Twitter as a Navigator for Stranded Commuters during the Great East Japan Earthquake

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ABSTRACT

The increased use of social media, such as Twitter, was widely reported on Japanese media after the Great East Japan Earthquake of March 11, 2011. This study is a qualitative investigation of the use of Twitter by the stranded commuters and their supporters in the Tokyo metropolitan area immediately after the earthquake. This paper describes the possibilities and problems of Twitter use under a rapidly changing disaster situation. During the first evening of this disaster, the Japan Railroad and other railroad systems ceased their operations in the Tokyo area. This left more than five million commuters stranded in the area. Many commuters walked hours to return home, while others struggled to find temporary shelter and stayed overnight in the city. This study also explores if Twitter was an effective navigator for helping stranded commuters return home or find shelter.

Keywords

Crisis informatics, Great East Japan Earthquake, Twitter.

INTRODUCTION

On March 11, 2011, at 14:46 JST, a magnitude 9 earthquake hit the northern pacific coasts of Japan. This earthquake and subsequent massive tsunamis caused unprecedented damage and casualties (15,859 deaths, 3,021 missing, 6107 injured as of May 23 2012[1]) in Japan. This devastating disaster impacted the Japanese citizenry economically, socially and politically.

This paper presents an empirical study on Twitter use in the Tokyo metropolitan area on the evening of March 11 and March 12, 2011. The earthquake was so powerful and widespread that even people in the Tokyo area, which is 232 miles away from the epicenter, felt a strong jolt and subsequent aftershocks. In the early evening of March 11, the East Japan Railroad (JR) and other subway systems stopped operations in response to the earthquake. At 18:20, JR officially announced that they would not operate that day. Later in the evening, after 20:40, some subway systems resumed their operations. This event forced more than five million commuters in the Tokyo area to either walk home for hours, find other transportation, stay at their workplaces or find temporary shelter in the city. The cell phone infrastructure could not handle the sudden increase in usage immediately after the earthquake although the majority of Japanese citizens rely on cell phone systems. As a result, Japanese citizens could not verify whether their family members and friends were safe following the first jolt. Many citizens switched to communication mediums on the mobile Internet, such as Twitter and Skype on their cell phones.

The central motivation of this paper is to gain insight into how Twitter was used by stranded commuters and how others—their families, friends and the general public—used Twitter to help these commuters. In investigating whether Twitter was indeed an effective navigator for stranded commuters, this study poses two research questions:

1) How did stranded commuters and others use Twitter to aid themselves or others?

[1] http://www.npa.go.jp/archive/keibi/biki/higaijokyo.pdf

2) What are the problems or limitations of using Twitter to support stranded commuters under a rapidly changing disaster environment?

The purpose of this paper is to show how Twitter was helpful during a quickly changing disaster, while also indicating the problems commuters faced using Twitter.

DATA DESCRIPTION AND METHOD

The data used for this paper consists of tweets pertaining to stranded commuters in the Tokyo area and surrounding vicinities on the evening of March 11 and March 12, 2011. Qualitative method, which has been well-supported in disaster research [11], was employed to understand the context of tweets. These tweets were written in Japanese. Because the author is fluent in Japanese, example tweets listed in this paper were translated into English. In order to protect the identity of the Twitterers, pseudonyms were used for their Twitter usernames.

Pilot Study and Its Findings - Keywords and Hashtags

Because this research started several months after the disaster, data collection was a challenge. The author initially conducted a pilot study with an opportunity sample of 2,076 tweets by 123 Twitterers, posted between the late afternoon of March 11 and early morning of March 12, 2011. The data was manually collected by submitting queries to a Google search using common disaster keywords, such as 地震 (earthquake) and 帰宅難民 (stranded commuters) and the date 2011-03-11. A number of keywords were added for subsequent Google queries after reviewing collected tweets by each Google query. The search queries retrieved tweets posted on Twitter, various third party Twitter application sites and individual blog sites. This pilot study revealed that many commuters did not come home until the evening of March 12, 2011. In addition, anticipated disaster keywords and hashtags rarely appeared in this sample dataset.

Past literature [1, 12, 14, 20] showed that a number of crisis informatics studies often used commonly-used disaster keywords or hashtags, such as "earthquake" as well as the location of the disaster, in order to extract tweets about a certain disaster from a large corpus of Twitter data. After reviewing the dataset of this pilot study, it became evident that tweets about stranded commuters did not typically contain keywords such as 地震 (earthquake) or hashtags #jishin (#earthquake).

