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Review

Socializing in emergencies—A review of the use of social media in emergency situations

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ABSTRACT

Social media tools are integrated in most parts of our daily lives, as citizens, netizens, researchers or emergency responders. Lessons learnt from disasters and emergencies that occurred globally in the last few years have shown that social media tools may serve as an integral and significant component of crisis response. Communication is one of the fundamental tools of emergency management. It becomes crucial when there are dozens of agencies and organizations responding to a disaster. Regardless of the type of emergency, whether a terrorist attack, a hurricane or an earthquake, communication lines may be overloaded and cellular networks overwhelmed as too many people attempt to use them to access information. Social scientists have presented that post-disaster active public participation was largely altruistic, including activities such as search and rescue, first aid treatment, victim evacuation, and on-line help. Social media provides opportunities for engaging citizens in the emergency management by both disseminating information to the public and accessing information from them. During emergency events, individuals are exposed to large quantities of information without being aware of their validity or risk of misinformation, but users are usually swift to correct them, thus making the social media "self-regulating".

Contents

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1. Introduction

Social media (SM) tools, especially Facebook and Twitter, are taking an ever growing part in disaster response (Cohen, 2013; Sarcevic et al., 2012). SM during disasters and emergencies was initially utilized by the general public to communicate, and is now being adopted by emergency responders, governments and non-governmental organizations as an integral tool for disaster management (DM).

This paper reviews how SM tools are used in disasters by the public, emergency organizations and academic institutions. This paper reviews the literature concerning utilization of social media in emergencies between 2007 and 2014. Some of the reviewed articles reference earlier materials and these are noted in the review concerning specific topics.

1.1. Disaster characteristics

In the last few decades, numerous regions worldwide have been stricken by severe natural disasters, such as earthquakes, floods and hurricanes, causing extensive damages to human lives and infrastructures.

Disasters have been defined as a state in which the social fabric is disrupted and becomes dysfunctional to a greater or lesser extent causing "maximum community disruption and dislocation" (Britton, 1988; Fritz, 1961).

Natural disasters have spatial characteristics such as extent and boundaries. This configuration is disrupted during the onset of a sudden disaster which adversely affects the natural and human resources, as well as the social relationships in the region (Jigyasu, 2005; Palen & Liu, 2007). At present there seems to be a consensus among researchers that a disaster cannot be explained by a number of recognizable factors, and efforts are being made to understand why and when people perceive a certain period or common experience as a disaster (Boin, 2005).

In response to disasters, numerous agencies and organizations often work together and direct their efforts towards a common goal (Reddy et al., 2009; Kopena et al., 2008). Frequently, the public-private interface is strengthened to support crisis management, and governments may simplify processes to access resources and goods without due process (Quarantelli, 2006).

1.2. Social order

According to Alexander (2005) an average day in the world "would see two to three disasters in their emergency phases, 15–20 in their recovery periods, and about a dozen conflict-based emergencies in progress". These include events such as wars, earthquakes, and extreme weather conditions. Coupled with the loss of communications, it becomes a period of uncertainty that may cause collective stress resulting from deprivation of a large portion of the society from expected routine conditions. These conditions, deprived from many, are socially defined as normal human needs (Barton, 2005). However, the general public often takes an active role in disasters and their involvement is becoming more and more visible, through the use of Information and Communication Technologies (ICT) (Palen & Liu, 2007).

1.3. Disaster management

An organized response to disaster management (DM) is crucial to mitigating loss of lives and damage to infrastructure. Dynes (1970) described both theoretical and practical aspects of an organized response, including staffing, strategy, tasks, and relationships between various responding organizations and the social environment itself.

Information sharing and coordination are a critical factor in DM, especially among responding organizations (Yates & Paquette, 2011; Bharosa, Lee, & Janssen, 2010). In his research, Bharosa et al. (2010) found that responders prefer to receive information and are reluctant to share it with others. Also, even when formal information flows through the command structure, ad hoc and personal-basis channels are created to support multi-level information sharing (Bharosa et al., 2010). The US National Incident Management System (NIMS) is based on a hierarchical command structure to "divide responsibility of labor and support inter-jurisdictional coordination" (Palen & Liu, 2007). According to this model, there is a single official, the Incident Commander (IC), to whom all responding organizations report, and he has the authority and overall responsibility to maintain a unified command during the entire event.

