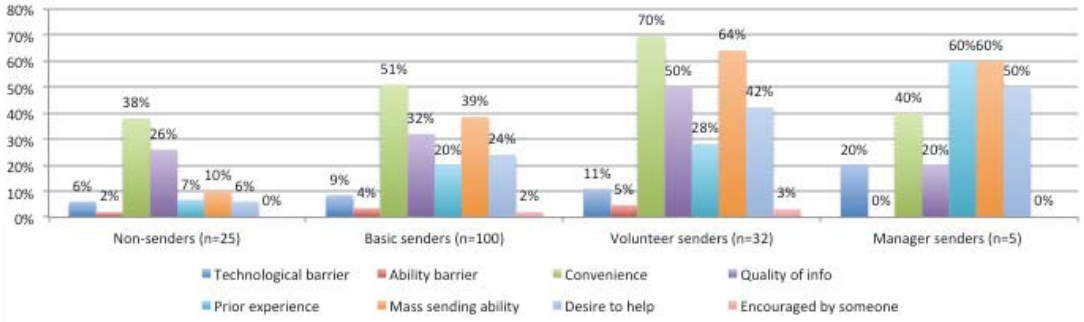

Figure 6. Reasons for utilizing social media to receive information (multiple choice)

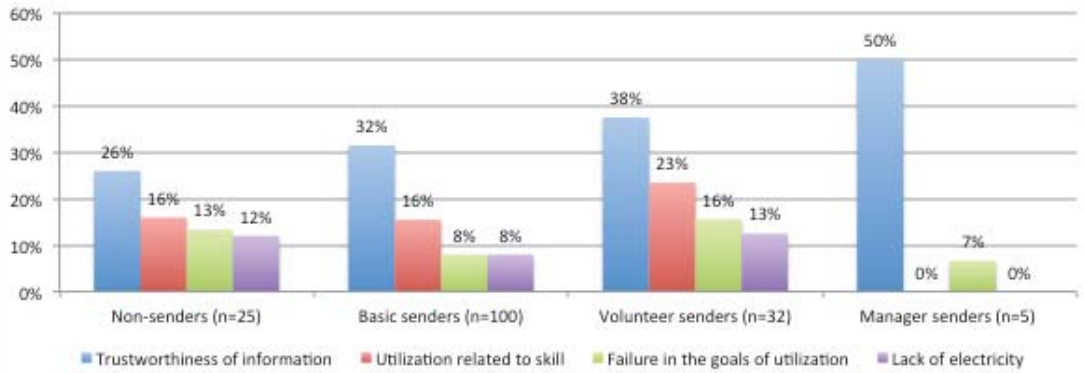

Figure 7. Problems in receiving information through social media during the disaster (multiple choice)