The dataset showed that a large number of Twitterers used the keyword 地震(earthquake) or 余震(aftershock) in their tweets moments after they felt the strong jolt. However, a few hours after the first shock, these keywords rarely appeared in tweets about stranded commuters, even though commuters were stranded because of the earthquake. A third party Twitter service, Twipple Trend (tr.twipple.jp) lists the top fifty keywords and hashtags used every 5 minutes throughout Japan. The finding is consistent with Twipple Trend's list on March 11, 2011.

These Twitterers rarely added earthquake-related hashtags, such as #jishin (#earthquake). This finding also corresponds with a list of the top fifty hashtags compiled by Twipple Trend on March 11. Prior studies [17] reported that Twitterers used hashtags to filter information. Nevertheless, in this study, hashatgs were rarely used immediately after the earthquake. It is not evident from the dataset why hashtags were not used. These findings suggest that it is not sufficient to rely on commonly anticipated hashtags and keywords to extract tweets on stranded commuters. One may extract biased data or perceive an incomplete picture of the event or the topic if their retrieval method is solely based on anticipated keywords and hashtags.

Data Collection

Because of the findings of the pilot study about keywords and hashtags, subsequently, tweet streams for these two days by randomly selected Twitter users were collected from a list of approximately 14,000 users at a third party Twitter service site Twilog (twilog.com), instead of using keywords and hashtags for data retrieval. This dataset is independent from the opportunity sample of the earlier collection of 2,076 tweets.

8,078 tweets about stranded commuters—found from tweet streams on March 11 and 12 of 227 Twitterers-were collected from Twilog. This site organizes each Twilog user's tweets in a blogging format. Each user's tweets for March 11 and March 12 can be easily retrieved and displayed on the screen by selecting these two dates from the attached calendar. First, Twilog users were randomly selected from the user list in order to eliminate the author's bias. If the user location was either Tokyo, nearby vicinities or a fake location, then these tweets were added to the data list. Tweets for March 11 and March 12, 2011 for each user were reviewed to see if any

tweet included any content that referred to the stranded commuters. At the Twilog site, tweets on each day by each Twitterer are displayed on the screen; therefore, each page can be converted into a PDF file and tweets can be easily processed on Atlas.ti (atlasti.com). Data collection and data coding and analysis were conducted iteratively.

Twitter Users

Twitterers were broadly grouped into two types—stranded commuters and supporters. The supporter type encompasses the general public, friends and families. These Twitterers often changed their roles. For instance, fortunate stranded commuters who could come home early on the evening of March 11 turned into supporters who disseminated useful information to other commuters who were still stranded in the city. In this paper, if at least one of tweets of a given Twitterer indicated that he or she was a stranded commuter, then the Twitterer was counted as a commuter even the Twitterer also acted as a supporter. Table 1 shows the number of tweets by each Twitterer type:

	No. of Twitterers	No. of tweets
Commuters	131	5,378
Supporters	96	2,700
Total	227	8.078

Table 1 – No. of Tweets per Twitterer Type

Data Coding

The tweets in the dataset were reviewed and coded at least twice by the author. Open coding, memo and diagram techniques of Straussian grounded theory [18] were employed to analyze the data. The purpose of using grounded theory techniques was to review the content of tweets and to establish relationships between emerged concepts. The first round of coding was performed to validate and invalidate concepts emerged in the pilot study and to identify additional concepts. The second round of coding was performed for refining and grouping the emerged concepts into central categories that are either purpose or action-related. During the second round of coding, disaster keywords and other keywords that frequently appeared in tweets were also marked for subsequent analysis.

Category	Description	No. of Tweets
Stranded Commuters		
Emotional support	Seeking/receiving emotional support	1,819
Information seeking	Seeking and exchanging information about shelter or transportation systems	1,713
Situational update	Providing information about their current location, physical condition and surrounding	1,660
Others	Other than the above	186
Supporters – Families, Friends and the General Public		
Information diffusion	Disseminating useful information	1,719
Emotional support	Encouraging stranded commuters or getting support from other Twitterers	447
Collaboration and information generation	Collaborating with other Twitterers and generating useful information for stranded commuters	214
Providing advice	Providing advice to stranded commuters	191
Others	Other than the above	129

Table 2 – Tweet Categories

Basic information (Twitter username, location, Twitterer type [stranded commuter or supporter], number of tweets per each category and tweet type [original, retweet or dyad]) were extracted and saved in an Excel file for further analysis. Using the data coding method, tweets are categorized into several purpose/action criteria as

show in Table 2. Detailed findings about each category are described in the subsequent sections.