An integral part of DM is situational awareness (SA), described by Vieweg, Hughes, Starbird, and Palen (2010) as features contributing to the understanding of the emergency situation, especially in respect to the operational needs of command and control. SA reports can originate from local residents, reporters, first responders or from authorized information sources (Qu, Huang, & Zhang, 2010).

1.4. Communication challenges

Communication is one of the fundamental tools of emergency management. It becomes crucial when there are dozens of agencies and organizations responding to a disaster. DM requires that these organizations' rapid response, along with their own set of roles and responsibilities, be coordinated within and between sectors (Reddy et al., 2009).

Each organization operates its own radio frequencies, making it difficult to create a unified and synchronized response. The primary challenge is technological, ranging from rapid deployment of a communications system for first responders, to interoperability between various organizations. Communication systems must be able to withstand a disaster and enable devices to function effectively even when communication networks have collapsed (Manoj

& Baker, 2007). These findings were further reinforced by Reddy et al. (2009) who found that current technologies are ineffective and inadequate to support the flow of information within and between coordinating teams during a disaster.

1.5. Loss of communication

Most disasters cause severe damage to communication infrastructure (Low et al., 2010). Phone switches and cell phone towers might collapse, fully or partially, thus disrupting the much needed communication (Palen & Liu, 2007). Regardless of the type of emergency, whether a terrorist attack, a hurricane or an earthquake, communication lines may be overloaded and cellular networks overwhelmed as too many people attempt to use them to access information. Severe natural disasters may cause the entire communications grid to blackout, as infrastructure is severely damaged (Stiegler, Tilley, & Parveen, 2011). In some cases the disaster may strike a geographic region that lacks communication infrastructure; but even in places where partial communication infrastructure remains intact, deployment of new systems may be found to be complex (Manoj & Baker, 2007). As the conventional means of communication become irrelevant during and immediately following a disaster, alternate means such as social networks become an important conduit for information gathering and sharing (Hughes, Palen, Sutton, Liu, & Vieweg, 2008; Bird, Ling, & Haynes, 2012; Huang, Chan, & Hyder, 2010).

1.6. Public participation

People have experienced disasters since the dawn of humanity, and as such their high involvement in the response phase is not new. The public's part in disasters has been studied by many sociologists since the 1950s, including emergent behavior as a means to substitute and form important societal functions after a disaster strikes. Individuals and groups agree that action must be taken in response to an event (Drabek & McEntire, 2002). This usually materializes as volunteerism, both emergent and organized, with different manifestations depending on the type of disaster, stage of the response, region and society. Some volunteer from personal reasons and some for altruistic causes (Wolensky, 1979). Studies have presented that while victims of physical disasters such as earthquakes engage in active self-help, victims from other situations of mass deprivation (i.e. starvation, economic crash or oppression) seem to generate fatalism, lack of active self-help, self-blame, or an irrational search for a guilty party (Barton, 2005).

Most social scientists have presented that post-disaster active public participation was largely altruistic, including activities such as search and rescue, first aid treatment, victim evacuation, and on-line help (Kendra & Wachtendorf, 2003; Palen & Liu, 2007). The general public serves as the true "First responders", with a visible, active, and extensive high involvement. Today, through the use of new ICTs, their role offers additional ways to participate and communicate (Palen & Liu, 2007; Lu & Yang, 2010). Researchers have compared the physical convergence of people to a geographical site after a disaster to the convergence to online SM tools, and found similarities in the population's behavior. At present, there are no limitations to the locations or number of people that can participate in the on-line convergence (Hughes et al., 2008).

1.7. The need for information

People are natural information seekers, relying primarily on their own social networks (Palen & Liu, 2007). Following a disaster, the public initially seeks the most common and familiar channels; phone calls, emails, or text messages. If unsuccessful, they turn to alternative and/or official sources of information (Stiegler et al., 2011). Mileti & Darlington, 1997 presented that individuals in emergency situations use whatever means available to find information. People seek information for themselves, to learn about the emergency event, locate their family and friends, and reduce uncertainty regarding what has happened; they will seek any available venue of information including newspapers, television, and the Internet (Boyle et al., 2004; Stiegler et al., 2011; Hughes et al., 2008). Skinner (2013) describes how she as a researcher collects and aggregates information from different sources during emergencies, and publishes it in order to inform those who are affected by the event. In events that endanger the public's health there is high importance to the ability to act, especially when expected to take ameliorative actions, or actions to identify the risk (Maxwell, 2003). Messages should be disseminated quickly and be simple enough so that people with high anxiety would be able to comprehend and comply appropriately (Wray et al., 2008).

