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ICT infrastructure and social media tools usage in disaster/ crisis management

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ICT Infrastructure and Social Media Tools usage in Disaster/Crisis Management

Abstract

This article explores the ICT infrastructure enabling social media usage for disaster management. In the era of pervasive social media, the study seeks to probe the usage of social media tools and functionalities in times of disasters. The study deploys Grounded Theory approach. Extending on disaster management cycle, this study examines the various source of information in social media followed by the type of information disseminated by them and additionally the most extensively used form of information. Three recent catastrophic events in disaster-prone Asia Pacific region were selected, Kashmir floods (September 2014), Indonesia landslide (December 2014), and Cyclone Pam (March 2015). Twitter was deployed for data collection under two phases, immediately aftermath of the event and a random sample from the first 5 days of the event. These two data sets examined the research questions by presenting timely and panoramic dimensions. The study is novel since it extends the literature on disaster management by providing a content analysis of social media instead of relying on self-reported data by comparing and contrasting across disasters. The triangulations between the qualitative and quantitative methods were adopted to check the results.

Drawing the principles of grounded theory, a framework is proposed accordingly with key focus on information flow. In the existing ICT Infrastructure, social media tools have the capability of effectively diffusing the information from perspective of the sources and the available functionalities. Data suggested new insights in context of socio-cultural aspect, and development, which imply on the level of ICT infrastructure. In the end the study proposes certain practical and policy implications highlighting the changing trends of information consumption traits.

Keywords

ICT, social media, information flow, disaster, crisis, kashmir floods, indonesia landslides, cyclone pam.

Introduction and Background

“The occurrence of the earthquake in the Sunda Trench on 26 December 2004 was known on the other side of the world in Hawaii at the Pacific Tsunami Warning Center almost as it ended 500 seconds after 12.59 am Universal Coordinated Time (UTC) and was communicated to warning centers across the Pacific by 1.10 am UTC (National Oceanic and Atmospheric Administration). All this was made possible by the underlying infrastructure of fiber optic and copper cables, satellites and other telecom equipment” (Samarajiva, 2005, p. 731-747). More recently, when Hurricane Sandy slammed the East Coast of the United States, the cell phone service came to halt, and social media filled this void. Authorities and millions of Americans turned to Twitter and Facebook to be informed, notify authorities, locate individuals, and further express support. However, this event strongly appreciated the usage of social media and supposed that it will not do away with the emergency broadcast system but rather acknowledge it to reveal new data for researchers, federal agencies and NGOs (Maron, 2013).

In today’s world Information and Communications Technology has left no stone unturned in terms of accessibility with an evident usage in all walks of life. So is in the case of disaster, where ICT is recognised and integrated in managing the same. One of the key attribute during crisis is information dissemination, as such information encourages the receiver to take some actions to avoid a possible threat or harmful effect and to create a rational understanding of the risk (Seeger, Sellnow, & Ulmer, 1998). The survivors of Hurricane Katrina narrated their stories of texting messages on mobile phone to save lives and internet access during post-evacuation served as crucial information source (Procopio & Procopio, 2007, p. 67 - 87).

The conventional media, e.g. TV, radio, newspaper, etc. plays an active role in information

dissemination. As a top-down medium, the response remains as the weakness due to its one-to-many communicative characteristics in contrast to booming social media tools. With the extensive popularity of social media tools, e.g. Facebook, Twitter, WhatsApp, Instagram, etc. the applications are not only embedded in our daily smart devices, like cell phone, tablet, etc., but also integrated with our networked social life. It is estimated that there are over 2 billion active social media accounts and 1.685 billion active mobile social accounts on the globe “based on the monthly active user numbers reported by each country's most active platform” (Kemp, 2015).

The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) affirms that Asia-Pacific region continues to be vulnerable to natural disasters. Statistics indicates amongst the disasters occurred from 2004 to 2013 around the world, 41.2% prevailed in Asia-Pacific region. However the frequency of natural disasters during the two decades remained static, the mortality rate has increased thrice. The increase in the number of deaths can be largely attributed to the effects of only a handful of catastrophic disasters including the 2004 Indian Ocean earthquake and tsunami, the 2005 Kashmir earthquake in Pakistan, the 2008 Sichuan earthquake in China and Cyclone Nargis in Myanmar, as well as the 2010 heat wave in the Russian Federation (UN, 2014).

Likewise, there has been a growth in ICT usage in Asia-Pacific region (Refer Figure 1). According to (ITU, 2014), it was projected that by end of 2014 there would be almost 3 billion internet users and 45% percent of those from Asia-Pacific region. The report also projected that the number of mobile-broadband connections would reach 2.3 billion globally and the penetration level of this in Asia-Pacific region is 23%.