POSSIBILITIES OF USING TWITTER DURING A DISASTER

The dataset revealed that numerous Twitterers expressed the usefulness of Twitter during this disaster. The merits of using Twitter can be grouped into several categories, as listed in Table 2. A number of studies on Twitter use during disaster situations reported situational updates [3, 12, 15, 20], information diffusion and exchange [3, 12, 15, 16, 17], providing advice [3] and collaboration [17]. Prior studies also reported that the general public became altruistic during disasters and tried to help those in crisis. For instance, Starbird and Palen [17] explored the motivation, resources, activities and products of digital volunteers and important features of self-organization in a networked world after the 2010 Haiti earthquake. Sarcevic et al. [14] reported that Twitter showed possibilities for decentralized medical coordination among small teams in disaster response after the 2010 Haiti Earthquake. Some studies [1,6] also reported possibilities and problems of Twitter during the Great East Japan Earthquake. This study also identified that Twitter was used for information generation and diffusion for such purposes, as described in the following four sections.

Situational Updates by Stranded Commuters

This study found that stranded commuters used Twitter to update their locations, physical conditions and surroundings while returning home or finding temporary shelter. Situational update tweets by stranded commuters revealed a variety of information about the disaster. For instance, some communication mediums, such as cellular phones, were not operational, whereas public payphones and mobile Internet became reliable communication mediums. These tweets showed that easy-to-carry food and battery chargers from convenience stores were crucial items. While walking home, they observed that bicycle shops were crowded because of commuters who tried to use bicycles instead of walking. One of the problems they encountered was finding restrooms while walking home.

The following tweets, by a commuter who walked home for eight hours, portray his journey home. This particular commuter posted 26 tweets from the moment he learned that the train system halted its operations, on March 11 15:31:16, to the moment he finally arrived home, on March 12 02:58:49:

How should I go home? Train systems are completely halted.
2011-03-11 15:31:16 via Twitter for iPhone

My cell phone does not work. The Internet is the only reliable life line [means of communication].
2011-03-11 15:37:18 via Twitter for iPhone

I am passing through the Shinagawa area [in Tokyo]. Public telephones and local bus system are in great demand here.
2011-03-11 18:59:08 via Twitter for iPhone

Finally home! ... The JR [Japan Railroad] was not operating at all. JR, do your work! ...
2011-03-12 02:58:49 via Twitter for iPhone

Information Diffusion by the General Public

This study found Twitter useful for information diffusion by individuals, businesses, government agencies and nonprofit organizations. The general public broadcasted information on Twitter about temporary shelters, the condition of railroad and subway systems and free supplies. Some tweets contained basic information about shelters and transportation systems, while others were more specific to commuters in certain locations. Starbird et al. [16] identified three broad types of information production activities—generative, synthetic and derivative—on Twitter during the Red River Valley Flooding. In this study, tweets by the general public were not generally generative; rather, they often synthesized information from other sources and broadcasted as their original tweets or retweeted other tweets to a broader audience.

The following tweet demonstrated how Twitterers disseminated the information they found on websites or on the television. For example, this Twitterer spread the information that he or she heard from NHK Radio station and suggested that NHK Radio was a good source of information:

The Yokohama Arena is open. Food and blankets are available for 1000 people. They already started registration… Announced by NHK Radio #eqjp #kitakukonnan | NHK Radio provides abundant information!
2011-03-11 21:47:13

Collaboration and Information Generation by the General Public

Although tangible artifacts, such as web sites and newsletters, are usually not created for short-lived events, some prior studies [10, 13] reported tangible collaborative artifacts after disasters. The dataset revealed that web-based artifacts were created immediately after the disaster to help stranded commuters. One noteworthy example was a list of temporary shelters in the metropolitan areas found on Google Maps. With five other collaborators, a Twitterer who was a general public supporter gathered information about temporary shelters from fellow Twitterers and created this list. The list consisted of 60 universities and other types of schools, 37 municipal government and other government buildings and facilities, 16 sports arenas, convention centers and parks, 15 nonprofit and religious facilities, 65 businesses and 7 other locations. This Google Map site was visited by more than 300,000 viewers at 01:50 on March 12. Overall, more than 2 million viewers visited the site. The list started at 18:40 on March 11 and ended at 02:39 on March 12.