With the advancement of internet technologies and tools, users in crises surfed online to seek information specific to their neighborhoods and activate weak ties in their social networks (Abbasi, Hossain, Hamra, & Owen, 2010). These novel capabilities have created a new form of "civilian journalism" that enables participation during emergency events (Laituri & Kodrich, 2008). The internet is becoming a more reliable tool as traditional media channels suffer disruptions and damage caused by the crisis (Procopio & Procopio, 2007).

People have identified forums as a communication and information sharing platform through which they can seek, share, and synthesize information (Qu, 2009). The next step in the evolution was the massive use of social network sites, such as Facebook and Twitter.

2. Social media

2.1. Short introduction

Social media (SM) consists of tools that enable open and online exchange of information through conversation, interaction and exchange of user generated content (Huang et al., 2010; Abbasi et al., 2010; Kavanaugh et al., 2011). Unlike traditional ICTs, SM manages the content of the conversation or interaction as an information artifact in the online environment (post or tweet) (Yates & Paquette, 2011).

SM allows people to establish connections and links with other individuals who are similar to them, or whom they find interesting. Users can post news or links, discuss them, and share their opinions during real times. The SM can be utilized to mobilize and organize populations in order to achieve various objectives, and update them with the most up-to-date information, which might not be available through alternate official channels (Lerman & Ghosh, 2010).

During natural disasters SM provides access to relevant and timely information from both official and non-official sources, and facilitates a feeling of connectedness (Taylor, Wells, Howell, & Raphael, 2012). This connectivity to loved ones and the community provides reassurance, support and assistance to potentially distressed individuals and populations (Taylor et al., 2012).

Facebook is the largest SM network, with 1.35 billion monthly active users (Facebook Newsroom, 2014). The users of Facebook have the ability to connect and share thoughts and information with friends, join common interest groups and state their preferences (signify 'like'). People mark 'like' in posts, pages and groups they want to follow and publish their agreement, or support, of the content published (Bird et al., 2012).

Twitter is a service through which users can post short messages of up to 140 characters, called tweets, from web- and mobile-based clients. Twitter has 284 million monthly active users (Twitter,

2014). Users establish a network by "following" other Twitterers, and having others "follow" them (Vieweg et al., 2010). Users often mark their posts with topic labels, named "hashtags", which are used as operational proxies to identify messages (Weng, Flammini, Vespignani, & Menczer, 2012), and help others understand the context of the message (Starbird & Palen, 2010). Information can be redistributed by users in the form of re-tweets, which are a convention in Twitter to pass on already published information. Usually re-tweets are a response to tweets that users find more interesting or important (Vieweg et al., 2010).

Twitter provides an Application Programming Interface (API) that can be used to perform searches according to keywords and hashtags (Abbasi et al., 2010), but it is limited to accessing only a restricted number of entities (Lerman & Ghosh, 2010) These keywords have to be extracted from the public's Twitter stream, as conducted by Vieweg et al. (2010) in their research. The results can be traced back to the Twitterer and from there, the entire stream of tweets, replies and re-tweets can be accessed. There are many available tools on the internet that enable visualization of data from Twitter. Social networks' information exchange supports the persistence requirement stated by Palen & Liu, 2007 regarding forms of communications that emerge during or after an onset of a disaster. Persistency refers to communications that are visible, recordable, and/or transferable to other people over time.

Another advantage of the SM compared to the traditional media is the simplicity of collecting and disseminating information. Utilization of traditional media websites and channels necessitates an active search for information, while the SM accesses the information newsfeeds at live and real times (Bird et al., 2012). Coupled with an internet connection that has become available to all, individuals are connected almost regularly and continuously (Jansen, Zhang, Sobel, & Chowdury, 2009), which enables them to share, coordinate and distribute information regarding events in real time (Gupta, Lamba, Kumaraguru, & Joshi, 2013). SM provides unprecedented access to information that is published online by various users (Hale, Gaffney, & Graham, 2012). During emergencies, the amount of available information in SM exceeds the capacity of the public to consume it, and thus a competition over the attention of the individual and the public is created (Weng, Flammini, Vespignani, & Menczer, 2012).