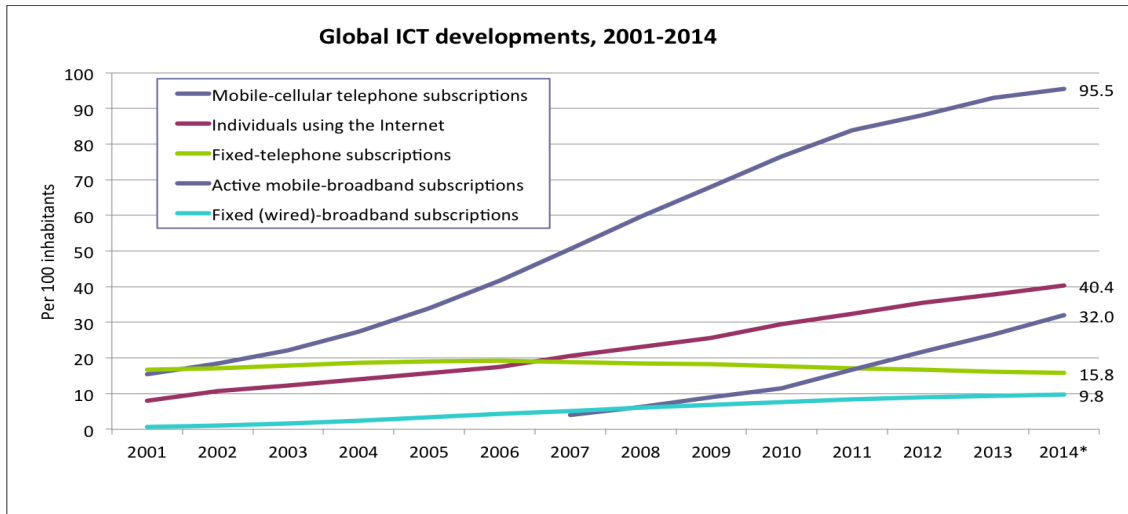


Figure 1. Global ICT development (ITU, 2014)

ICT in Disaster Management

In order to better understand and manage the disaster, the disaster management life cycle theory becomes a foundation to response and handles the emergency situations. The four phases (Figure. 2) are defined: response, recovery, mitigation and preparedness. The modern disaster management has great dependency on ICT to encounter crises of different scale. Mitigation phase is engaged to take actions to diminish the possibility of disaster occurrence through the assessment. In the preparedness phase (before event), efforts are taken to construct the response plans based on the destructive degree of disasters, e.g. alerting system, evacuation, epidemic control, etc. When the event bursts out, the response phase (during event) focuses on the actions taken to organize, deploy and implement the rescue tasks as per the defined response plans in the immediate aftermath. At recovery phase (after event), actions are shifted to the help in restoring normal life and work order. These four phases usually overlap (Wattegama, 2007).

This disaster management life cycle unveils the pattern of the development of a series activities and actions before, during and after the disaster. It is asserted that the activities and actions around disaster management are leverage of people, information, and resources that converge during crisis situations (Liu, 2014).



Figure 2. Disaster Management Life Cycle

It is difficult for the humans (individually) in proximity of a hazard to understand the warning about it, in certain cases though physical effects of the hazard may give people some signals/information about disaster, e.g. the advice given to the citizens of Hawaii about local tsunamis created by proximate earthquakes is: ‘Your feet are your signal; if you feel an earthquake, head for high ground’. Though these natural sensing capabilities provide disaster warning they cannot be taken as the most appropriate technique for disaster warning in today’s world where technology is progressing rapidly (Samarajiva, 2005). Researchers have taken unremitting efforts in asserting ICT enables to alleviate the influence of the disasters or crises during the entire disaster management cycle, for example, the early warning systems which can bridge the traditional and new media. And further in the disaster management cycle, ICT is being used in all the phases, but the usage is more apparent in some phases than in the others (Wattegama, 2007).

Hyogo Framework, a strategic & systematic approach adopted by United Nations International Strategy for Disaster Reduction (UNISDR) from 2005 to 2015, further restated the reliance upon technology and enhance the role of infrastructure and scientific implications during disaster management (UNISDR, 2005).

More researchers supported that using ICT has been an effective approach to information dissemination in disaster responses in the context of communication facilitation and coordination. The

tools like Geographical Information System (GIS) are actively invoked during disaster-relief actions. (e.g., Grunfest & Weber, 1998, p. 55-72; Thomas et al., 2006). It is also asserted that the increasing importance of ICT in the coordination among individuals, organizations and governmental bodies is accepted publicly in times of disasters to secure the information flow in a timely and transparent manner (e.g., Chen et al., 2008, p. 200-230; Day, Junglas, & Silva, 2009, p. 637-660; Pan et al., 2012, p. 31-56). With modernization of ICT infrastructure, the popularity of smart devices comprising of powerful functions with connectivity, computation, sensing capabilities, memory, etc. broadens the information sharing channels between disseminator and recipient. Richness and variety of data via ICT plays a crucial role to determine the diversified source of data. Data sources typically include blogs, interactive maps and GIS and Remote Sensing are being widely used in almost all the phases of disaster management activities (Wattegama, 2007), from digital libraries to e-government portals, from television to news feeds. Advanced smart-phones and handheld-devices are equipped with various sensors, including a Global Positioning Services (GPS), accelerometer, gyroscope, microphone, camera, and Bluetooth. These data sources of ICT services provide a platform to a broader user base, including citizens, businesses, government and research institutions during catastrophic events (Adam, Shafiq, & Staffin, 2012, p. 90-96). However, the increase use in social media which are enabled through ICT has made an effort to be a part of disaster management cycle.

Social Media Tools and Networks

Social media is accessible via ICTs such as desktop, laptop, mobile phones and tablets, among which the mobile devices are on a rise for individuals (Brenner & Smith, 2013; Constine, 2013). Some researchers also asserts that the value conveyed by social media is empowered through network-based platforms and services used for information-sharing (Blank & Reisdorf, 2012, p. 537–554), e.g. Twitter, Facebook, YouTube, Reddit, etc. (Fraustino, Liu, & Jin, 2012). The preference of social media also varies from country to country, for example, Chinese favors Weixin (WeChat) and Brazilian and Indian

avored Orkut by contrast with Facebook and Twitter. Moreover, the functionalities provided by social media enable to navigate automatically to the local connections when using a global social media platform.