The following sample tweets, from the initiator of this Google Map, describe the collaborations amongst Twitterers:

Please let me know shelter information! I will add it into my list.
2011-03-11 18:53:22

[To Stranded Refugees in Tokyo 23 Wards] *I posted shelters on Google Map! [bit.ly address] JR East Japan decided to stop operating today (18:40 NHK) I will update the Google Map continuously (DM if you know any shelter)*
2011-03-11 18:42:38

I got collaborators. Listed 80 shelters so far. Thank you for your cooperation. We will try our best.
2011-03-11 20:49:25

Thank you, collaborators… we completed our mission. We will stop updating our list [of shelters]... No need to ask permission to reuse our information. I pray for your safety. Good night.
2012-03-12 02:39:32

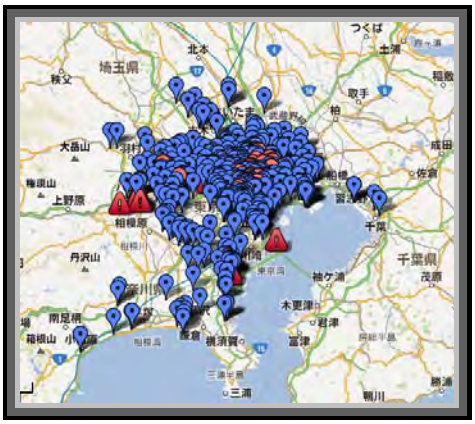

Figure 1 – Temporary Shelters on Google Map

This map was one of many benevolent acts done by the general public to assist those in crisis. Similar maps were created to support commuters and the information was diffused on Twitter.

Providing Advice

In the dataset, a number of government agencies released information and advised commuters on Twitter. For example, the Fire and Disaster Management Agency (FDMA) posted advice for stranded commuters on finding shelters, such as their workplaces, rather than trying to go home. The following tweet by FDMA was widely diffused on Twitter:

It is now usual time to go home. However, it may be possible to get involved in secondary disaster if you try to walk home when public transportation is not in operation. Instead, please consider staying at safe places [in the city], such as a workplace.
2011-03-11

A number of Twitterers figured out which keywords would help stranded commuters find shelter. This individual provided advice on how to search for shelter on Twitter:

RT @supportAAA *If you are thinking about walking home, search the keyword 開放(open to public) on Twitter. You may find places to rest or sleep over at…*
2011-03-11 19:34:51

Emotional Support to Commuters and Their Families and Friends

Twitter provided emotional support to stranded commuters while they were walking home, searching for shelter or when they were left in their workplaces. Twitter also provided comfort to their family members and friends who needed to know the statuses of their loved ones.

The following examples demonstrate how commuters were comforted by simple exchanges with other Twitterers and also how supporters tried to comfort fellow Twitterers by encouraging them to join on Twitter. Twitter was also an important communication medium for commuters since other platforms, such as cell phones, were congested and not functioning.

I felt very anxious while walking home alone. But, being on Twitter made me feel relaxed. Appreciated (.-_-.)
2011-03-11 16:12:20

@friend666 *Everyone has gathered on Twitter...!! I can converse with you if you want me to.*
2011-03-11 23:39:41

RT @friend777*: Some people may be much more anxious because it is getting dark… This is Twitter, a forum to express your feelings! Unless you tweet, we cannot encourage you…*
2011-03-11 22:38:03

RT @friend555 *I learned I could rely on Twitter during disaster situations. Unlike cell phones or email, Twitter is operational. Thanks to everyone, I got useful information and encouragement [on Twitter].*
2011-03-11 21:21:23

While cell phones did not work, Twitter provided me enormous relief.
2011-03-11 17:58:38

When these commuters returned home safely, they sent a number of short tweets about their safe return. Many of them expressed their relief to fellow Twitterers. For example, this Twitterer met up with her father at the Yokohama station and came home in his car. After she took a bath and relaxed, she engaged in conversations with fellow Twitterers by posting a series of short tweets:

Arrived at my family's home.
2011-03-12 01:38:48

@friend999 *Arrived home. Just took a bath.*
2011-03-12 02:23:12

@friendAAA *Thank you. Pretended to be optimistic and took a bath.*
2011-03-12 02:23:52

Information on Twitter also provided comfort to commuters. When other communication mediums were not available, situational update tweets by commuters also helped family members realize that their loved ones were safe. For instance, this Twitterer found her husband was safe by reading his tweets:

@friend111 *… I was anxious since I could not contact [my child's] day care center and my husband. I was relieved when I read his tweet 'walking home'.*
2011-03-11 20:42:08

Twitterers, whose family members or friends became stranded commuters, kept sending useful information to their loved ones, while simultaneously trying to encourage and support commuters. When they did not know the statuses of their loved ones, they exchanged information with other Twitterers, who tried to relieve their anxiety. For instance, one Twitterer tried to gather information about the city in Ibaraki from fellow Twitterers, since he could not communicate with his father, who was in the city.

My father, who was playing golf, has not come home yet due to the traffic situation. I am worried since my family has not even received a phone call from him. Please let me know the situation in Ibaraki.
2011-03-11 21:57:28

When he finally learned that his father contacted his family, he thanked fellow Twitterers and called Twitter an *"amazing lifeline."*

The dataset revealed that Twitter helped relieve uncertainty and anxiety among stranded commuters, their

families and friends throughout these two extraordinary days. Twitter became a forum for emotional support in two ways—providing the information they needed and enabling them to chat with others.

PROBLEMS OF USING TWITTER DURING A DISASTER

In the previous section, the usefulness of Twitter during the Great East Japan Earthquake was described. In this section, the problems of using Twitter as a navigator during a disaster situation will be explored. While Twitter clearly provided useful information and emotional support to commuters, a couple of limitations about Twitter's usage as an information diffusion service during disaster situations must be addressed. In particular, concerns about tweets generated by the general public were addressed.

A number of these tweets often lacked up-to-date, correct information, although the dataset does not indicate that Twitterers maliciously disseminated incorrect information. In fact, only a few malicious tweets were identified in the dataset and Twitterers quickly detected that these tweets were false rumors. One of the challenges in using social media during disaster situations is determining the trustworthiness of the information disseminated [1, 4, 8]. For instance, Castillo et al. [4] and Mendoza et al. [8] analyzed the credibility of information on Twitter, reporting that false rumors tend to be questioned more than trustworthy news on Twitter. Unreliable information could potentially confuse stranded commuters. In some situations, because incorrect information was spread on Twitter, some commuters ended up unnecessarily walking miles to find out that shelters were not open or subways were not operating.

A number of Twitterers cautioned fellow Twitterers not to retweet without verifying the information. For instance, this Twitterer retweeted the third party Twitter service's warning:

RT @TwitterService000: *Everyone, although a lot of information has been exchanged on Twitter, please act or retweet after checking the credibility of information. Even if the information is correct, it may be incorrect as a result of [retweeting] timing.*
2011-03-11 22:04:53

A few examples of inaccurate or obsolete information diffusion are listed in this section. A large number of tweets stated Bunka Fashion College was open to stranded commuters; nevertheless, a small number of tweets also rectified earlier tweets that this school provided shelter only to their students. Another example is Suntory vending machines. Not all Suntory vending machines are emergency vending machines. However, many commuters believed that all Suntory vending machines were free; as a result, a number of commuters posted that tweets about Suntory vending machines were false rumors. The following tweets, by three different individuals, show three types of tweets about Suntory vending machines. The first two provided incorrect information, because supporters disseminated information without verifying it:

RT @support333*: … if you need refreshment, Suntory vending machines provide free drinks.*
2011-03-11 19:23:00

@friend999 *I am sorry. The information about free Suntory drinks was false.*
2011-03-11 20:14:28

RT @support444*: about Suntory* ***RT @support555: @support444*** *[free drinks are] available only in emergency vending machines. http://bit.ly/ i1pz6R*
2011-03-11 20:24:38