2.2. Social media for emergency management

The utilization of SM for communicating during emergencies was initiated by the public before its utilization by emergency authorities. It is possible that the way emergencies are managed and the uni-directional communication coerced the public to find alternate ways to search and publish relevant and updated information concerning the event (Sutton, Palen, & Shklovski, 2008). According to Latonero & Shklovski, 2010, two main branches of research deal with the uses of social media during an emergency; the first focuses on ways in which emergency organizations use it to coordinate activities during their response actions, and the second deals with the ways the public and victims share information during emergencies. This review article is based on 57 research articles that delineate various aspects of the use of SM during emergencies. Table 1 classifies these articles according to the emergency/disaster type they address (natural disaster, terror attack, communicable disease, public order and non-specific events), the research methodology utilized (quantitative or qualitative), the SM they cover (Twitter, Facebook, Flickr, or other), the research type (active, passive, simulated, or exercise), and the year of the event. The research type relates to the method the data was collected by, where passive indicates using any computational way to collect SM data (i.e. Twitter API). Active means that the researchers made an 'active' effort to collect the data/information (i.e. interviews); simulated generally refers to computer models who do not deploy real information to run; exercise refers to research that used an exercise to test a theory and collect the information.

Table 1
Classification of articles according to topics analyzed in each manuscript.

	# Of articles	Percentage	Comments
Type of disaster covered			
Natural disaster	26	46%	
Terror attack	3	5%	
Communicable disease	3	5%	
Public order	2	4%	
Non-specific	23	40%	
Research methodology			
Quantitative	31	54%	
Qualitative	26	46%	
Social media analyzed			Some articles cover several types of SM
Twitter	35	61%	
Facebook	11	19%	
Flickr	2	3%	
Other	17	30%	
Research type			
Active	34	60%	
Passive	19	33%	
Simulated	2	3.5%	
Exercise	2	3.5%	
Years of occurrence			
2007–2008	5	9%	
2009–2010	19	33%	
2011–2012	9	15%	
2013–2014	3	5%	

Fig. 1 presents the total number of tweets in four major emergency events that occurred between 2010 and 2013, and a trend line showing the rise in SM adoption during such events. Following the Haiti earthquake, 3.28 million tweets were posted (Sarcevic et al., 2012); 20 million tweets were posted during hurricane "Sandy" in 2012 (Olanoff, 2012); 27.8 million tweets were posted following the Boston Marathon bombing in 2013 (Rovell, 2013); and, 5.72 million tweets were posted during typhoon "Haiyan" in 2013 (Levine, 2013).

2.3. Social media and preparedness

SM provides opportunities for engaging citizens in the emergency management by both disseminating information to the public and accessing information from them. These tools have been used to improve preparedness by linking the public with day-to-day, real-time information, as was well presented during the 2009H1N1 pandemic. A few minutes after the Alexandria, Virginia health department tweeted regarding availability and location of vaccines, people rushed to the vaccination sites (Merchant, Elmer, & Lurie, 2011). This has presented that integration of social tools into preparedness activities could facilitate an effective emergency response for professional responders as well as the citizens, using familiar tools during a crisis (Merchant et al., 2011). Despite the low cost, wide reach and proven advantages before, during and following crises, SM tools have been shown to be underused by health professionals (Vance, Howe, & Dellavalle, 2009).

2.4. Technology adoption and usage

Most individuals tend to use technologies that they are familiar with (such as mobile phones, email and known news websites)

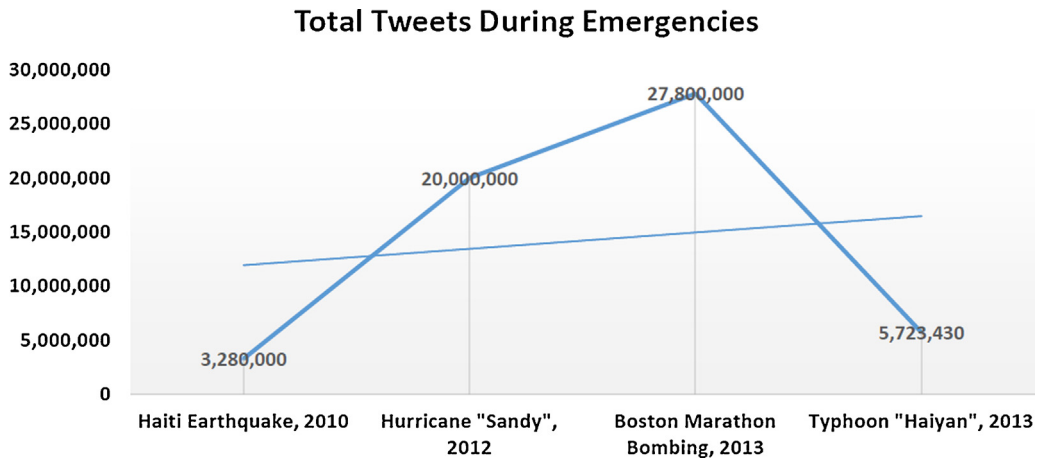

Fig. 1. Total number of tweets posted during emergencies between 2010 and 2013.