The mainstream media is exclusive source to acquire and update the information related to the disasters (Perez-Lugo, 2004, p. 210–25). Furthermore, it is widely believed that mass media enables to influence the outlook and actions amongst population and government towards the disasters, which ranks media as powerful tool in individual's perception toward disaster. The limitation though lies in the fact that it is one-to-many communication where from one source information is disseminated to target recipients with primitive participation from them (Houston et al., 2015, p. 1-22).

On the other side social media provides an interactive platform where information can be shared, discussed and provided in diversified forms. The notion of online communication was majorly on websites (Perry, Taylor, & Doerfel, 2003, p. 206-232; Taylor & Kent, 2007, p. 140-146) and also blogs (Bates & Callison, 2008; Sweetser & Metzgar, 2007, p. 340-342). However, the trend towards social media began to grow (Palen et al., 2007).

Recognizing the use of information sources in crises, the study draws the Users and Gratification Theory (UGT). The UGT posits that people proactively select and consume media that best meets their particular informational, social, and/or psychological needs (Ruggiero, 2000, p. 3–37). It has been subjected to immense scholarship on whether the public (or otherwise known as consumers of media) are influenced by the media sources in lieu of their supposedly ability to fulfil their different needs (Levy & Sven, 1985, p. 109–122) including cognitive, affective, personal integrative, social integrative and tension free needs and in doing so, influencing their decision making. Fulfilling cognitive needs is relatively straightforward. There is an intellectual gap and those with this gap reach out to the media for the information that best matches (or plugs) this. This could be achieved in a more passive manner by watching news bulletins on TV or more proactively by using Internet search engines for more niche pieces of information.

It is public perceived that the information are promptly accessible via social media during crisis despite mainstream media being still regarded as a main source to obtain such information, but there is an increasing goodwill to accept social media as credible (Cho, Jung, & Park, 2013, p. 28-40). Besides social media serving as an online word-of-mouth (Austin, Liu, & Jin, 2012, p. 188-207) with the facilitation in interaction and information-sharing among organizations and stakeholders (Wright & Hinson, 2009), its characteristics, participation, openness, conversation, community and connectedness, have attracted the public attention rapidly. In addition, being an online source, social media plays an ideal role in inducing timely punctual communication (Taylor & Perry, 2005, p. 209-217).

The scalability, reliability, mobility, cost efficiency, convenience, penetration and swift nexus of social media provide potential for both one-to-many as well as many-to-many communication (Seltzer & Mitrook, 2007, p. 227-229) in addition to GIS capacity and visualization tools, making it an ideal emergency communication tool. The attributes of social media such as information flow, information control, adaptability, relevance for local residents, intelligence, empowerment, dependency on the power grid, cost, accessibility, and timeliness of information are advantageous over the traditional media during disaster communication. Social media enables mobile devices such as smart-phones and tablets to serve as an impressive tool during disaster in remote locations with its ease of being able to document and share information about events spontaneously in absence of mass media (Houston et al., 2015, p. 1-22).

Social media facilitates individuals and groups by providing platforms where they can share their ideas and information by posting, replying and re-posting information that they feel is appropriate to be shared. Information shared can involve/encompass images, videos, audios, opinions (Lai & Turban 2008, p. 387-402). In time of crisis, social media platforms, such as Facebook and Twitter, provide a zone for social interaction and group-formation. In observance of recent catastrophic events, the requirement for authentic and up-to-date information during period of emergency has become apparent. The delivery of information, resources and awareness to citizens prior, amid, and following the commencement of disaster can aid community engagement (Tolhurst, 2011). Peer-to-peer communications through social

media are spreading as means for aiding auxiliary, often critical and precise diffusion of information within the public sphere (Sutton, Palen, & Shklovski, 2008). Public have begun to count on social media to share information during crisis with family, friends and to a greater extent with government and NGO's who manage social networking profiles (American Red Cross, 2010; Bunce, Partridge, & Davis, 2012, p. 34-45).

Drawing from the ubiquity of social media applications in the real-life settings, there is a shift from “push” information to “pull” information in a timely manner compared with that of mainstream media. Recognizing the increasing potential in the foreplay of disaster management, UNISDR has adopted social media into the mainstream emergency communications under the Sendai Framework for Disaster Risk Reduction 2015 to 2030 on 15 March 2015 (UNISDR, 2015).

Confidence is shown on social media's potential to improve disaster management from the aspects of the information dissemination, communication, organization and deployment (see, for example, Lindsay, 2011; Fraustino, Liu, & Jin, 2012; Reynolds & Seeger, 2012; Williams, Williams, & Burton, 2012) relying on the advantages of social media that the traditional media does not process particularly in disaster management, for example, “dependability and interactivity” (Jaeger et al., 2007, p. 592–604). It is asserted by some researchers that the ideal emergency communication system should be of cost efficiency, convenience, mobility, reliability, etc., which are also the characteristics of social media, even facilitating many-to-many communications beyond the traditional one-to-many communication (Mills et al., 2009, p. 3–26).

It is presumed that the social media accessing via mobile smart devices is very likely to play a particular role in the context of disaster management by using the featured functions provided by social media, particular for the cases that the disaster occurs without early alerting or in the remote location, in which the news or information might not be reachable through news agencies or journalists, In line with the facilitation of social media in the disaster context, it is increasing of public concern that has has been further studied by organizations, governments and scientific institutes. (see, for example, Lindsay, 2011;

Fraustino, Liu, & Jin, 2012).