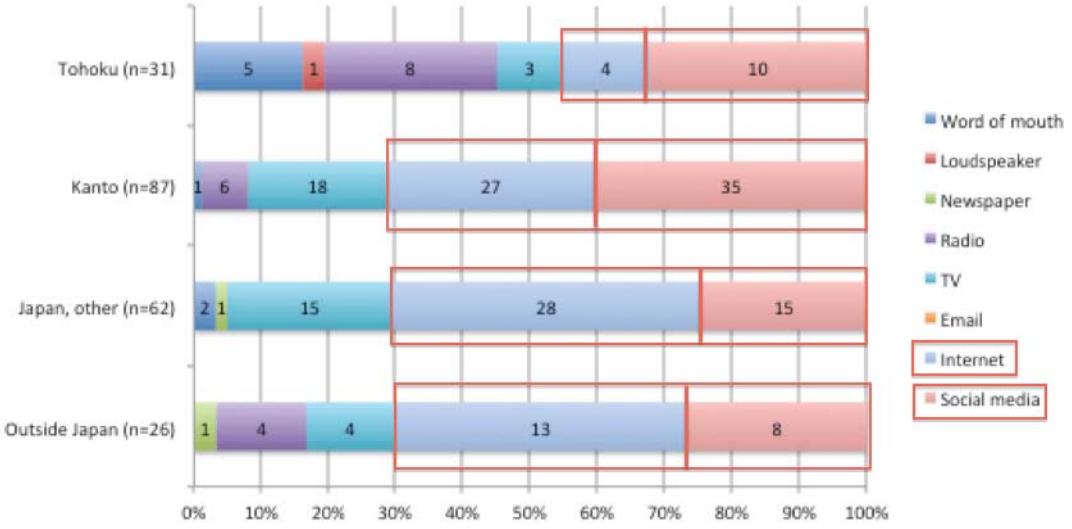

Figure 8. Relationship between location and most relied on source of information during the disaster

and tsunami, relied upon social media primarily, followed by the Internet, and then word of mouth and TV. Respondents in the Kanto region also relied upon social media to the largest degree, but also on the Internet to a high degree, followed by TV. Nearly 50% of respondents in other areas of Japan relied on the Internet for information, with TV and social media being used to the same degree. Respondents outside Japan relied upon the Internet the most, followed by social media, with radio and TV making up equal portions. All areas except for the Tohoku region relied on social media as well as the Internet, followed by TV. Respondents in Tohoku used a greater variety of sources of information, although social media was the most relied upon. This might be due to problems such as lack of electricity and need for immediacy, where the social media could be used on mobile phones in spite of the immediate effects of power failure.

Key findings show that over 60% of non-affected individuals, nearly 80% of indirectly affected individuals (individuals who were not affected, but had family or friends that were affected), and over 55% of directly affected individuals (individuals who experienced the earthquake to a strong degree or had to evacuate due to the tsunami) responded that social media or the Internet was their most relied on source of information. While areas outside the Tohoku region cited social media and the Internet combined at a rate near 70% (Kanto 71%, other areas in Japan 69%, areas outside Japan 80%), individuals in the Tohoku region, the area affected by the tsunami, cited social media and the Internet combined at a much lower rate of 45%. Respondents in all areas in Japan evaluated "lack of trust in information" as the greatest problem associated with social media use in the disaster, with respondents in all locations rating it over 33%, whereas respondents outside Japan rated it much lower at 14%. Users regardless of location (inside disaster areas and non-disaster areas) or level of affectedness (non-affected, indirectly affected, and directly affected) both overwhelmingly evaluated social media to be "helpful" or "extremely helpful" during the disaster at a combined rate of 94%. Support for government use of social media for respondents in the disaster affected areas (Tohoku and Kanto regions) was 95%, higher than those of other areas, which was over 84%. Support for government use of social media in disasters is extremely high, above 80% for individuals in all locations, levels of affectedness, and user roles.

6. THE WAY AHEAD

The results of the current survey suggest that social media was reliable in the disaster to very high levels regardless of user role, location or level of affectedness and perceived reliability was even higher. For directly affected individuals and individuals in the affected areas convenience and mass sending ability were the strongest reasons for utilizing social media during the disaster. Problems with trustworthiness of information were experienced by all to a certain degree. Even though problems were experienced, us-

ers found social media to be extremely helpful in the disaster and beneficial in disasters in general to an overwhelmingly degree. Users felt that all areas of information sharing through social media in the disaster need to be improved, infrastructure information to a particularly high degree. Support for government use of social media in disasters was extremely high and was higher among directly affected individuals, individuals in disaster areas, and group senders. The higher the level of participation in sharing of information through social media during the disaster, the more likely an individual was to received and share a broader amount of information, with a higher likelihood that that information was from a credible source (Peary Shaw and Takeuchi 2011).

As Tseng, Chen and Chi (2011) demonstrate, social media can be used for information dissemination and resource mobilization that allow the public to participate in disaster relief and play vital roles as collaborators, and that social media is a more efficient method of disaster backchannel communication, so government and public participation in disasters is possible. In addition to this fact, results of this survey show that participation by organizations and government bodies in social media use for disaster preparedness and disaster relief can be beneficial. The key findings of this research can be used to explain why organizations and government bodies should utilize social media for disaster preparedness, relief, and recovery.