Twitter provides real-time, continuously changing information as Twitterers experience an event. The environment that Twitterers faced changed much faster during the disaster situation; thus, the information that spread across Twitter several minutes earlier quickly became obsolete and incorrect. The following series of tweets, posted by a Twitterer on board, shows a continuously changing train operation. The tweets demonstrate how the environment was in flux:

The Ginza Line resumed operation!!! Reported at their official site http://bit.ly/gyJLj0
2011-03-11 20:44:14

The Ginza Line, stopped at the Kyobashi Station… examining its operation … (; ′Д `)
2011-03-11 21:48:44

The information about the Ginza Line not being crowded is 40 minutes old! Please verify the information before retweeting! Now, Ginza Line has stopped.
2011-03-11 22:14:17

In addition, the dataset shows that available information on temporary shelters and transportation systems were

not evenly diffused on Twitter. A number of vending machines have a feature for providing free drinks during disaster situations, as part of crisis management. Yet, only Suntory's vending machines and a few tweets about Coca Cola vending machines were identified in the dataset. Another example of unevenly diffused information on Twitter pertains to temporary shelters. The Google Map of temporary shelters from the previous section listed 15 shelters by religious organizations. Besides these 15 shelters, various articles about stranded commuters reported that a number of other religious organizations opened their doors for stranded commuters. Nevertheless, the dataset contained tweets informing that only a handful of shelters were opened by religious organizations – a tweet by Tsukiji Honganji Temple was broadly retweeted and synthesized in numerous tweets in the dataset. The Tsukiji Honganji Temple was one of the top fifty hot keywords at one time on March 11, 2011 on Twipple Trend, while no other religious organizations appeared as hot keywords.

In this section, two problems, which were attributed to Twitter, were presented—confusion due to inaccurate or obsolete information diffusion and unevenly diffused information. These problems will be further discussed in the following section.

DISCUSSION

In the previous sections, the possibilities and problems of Twitter use during the disaster were portrayed. In this section, the attributes of Twitter will be further examined, in respect to information generation/diffusion and the conversational aspects of Twitter.

The first research question focuses on the possibilities of using Twitter in a rapidly changing disaster environment. In the previous sections, the merits of using Twitter during the disaster—situational updates, information diffusion and exchange, collaboration and information generation, providing advice and emotional support—were described.

One notable difference in the dataset of this study is that a considerably large number of tweets provided emotional support to commuters and their families and friends, when routine activities and communications were disrupted. The dataset revealed that the conversational aspect of Twitter was crucial to stranded commuters who were left in the city or who were walking home. A growing number of Twitterers used Twitter for conversational purposes [2, 5, 21]. The dataset also showed that Twitterers used short, dyadic interactions in order to exchange information and to provide emotional support. Prior studies [12, 15] reported that Twitter or other microbloging services were used for expressing feelings or emotional support. However, these studies did not find interactions among members or did not provide detailed descriptions on how people in crisis were comforted by social media.

Commuting in a metropolitan city is a routine activity and a variety of communication mediums support these routine activities. The disaster disrupted work routines and the communication medium in which people relied on most—the cell phone system—was not operational during most of that evening. Although the disruption these commuters faced was temporary, it was enough for those who were accustomed to convenient city life to feel vulnerable. Vulnerability is characterized as "a person or groups in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard" (as cited in [9], p. 28). Today a larger number of people are more vulnerable during natural disasters. One reason why is unexpected technological malfunctions in conjunction with natural disasters [9]. When commuters felt most vulnerable and uncertain, Twitter became a vital medium for commuters to converse with others and to seek information and comfort.

The second research question addresses the problems of using Twitter under a quickly changing disaster situation. Obsolete or inaccurate information was widely diffused on Twitter. In addition, all of the useful information about shelters and transportation systems were not evenly diffused on Twitter. The general public's behaviors of disseminating information quickly, retweetability and the retweet mechanism may attribute to these problems.

Tweets by stranded commuters were typically based on first-hand observations and experiences; on the other hand, the majority of the general public's tweets in the dataset were derivative—the information they obtained from other mediums, such as TV, railroad company websites and also tweets posted by others. Even tweets by the general public that did not contain retweet syntax (e.g. RT) had synthesized information, which was copied from other sources. The dataset revealed that many general public supporters immediately disseminated information or retweeted as information became available to them without verifying the information. Some Twitterers warned about such behaviors and advised stranded commuters not to take action without verifying such information.