In prior studies, it is quite evident that most of the studies on disaster management typically has employed in-depth interviews with those who had a direct encounter with natural disasters, which majorly relies on self-reporting of data (Cho, Jung, & Park, 2013, p. 28-40). Analyzing these self-reported data might as well be a hindrance and limit the scope of study. Subsequent previous research has observed and reflected on the social media as a whole or case study of a particular event. (Adam, Shafiq, & Staffin, 2012, p. 90-96; Alexander, 2013, p. 717-733; Austin, Fisher Liu, & Jin, 2012, p. 188-207; Cho, Jung, & Park, 2013, p. 28-40; Houston, et al., 2015, p. 1-22; Majchrzak, & More, 2011, p. 125-132; Pierpoint, 2011, p. 53-58). The research expands on these previous studies by looking at social media within the context of mass convergence and emergency events. This study further investigates use of social media across disasters by comparing and contrasting the social media usage and proposes a possible framework.

Research Approach

This paper proposes to investigate how social media tools and functionalities help in times of disasters, given the ICT infrastructure in place (Foo, Sharma, & Chua, 2007). The proposal is deciphered and this study interrogates the following research questions:

1. Who are the various stakeholders of information dissemination in social media during disasters?
2. What are the types of information disseminated in social media during disasters?
3. Who disseminates what type of information in social media during disasters?
4. What is the most extensively deployed type of information disseminated by the foremost source of information using the primary used functionality of social media during disasters?

This study seeks to qualitatively investigate the use of social media, given the ICT infrastructure in place. Though the questions of “how or what” are determined as a qualitative approach, their relevance are explored in greater aspects within its natural settings. The most widely accepted definition restates that it is a “multi-method,” “interpretive,” “naturalistic,” “sense making” practice where researchers

“build a complex, holistic picture, analyzes words, reports detailed views of informants, and conducts the study in a natural setting” (Creswell, 1998). Qualitative approach is mostly deployed in a field setting where researchers engage with individuals who have undergone through the phenomenon or lived within the vicinity in the past. Miles and Huberman (1994) believe that it is carried out with a goal to achieve a “holistic” or systemic approach that underlines the “logic . . . arrangement . . . [and] rules” of the phenomenon. Further they articulate that analysis of these words “permits the researcher to contrast, compare, analyze, and bestow patterns upon them”. This study also adopts partial quantitative approach. As recognised by Conrath, & Sharma, (1992, p. 37-44), the study adopts a mixed method approach which results in a set of criteria that can be used to extract generalizable findings from case studies.

The research adopts Grounded Theory (GT) approach. The purpose of GT approach is for an exploratory data and as well the qualitative method, which reveal structures and categories that are intrinsic or dormant within the rich data thereby making emerging categories fit the incidents they are representing better. Besides as data changes, the structures can modify themselves naturally.

The Glaserian approach and Straussian approach are two commonly used ones in the GT, where the main difference are well-defined coding structure or extracted theoretical codes. The Glaserian approach focuses on induction based on researcher’s creation under a well-defined framework, and the Straussian approach emphasizes “validation criteria and a systematic protocol”. It is public believed among researchers that using GT is a matter of more or less fit, rather than right or wrong (Bryant & Charmaz, 2007). Another approach to GT is constructivist, which co-constructs the theories and data trend, rather than explores, but it would be affected by researchers’ subjective factors, e.g. values, positions, etc. This approach stands between the realist and postmodernist by hypothesizing an “obdurate reality” as well as the related perspectives. The literature use is the core of the constructivist approach.

In this study, we employ the Constructivist Grounded Theory (CGT) approach as it has shown itself to be effective in a number of field studies involving ICT and its qualitative impact (Bryant, 2002, p. 25–42).

Data Collection

This study extends the literature on disaster management by providing a content analysis of social media across time immediately after the crisis instead of relying on self-reported data. There is great deal of rich data available on social media as users across all walks of life have their presence and especially in events of crisis. Content analysis provides an approach to reveal the content within such a source such as the traditional mass media as well as the social media. The repeatable and precise results about the text are to be yielded (Neuman, 2014). In turn it turns out to be a non-reactive research, which does not involve any direct elicitation with the research subjects but rather a discrete approach of collecting data. So rather than beginning with a hypothesis, the study accentuated on exploratory data collection from social media evidently from twitter. The motive behind Twitter being, it facilitates varied/diversified kinds of communication activities while acting as an official information source. Twitter users converse regarding crisis, share their responses and experiences and exchange information related to help and financial aid with each other (Bruns et al., 2011). Hughes & Palen (2009) believe Twitter is exclusive for real-time information sharing during disaster. As Twitter was primarily used in the catastrophic events considered for the study it is the other motive of the research.

Initially the study proposed to investigate four disasters in Asia-Pacific region with emphasis on recent ones, also acknowledging the potential growth and usage of social media in the region. They are:

1. Kashmir Floods

The floods that hit on September 3, 2014 had affected nearly two million people in the state of Jammu and Kashmir (J&K). The disaster affected 253 thousand houses in the state and death of 1,281 people. Over 550,000 people had been displaced from their homes and were forced to live in camps. Public service infrastructure like hospitals, schools and local administrative units had been severely damaged. (Oxfam India, 2014, November 11). The Indian Armed Forces were deployed in increasing numbers starting September 3, 2014 to conduct search, rescue, relief, relocation, humanitarian assistance

and rehabilitation missions in J&K. By September 18, over 200,000 people were rescued from various parts of J&K by the Armed forces. Army used social media apps such as Twitter, Facebook & WhatsApp to save the lives of people stranded in flood affected areas of Jammu & Kashmir (PTI, 2014, September 9).