An important aspect of social media use in disasters is its ability to be used inside and outside the disaster-affected areas. When speaking of social media use in disasters, often people imagine only directly affected individuals utilizing social media. This research shows that directly affected individuals and individuals in the affected areas believe that social media and the Internet combined were the most viable forms of communication so social media is valuable to these groups, as the collected examples show there are many individuals who use social media to contact their family or friends and there are also many individuals who use social media to provide support such as the case of the Anpi Report or to receive vital information such as the case of the "homemade" sign language news group. There are many examples of ways individuals can offer support from outside the disaster-affected areas, such as gathering information on the safety of individuals or gathering information for crisis-mapping, etc.

After the 2011 East Japan Earthquake and Tsunami, there was a great outpouring of good will and desire to help, but it was made clear by the government and organizations that the only way to help was to donate funds. One possible way to direct this good will and mass amounts of human resources into a positive form of support for affected individuals may be through encouraging individuals to participate in social-media-driven support projects. Finally, due to the fact that social media use in disasters is relatively new, it is likely that, just as new uses for social media in disasters are being developed, new problems will arise. Organizations and governments that utilize social media in disasters should be aware of these limitations and risks and do their best to minimize negative impacts from them.

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REFERENCES

Abram, C. (2006) Welcome to Facebook, everyone. The Facebook Blog. Retrieved from: http://blog.facebook.com/blog.php?post=2210227130

Acar, A. and Murakami, Y. (2011) Twitter for Crisis Communication: Lessons Learnt from Japan's Tsunami Disaster. International Journal of Web Based Communities. Retrieved October 31st, 2011 from http://www.eurekalert.org/pub_releases/2011-04/ip-tan041511.php

Barnes, A. & Carrell, S. (2005) How 3G phone technology created instant history. *The Independent*. Retrieved from: http://www.independent.co.uk/news/uk/crime/how-3g-phone-technology-created-instant-history-498279.html

Cell Phones Capture London Blasts. (2005, July 8). *Wired*. Associated Press. Retrieved from http://www.wired.com/science/discoveries/news/2005/07/68143

Cowell, A. (2005) After Coordinated Bombs, London Is Stunned, Bloodied and Stoic. *The New York Times*. Retrieved from http://www.nytimes.com/2005/07/07/

international/europe/ 07cnd-explosion.html

Facebook. (2011) Statistics. Retrieved October 19, 2011. Retrieved from: http://www.facebook. com/press/info. php?statistics

Flaccus, G. (2007) 1,500 homes lost; $1B loss in San Diego area. *The Seattle Times*. Retrieved from http://seattletimes.nwsource.com/html/nationworld/2003971082_ wildfires24.html

Gibbs, N. (2007) San Diego Fire Updates. Retrieved from http://www.nathangibbs.com/ 2007/10/23/san-diego-fire-updates/

Hirotada H. (2012) Kyodai saigai no seiki wo ikiniku, Syuueisya Shinsyo, in Japanese

Hodge, N. (2011) Military may Crowdsource Haiti Relief. *Wired*. Retrieved from http://www.wired.com/dangerroom/2010/01/military-may-crowdsource-haiti-relief/

Huck, P. (2005) 'We had 50 images within an hour'. *The Guardian*. Retrieved from: http://www.guardian.co.uk/technology/2005/jul/11/mondaymediasection.attackonlondon

Jishin – Mikushi, Mixi no jishin kanren komyunitii matome peeji wo kaisetsu (2011) Livedoor News. Retrieved from http://news.livedoor.com/article/detail/5410243/

Kaplan, A., & Haenlein, M. (2010). Users of the world, unite! The challenges and opportunities of Social Media, Business Horizons, 53 (1). 59-68. Retrieved from: http://www.sciencedirect. com/science/article/pii/S0007681309001232