In addition to the general piblic's behavior of information diffusion, the retweet mechanism may exacerbated the issue of disseminating obsolete or inaccurate information. Retweeting enables information diffusion to a

broader audience than the original source's followers. Time lag, from the original tweet to the first hop of retweets, is relatively short—some studies [7, 19] found it took place within 60 minutes. However, considering a rapidly changing disaster environment, this time lag is not short enough. When a tweet about useful information is retweeted by a number of Twitterers, accurate information may become obsolete or inaccurate information by the time the tweet reaches a large audience. The temporal aspect of tweets diffusion needs to be further considered in disaster situations.

Retweetability—i.e. certain tweets spread more widely than others—is determined by various factors. The factors may be the number of followers, the age of accounts, URLs and hashtags. The general public's behavior of information diffusion and retweetability may have contributed to why some information was spread more broadly than other information and led to unevenly distributed disaster information. Other Internet sites, such as the Google Map shelters described in the previous section, and traditional media organized and provided a list of fairly comprehensive resources. On the other hand, the dataset indicated that the information on Twitter was not as comprehensive in comparison to other media. If stranded commuters relied only on information from Twitter, they may not have had access to the most useful information for their situation.

The author poses the question on whether Twitter was indeed an effective navigator for stranded commuters during the disaster. Certainly, valuable information was diffused broadly on Twitter. However, it is not evident from the dataset whether the majority of information posted by the general public was actually used by stranded commuters. Because of the unique properties of Twitter, such as the message size limitation of 140 characters, abbreviations, Internet slang, Twitterers do not usually post well-formed, complete sentences. Therefore, tweets by stranded commuters in the dataset usually lacked clues, which information source stranded commuters used to navigate in the city.

Some prior studies suggested that people relied on information generated by locales on social media when such information was scarce and they could not rely on information generated by the mass media. For instance, during the 2007 Southern California Wildfire, evacuators needed to rely on local knowledge from ICT (information and communication technologies), provided by locales, when the credibility of information provided by mass media declined [20]. In this study, the disaster event took place in a metropolitan area and the information from mass media and other sources was also available. The information on Twitter was not the only source available to stranded commuters. Therefore, it is accurate to say that Twitter was a useful information service~~s~~ for stranded commuters, but certainly not the only source of information.

On the other hand, it is apparent from the dataset that the conversational aspect of Twitter provided clear merits to stranded commuters. ~~S~~short interplays among Twitterers gave them comfort when they were most vulnerable and anxious. Vulnerability, technology breakdown and comfort, provided by the conversational aspect of Twitter during disaster situations, need to be further investigated to better understand the use of social media during times of crisis.

LIMITATIONS AND CONCLUSIONS

The three main limitations of this paper are listed in this section. First, the dataset is relatively small, in comparison with quantitative studies of Twitter. The data collection started almost one year after the disaster; therefore, collecting data through real-time data streams using Twitter API was not feasible. Obtaining historical data in a large metropolitan area without filtering by keywords or hashtags is extremely costly. For these reasons, the data selection method was limited. The dataset could be expanded by combining other qualitative data collection methods, such as interviews that is fairly common qualitative data collection method in disaster research [11]. Second, because this study focuses on a very specific disaster situation, it is difficult to generalize the findings of this study to other disaster situations. Disasters are multidimensional [9]—how people react and cope with a disaster is greatly influenced by cultural, environmental, social, economical, political and technological factors. Therefore, it is questionable if any disaster study can be easily generalized. In addition, qualitative research focuses on explanatory power—"predictive ability"; rather than the canon of generalizability [18]. Third, based on the adoption status of Twitter around March 2011 in Japan, the Twitterers who used this third party Twitter application can be considered ~~-~~early adopters; therefore, they may not represent the general population of stranded commuters. Nevertheless, the author believes that this paper sufficiently answered the research questions and added value to existing work on social media use during disaster events.

The contributions of this paper are finding how Twitter was used for stranded commuters and their supporters to cope with the short-period disruptions caused by a disaster in a large metropolitan city. Although this study setting is unique, the author believes that the findings can apply to other types of disaster or crisis settings in large populated metropolitan areas.

Twitter can propagate real-time, situational, and first person accounts of events [3, 15, 20]. Therefore, the author believes that tweets by stranded commuters can provide valuable information that would be helpful for future disaster preparation in metropolitan cities.

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