2. Indonesia Landslide

On December 13, 2014 a landslide in Indonesia, killed at least 56 people, and 52 were missing. Heavy rain had caused the landslide near Jemblung village in central Java. The country's national disaster agency reported that hundreds of houses had been destroyed by the landslide, and more than 400 residents were moved to temporary shelters (BBC, 2014, December 13).

3. Cyclone Pam

On March 14, 2015 Cyclone Pam attacked the Republic of Vanuatu, an island nation located in the South Pacific. Over 166,000 people are affected in Vanuatu. This severe tropical cyclone also impacted other island nations on the Oceania, e.g. the Solomon Islands, Tuvalu, and New Zealand. This catastrophe also aroused the great concern of Canada and Australia (CNN, 2015, March 20).

4. Nepal Earthquake

On April 25, 2015 an earthquake of 7.6 magnitude struck nepal claiming more than 10,000 lives and injuries leaving millions of people displaced from rural hilly areas and Kathmandu valley. It triggered an avalanche on Mt. Everest and aftershocks continued for about 4-5 days having massive impact on the population and claiming more lives. The neighboring countries also had its impact with loss of lives of about 200 from India, China and Bangladesh in total. It was one of the worst natural disasters to strike Nepal (Nepal Disaster Risk Reduction Portal, 2015).

Keeping in mind the disaster management cycle, the data was collected under two phases: One set of data being immediately after occurrence of the crisis and the other set of data which includes data from the time of occurrence up to five days. The most crucial period of a disaster is the immediate aftermath. This period calls for prompt action, within an exceptionally short period of time. In the aftermath of any

disaster, a significant number of individuals will be injured and/or displaced. Many of them might still be living with the trauma they have encountered, including loss of loved ones. Affected individuals might also be without food or other essential items. They might be waiting in temporary shelters, with no idea of what to do next. Some might need immediate medical attention, while the disaster aftermath environment also creates ideal breeding grounds for possible epidemics. So the study adopted to use timeliness as a measure to look at the use of social media. Subsequently to know the usage of social media functionalities overtime the study anticipated to collect another set of data for up to five days after the catastrophic events. For the first set of data, a convenience purposive sampling method was deployed and a convenience random sampling method for the other.

Data collection was a semi-automated process with support of Scraper. Scraper is a simple data mining extension for Google Chrome™ that is useful for online research when to quickly analyze data in spreadsheet form is needed. Users select a specific data point, a price, a rating etc. and then use browser menu: click Scrape Similar which gives multiple options to export or copy data to Excel or Google Docs. This plug-in is really basic but does the job it is built for: fast, reliable and easy screen scraping (Bobbink, 2014). Further while achieving content analysis, the study restates the reliability of Scraper, since it can be revalidated with Advanced Twitter Search. The attributes considered for crawling of data across all the four disaster were Twitter ID, Date and Tweet

Researchers made their best effort in collecting data for Nepal Earthquake but there was no success since the tool deployed, Scraper for crawling of Twitter data did not support a massive dataset of about 20,000 tweets for just 6 hours. So researchers dropped Nepal Earthquake from the scope of this study and considered the remaining three disasters.

However, under phase one of timeliness data, a purposive sampling of first 1500 tweets were crawled across disasters with the following hashtags as search terms “#KashmirFloods”, “#CyclonePam” and a keyword “Indonesia Landslide” since there was no significant tweets using the hashtag. Under phase two of data collection, the previous search was extended up to five days from the date of events and

the following numbers of tweets were crawled.

Disasters	Number of Tweets
Kashmir Floods	3,878
Indonesia Landslide	7,830
Cyclone Pam	6,141

Table 1. Data Set

Followed by which a random sampling method was deployed to get an overview of social media usage across time in line with the disaster management cycle. The formula adopted for random sampling was $\text{MOD}(\text{ROW}(), n) - 1$. The idea behind was to select every n^{th} row from the extract based on total number of tweets. The value of n was altered in accord with number of tweets. And finally the study deployed 1500 tweets for content analysis.

After crawling the data, the study appropriated open coding scheme, where researchers located themes and assign initial codes in first attempt to condense the mass of data into categories. While further engaging in reading field notes, it enabled to look for critical term. Next step was to write a preliminary concept or a label at the edge of a record and highlighting it in a distinctive way which enabled to keep it open in creating new themes and to changing these initial codes in subsequent analysis. This was a constant comparative technique. When using open coding, themes were highlighted, based on the functionality, mostly low level of abstraction that came from initial research questions. This served the purpose to see emerging themes at a glance, stimulating us to find themes in future open coding while we engaged in detailed content analysis. Every time data was analyzed, researchers could return back to the coding form and reflect the necessary changes. This list had a potential to build a universe of all themes in the study, which we reorganized, sorted, combined, discarded, or extended in further analysis.

Further, all the team members were involved in all stages of coding from creation, refinement and building the corpus for the coding scheme. And since it was an open coding, each team member further enhanced the refinement with new perspective as and when new themes were discovered. Predominantly,

the entire process comprised of all the core team members ensuring the research goals and as well as being considerate with the corpus and the context of the data, with a prime focus on analysis.

The coding of collection began with following steps. Primarily, coders independently evaluated all the data, then as a team, compared the emerging themes and discussed their differences and similarities. After subsequent discussions amongst the group and with professor, the team established a coding scheme. Subsequently, one of the data was coded and analyzed, then the coding was reviewed, and also anticipated newly emergent themes and issues raised in applying the codes created from the initial themes. At this stage all the coders compared results and resolve differences and finalize the coding scheme, followed by which coders recognized the consistency and acknowledged that a highly reliable and valid coding scheme was achieved emphasizing the inter-coder reliability. The coding scheme is appended at the end as Appendix 1.