Kaste, M. (2011) Facebook's Newest Challenger: Google Plus. National Public Radio. Retrieved from: http://www.npr.org/2011/06/29/137507567/facebooks-newest-challenger-google-plus

Kietzmann, J. H., Hermkens, K, McCarthy, I. P. Silvestre, B. S. (2011, May-June) Social media? Get serious! Understanding the functional building blocks of social media, Business Horizons, 54 (3), 241-251. Retrieved from: http://www.sciencedirect.com/ science/article/pii/S0007681311000061

Mashable (2011) Twitter. Retrieved Oct 19, 2011from http://mashable.com/category/twitter/

Mayfield, A. (2008) What is social media? *iCrossing*. Retrieved from: http://www.icrossing. co.uk/fileadmin/uploads/eBooks/What_is_Social_Media_iCrossing_ebook.pdf

MMD (2011). Mobile Marketing Data Lab: Higashinihon daishinsaigo no sousharu media riyou nikansuru jitai chousa [Data file]. Retrieved from http://mmd.up-date.ne.jp/news/detail.php?news_id=799

Morales, X. Y. Z. G. (2010) Networks to the Rescue: Tweeting Relief and Aid During Typhoon Ondoy. (Unpublished master's thesis) Georgetown University, Washington D.C.

O'Reilly, T. (2005) What is Web 2.0. Oreilly.com. Retrieved from http://oreilly.com/ web2/archive/what-is-web-20.html

PBS (2011) Crisis Mapping [Television series episode]. Need to Know. Public Broadcasting Station. Retrieved from http://video.pbs.org/video/1923247005#

Pierce, D. (2010) Pentagon's Social Network Becomes Hub for Haiti Relief. *Wired*. Retrieved from http://www.wired.com/dangerroom/2010/01/pentagons-social-network-becomes-hub-for-haiti-relief/

Peary B. D. M. (2011): The Role of Social Media in the 2011 East Japan Earthquake and Tsunami and its Potential Future Application, Master thesis, Kyoto University.

Peary D. D. M., Shaw R. and Takeuchi Y. (2011): Role of Social Media in East Japan Earthquake and Tsunami, in East Japan Earthquake and Tsunami, Shaw R. and Takeuchi Y. (eds.), 109-142, Research Publisher, Singapore.

Poulsen, K. (2007) Firsthand Reports From California Wildfires Pour Through Twitter. *Wired*. Retrieved from http://www.wired.com/threatlevel/2007/10/firsthand-report/

Qu, Y., Huang, C., Zhang, P. & Zhang, J. (2011) Microblogging after a Major Disaster in China: A Case Study of the 2010 Yushu Earthquake. *Proceedings of the ACM 2011 Conference on Computer Supported Cooperative Work* (CSCW 2011). 25-34

Redmon, A. (2010) Department of Defense's APAN Community Wins Acclaimed Industry Award for Successful Social Technology. Retrieved from http://telligent.com/company/news/ b/press_releases/archive/2010/11/09/department-of-defense-s-apan-community-wins-acclaimed-industry-award-for-successful-social-technology.aspx

Shiels, M. (2011) Twitter co-founder Jack Dorsey rejoins company. BBC News. Retrieved from: http://www.bbc.co.uk/news/business-12889048

Svetlik, J. (2011) Google Plus has 40m users. CNET UK. Retrieved from: http://crave.cnet.co.uk/software/google-plus-has-40m-users-50005633/

Tseng, S., Chen, W., & Chi, C. (2011) Online Social Media in a Disaster Event: Network and Public Participation. *Communications in Computer and Information Sci-*

ence: Digital Information and Communication Technology and Its Applications International Conference, DICTAP 2011. 167. 256-264.

Vieweg, S., Hughes, A. L., Starbird, K., & Palen, L. (2010) Microblogging during two natural hazards events: what twitter may contribute to situational awareness. *Proceedings of the 28th International Conference on Human Factors in Computing Systems* (CHI 2010). 1079-1088.