Finding and Discussion

Before addressing the research questions, the study reviewed various functionalities of social media employed in three disasters. They are

1. Textual consisting Text, URL, Hashtag & Tagging
2. Multimedia with Image & Video
3. Geolocation
4. Synchronization with other applications like YouTube, Facebook, Instagram & Others

The detailed analysis across timeliness and random sampling from the three disasters derived that the most used functionality is Textual followed by Multimedia and Synchronization respectively.

Geolocation, though being most applicable functionality during a rescue operation, it is almost remote with no significance.

While it can be further declared that users most prefer using textual functionality (93%). Subsequently it included a combination of URL's (52.9%), Hashtag (70%) by providing its key feature that is to enable users to find similar information and Tagging (19.5%) provides two features namely, where users tag the source of the information and sharing the information amongst their network. Below are examples of usage of all attributes of Textual information.

#FJWx RT @FijiGov_RMDNDM: Tropical Cyclone PAM Category 1 TC Warning Number 10 issued 1929 UTC Monday 9 March 2015 <http://tinyurl.com/yona5m>

@weerenonweer Pam (Southern Pacific Ocean): Tropical Cyclone Pam formed in the Solomon Islands in the ... <http://1.usa.gov/1HnX4lk> #orkaan

Further under multimedia, Images were the most used function in the Cyclone Pam (30.2%) followed by Indonesia Landslide (14.3%) and Kashmir Floods (10.9%). In multimedia, images had higher frequency since they are the simplest way to communicate information without much effort but rather just upload and further it requires less bandwidth and consumes comparatively less time to upload contrary to the case in videos as it costs higher bandwidth and time to upload it which might probably a hindrance to share during the time of disaster. The use of Geolocation (0.012%) and Synchronization (0.037%) was very low across the disasters as it invokes privacy of users furthering them to disable it in their settings and there is likely a possibility of unawareness of synchronization functionality which might as well be one of the other reason. Another example cited below.

#NaturalDisasters NASA eyes rainfall in newly formed Tropical Cyclone Pam: Tropical Cyclone Pam formed in the ... <http://goo.gl/YCb50D> (YouTube)

Subsequently the data underlines that though the ICT infrastructure provides advanced functionalities like GIS, and Synchronization, there is hardly an effort to utilize them in the disaster context, which have higher potentials in locating individuals during rescue and also disseminating information across various platform. The choice of users remains to be textual followed by multimedia functionalities. Kindly refer Appendix 2 for the details.

RQ1: Who are the various stakeholders of information dissemination in social media during disasters?

As disasters are events of uncertainty, there is likely a significant effort by various stakeholders to either push or pull information. Based on the detailed analysis, the study estimated the following stakeholders as the major source of information dissemination in social media during disaster. They are Individual Users, Government Agencies, Media, Non-Governmental Organizations(NGO) and Corporate/Political Organizations.

As social media is credited on user generated content, individual users (75.9%) across timeliness and random sample are the primary source of information who are either present at event of occurrence or in their natives keeping upto date information or showing solidarity. Presumably Media (11.48%) stands in second place as the alternate source of information in terms of timeliness and random sample, followed by NGOs (0.73%) who play active role in relief. Subsequently Corporate/Political Organization (0.007%) are also amongst the source of information with Government Agencies (0.001%) almost negligible in number. Kindly refer Appendix 3 for the details.

RQ2: What are the types of information disseminated in social media during disasters?

Having discussed the functionality of social media and source of information, the immediate question one seeks to answer would be the type of information created by these sources. Users constantly look for information to meet their gratifications. However, by doing so there are various types of

information generated in social media during disasters. They are News, Ideas/Opinion, Research Results, People's Experience, Help and Others.

Across timeliness and random sample, News (67.8%) was the foremost circulated type of information suggesting users share factual information with their social circles during calamity. Nevertheless, along with facts, there are also a display of various attitudes and ideologies based on their cultural beliefs ranking Ideas/Opinions (31.7%) in second position. An example from Kashmir Floods is below.

kashmir is pluristic though much of tragedies now -Allah get kashmir over from this floods

People's Experience ranked in the third position during timeliness (0.013%) is reduced to fourth position across random sample (0.011%). Subsequently there is tender voice for help ranked in fourth position in timeliness (0.022%) and increased overtime in random sample to third position (0.12%). It was followed by information from that of the warning systems from research organization with R&D (0.002%) in adjacent place. Below is an excerpt on R&D results.

Update Tropical Low now Tropical Cyclone Pam 995hPa Category 1 near 8.4S169.8E at 090600UTC moving ESE at 04... <http://fb.me/1NY40hhE5>

However, while comparing the results of timeliness with random sampling, though there is drift in numbers, the overall results remained unchanged with News being top priority in most cases. Besides that of Ideas/Opinions (52.86%) ranking in next position highlighted in Kashmir Floods resulted in decrease of News (48.6%). The Opinions and cultural beliefs over a period of time had overruled the factual information. While in the case of Indonesia Landslide, there was not much effort from R&Ds being a developing country and no Ideas/Opinions came into light, and News (100%) remained active type of information across times. In the Cyclone Pam, apart from News (54.9%), Ideas/Opinions (42.4%) and R&D (0.003%) initially made their way but decreased over time with increase in People's Experience (0.018%). Request for help increased over time in the cases of Kashmir Floods (0.002% to 0.013%) and

Cyclone Pam (0.001% to 0.004%). Eventually when integrated with disaster management cycles, Cyclone Pam needs to be credited for its endeavor, with the reason being the developed nation across our study. Kindly refer Appendix 4 for the details.

RQ3: Who disseminates what form of information in social media during disasters?

Eventually the research mapped the source of information with the type of information comprehensively across timeliness and random sample. The result indicates Individual users majorly shared News, followed by Ideas/Opinions, Personal Experiences, request for Help and finally R&D results. Media again mostly shared News with a negligible Idea/Opinion and no other type of information. Government Agencies played a very low role with just about 6 tweets of News and no other information. On the other hand NGOs actively shared news followed by Idea/Opinion and also couple of tweets requesting help and presenting R&D results. Other Corporate/Political organizations made their presence by sharing News and Ideas/Opinions.

In the random sample the study gives predominant scope for plotting source of information vs type of information. Individual users earnestly share News signifying the purpose and the background being a crisis, proceeded with their beliefs as Ideas/Opinions while the rest was negligible. Media the immediate significant user continued to share News. While NGOs also emphasised on the News and also opined with their own Ideas. Considering the other key players as the major stakeholders, corporate/political organization were negligible and Government agencies were almost nil. Kindly refer Appendix 5 for the details.

RQ4: What is the most extensively deployed type of information disseminated by the major source of information using the most used functionality of social media during disasters?

Before we addressed the RQs, the study established the most used functionality of social media as Textual, then the result of RQ1 indicated the major source of information as Individual users, while RQ2

indicated the type of information disseminated was majorly News. Associating all the three would establish the most extensively deployed type of information disseminated by the major source of information using the most used functionality of the social media during.

Comprehensively, the most extensively shared information irrespective of timeliness and random sample remained as News using Textual functionality by Individual Users.

Conclusion

Initially the study discussed the various functionalities of social media, followed by various stakeholders and finally the type of information. Plotting the results of these would exhaustively enable researchers to build a framework on how information is disseminated in social media during a disaster, rather an information flow model of social media during disaster. Drawing the principles of Grounded Theory, the study proposes the following framework. In the disaster management with ICT infrastructure as foundation, there are information sources i.e. Individual, Government, Media, NGOs and Organization disseminating various types of information i.e. News, Ideas/Opinions, Personal Experiences, R&Ds, and Help plotted against the available functionalities i.e. Text, Multimedia, Geolocation and Synchronization of the Social Media mapped. The proposed framework associate with the information flow in social media during disaster which begins from various stakeholders as sources using assorted functionalities available in social media and ultimately resulting in specific type of information.

Having developed an information flow framework in social media during disaster, the study seeks to investigate additional challenges besides the research questions developed from the Grounded Theory approach. During detailed content analysis on various stakeholders who are also the primary source of information the research attempts to answer how to effectively optimize their use of social media tools during disasters?

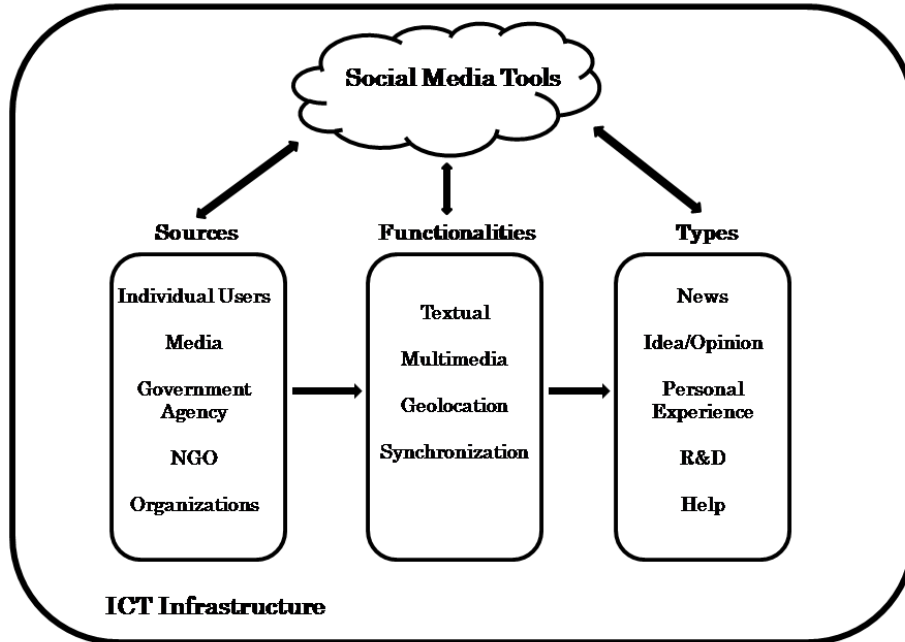


Figure 3. Framework of ICT infrastructure and Social Media Tools usage in Disaster Management

The study suggests apart from Individual Users the very next source of information was Media, followed by NGOs and Organizations with Government at last. Governments or the authorities being key players in disaster management from mitigation till relief should productively enhance their visibility in social media during disaster, with the support of the functionalities: textual, multimedia, synchronization and geo-location in the form of either News or results from R&Ds supported with figures or previous relief experiences for making their information effective as well as reaching wider audience. The other sources i.e. NGOs, Organization, Individuals and News agencies might as well use functionalities like multimedia and enable the geo-location and emphasize further on using auto-synchronization functionality for information dissemination across platforms by reducing misinformation/disinformation and underline the Sendai Framework.

Since this study focused on ICT infrastructure and social media tools during disaster, the data cited new insights. The crucial functionality such as geolocation which has its prime stake in disaster management is either deliberately or unknowingly disabled. The priority should be on educating users to

enable these functionalities on furthering the response and relief phases of disaster management cycle. Another key functionality is to disseminate information across platforms which are Synchronized. The most recent Sendai Framework for Disaster Risk Reduction adopted by UN (UNISDR, 2015), strongly acknowledges the fact of information dissemination on cross-platforms. The study unhesitatingly recommends, especially the authorities to establish a cross-platform information dissemination keeping in mind the context of disaster. In totality there was a trend suggesting the state playing a minimal role in social media, immediately aftermath of disaster as well as over the time, this study further emphasize on Governments taking up higher roles in social media.

The primary shortcomings of the study is making it hard to generalize, though the purposive sampling method keens on being judgmental and subjective it is only a disadvantage when such judgments are poorly considered and it drifts from being representative in nature. On the other hand the study deployed a Scraper tool to crawl data which is an extension of Google Chrome, and while the search term used might have biases of researchers. Overall, the qualitative research suffers from primary question of reliability. The findings from off the field analysis may neither be replicated nor free from anecdotalism, despite attempts at providing a structure to the GT memos and the involvement of three researchers.

In future, the proposed framework could as well be validated with the any catastrophic event. Furthermore, the researchers may consider other possible arguments whether is there any architectural fit between some types of social media tools and the purpose for which they are applied? Alternatively subsequent studies can focus more on URL or multimedia analysis of each tweet. And since the tweets are during catastrophic event, more research can investigate the reliability of information in social media. On the lines of ICT infrastructure the future studies might as well be in line with inclusive of social media.

The study emphasizes the notion of social media usage in disaster management while acknowledging the prior ICT infrastructure in place. While identifying how information is disseminated, the study interestingly developed an all inclusive framework of information flow in social media during

disasters. Besides data revealed a potential cultural ambience behind it, especially in geo-political context of Kashmir Floods. Further with Cyclone Pam threatening developed world of Oceania uncover the veil of developing nations effort vs developed nations effort in disaster management. Although recognizing the functionalities available in social media was unchallenging, the key functionalities such as Geolocation and Synchronization usage was depressing. However, the study acknowledges that the URLs under the textual information is also key indicator in disseminating factual information and mostly elevating misinformation and disinformation in the context of vulnerable situation.

Amongst the various stakeholders of information dissemination, the paper highlights the absence of authorities, and limited presence of NGOs and other organizations suggesting a shift in their policy towards disaster management.

As study presented various types of information, it acknowledged News which is mostly factual information is the need of the hour. Though Ideas/Opinions of various stakeholders had its role, results from R&Ds had very less significance. Personal Experience and Help rather varies on the intensity of the disaster.

Subsequently while asserting most extensively deployed type of information disseminated by the major source of information using the most used functionality of social media during disasters, the study appreciates that the News remains most used type using Textual functionality by Individual Users as source.

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Appendix

Appendix 1 Coding Scheme

Name	Code	Brief Description
1. Textual		Anything written in alphanumeric format
i. Text	T	Just the textual
ii. URL	U	Link to specific website or file on the internet
iii. Hash Tag	HT	A word or phrase preceded by #
iv. Tagging	TG	A label attached to someone or something preceded by @
2. Multimedia		Using more than one medium of expression
i. Image	I	Representation of world in art
ii. Video	V	Moving visual image.
3. Geolocation	G	Presence of Geolocation in tweet
4. Synchronization	Y*	Synchronized with other social media. Y* is the list of possible social media applications with Facebook = F; YouTube = Y; Instagram = I
5. Source		The original details of twitter handle
i. Individual	I	Common man/ General Public
ii. Government	G	Governmental Organization
iii. Media	M	Organizations reporting latest news
iv. NGO	NG	Non-profitable/ charity organization
v. Organizations	O	Corporate/ Political organizations
6. Types of Information		
i. News	N	Providing latest factual information to the community
ii. Ideas/Opinions	I/O	Appraisal/ criticizing government, organization, individual or comments & thoughts
i. Research Result	R&D	Situation reports, & description of warning systems
ii. People's Experience	PE	People's acquaintance/ familiarity
iii. Help	H	Aid request

Appendix 2

Functionalities of Social Media

Row Labels	URL	Text	HashTag	Tagging	Image	Video	Geolocation
Cyclone Pam	1474	2736	3010	877	906	105	97
Indonesia landslide	2995	3004	604	160	431		
Kashmir Floods	296	2697	2700	696	329	154	17
Grand Total	4765	8437	6314	1733	1666	259	114

Appendix 3

Sources of Information

Row Labels	Individuals	Media	Government	NGO	Organization
Cyclone Pam	2022	232	11	647	
Indonesia landslide	2274	691	2	9	27
Kashmir Floods	2543	111		1	43
Grand Total	6839	1034	13	657	70

Appendix 4

Types of Information

Row Labels	News	Ideas/ Opinions	R&D	Personal Experience	Help
Cyclone Pam	1647	1273	11	54	48
Indonesia landslide	3002				
Kashmir Floods	1459	1586	11	56	16
Grand Total	6108	2859	22	110	64

Appendix 5

Source of Information vs Types of Information

i. Timeliness

Row Labels	News	Idea/ Opinions	R&D	Personal Experience	Help
Individual	2219	1412	58	11	13
Media	557	14	0	0	0
Government Agency	5	1	0	0	0
NGO	281	76	1	2	1
Organization	51	6	0	0	0

ii. Random Sample

Row Labels	News	Individual Opinions	R&D	Personal Experience	Help
Individual	2258	1219	32	4	23
Media	447	16	0	0	0
Government Agency	5	1	0	0	0
NGO	232	61	1	2	1
Organization	48	15	0	0	0