prior to an emergency to access information, but some adopt new ICTs during an event. The goal is not the utilization of the technology itself but rather how communities fulfill unmet needs through adaptation and innovative uses of ICT (Shklovski, Palen, & Sutton, 2008). ICT offers a means for those living under extreme circumstances to reconnect with other residents, solicit and aggregate information that affects them all. It has been implied that people have "found community" (though a virtual one) through the use of ICT, in which they actively seek others with similar needs and concerns regarding their geographical communities (Shklovski et al., 2008).

There are significant differences in the adoption of Facebook and Twitter in terms of usage, news consumption, demographics and the country. A Princeton led survey found that 70% of Facebook users receive their news from friends and family and 13% from news organizations. On Twitter, 36% of the users receive news from friends and family, while 27% from news organizations. The survey also found that despite the rise of news consumption through SM, it does not come at the expense of direct access to news sites. 71% of Facebook users and 76% of Twitter users still get news directly from news sites or apps (Mitchell, Rosenstiel, & Christian, 2012).

2.5. Remote islands of innovation

Media coverage of an affected area is not equal in all disasters; while central locations are widely covered; remote sites with inadequate access tend to receive little or no coverage at all (Fernando, 2010). The need for local and reliable information can motivate residents with technical skills to create simple solutions for their community, facilitate exchange of information and promote humanitarian relief efforts in their area. These actions can accelerate empowerment of the community, provide support during and between variable emergency events, serve as a communication platform during a specific emergency (Procopio & Procopio, 2007), and shut down not long after the emergency has subsided. The outcome depends on the maturity and experience of the community (Shklovski et al., 2008). If the public will not find or receive information from official sources, they will turn to unofficial sources in order to access it in real time (Hagar, 2013). Community solutions appeared almost immediately following the floods that were experienced in Australia during 2011. The local residents accessed community Facebook pages in order to assist their families and allow others to share photos. Though formal administrations integrated official information into their web pages, the most important source of information was accessed from local residents (Bird et al., 2012).

2.6. Recruiting the public

Once sources of information have been recognized, technologically competent residents in the disaster area are able to utilize a range of SM to redistribute information to community members who might not have the same access. These community mechanisms, information hubs and repositories of local information are available resulting from the common concern and joint actions of local area residents. Twitter users have frequently filled the function of information hubs following disasters (Hughes et al., 2008). The unidirectional communication and information distribution of emergency authorities might have 'compelled' the public to find alternative ways to search for and disseminate updated and relevant information regarding the event (Sutton, Palen, & Shklovski, 2008). People have reported feeling compelled to collect and disseminate information as a way of alleviating concerns of those around them (Shklovski et al., 2008; Bird et al., 2012). Using an online survey Bird et al., (2012) discovered that most people identified relevant community pages through friends' invitations, or a Facebook search. She also presented that two-thirds of the respondents accessed Facebook groups to find information regarding their own community. Taylor et al. (2012) claimed that the activity of people utilizing SM mirrors their actual needs, whether searching and seeking information about what was happening, or actively asking for information and providing assistance to others.

2.7. Crowdsourcing in disasters

The term "crowdsourcing" was first coined in 2006 referring to organizations outsourcing tasks to the connected crowd, irrelevant of their location or identity (Howe, 2006). It is also defined as an "online, distributed problem-solving and production model" (Brabham, 2008), allowing "capable crowds to participate in various tasks, from simply 'validating' a piece of information or photograph to complicated editing and management" (Gao, Barbier, & Goolsby, 2011).

Following the 2011 Haiti earthquake, an unprecedented activity was observed in which many communities world-wide understood that they did not need to be in Haiti physically, in order to provide assistance. Through common workgroups established in 2009, as CrisisCamps and CrisisCommons, civilians, NGOs, governments and private companies combined their efforts to collect massive amounts of data to create maps. These maps were disseminated directly to the Haitian government, emergency responders and the US Army that were on site (Zook, Graham, Shelton, & Gorman, 2010). Crowdsourcing was incorporated to the DM field

following the 2010 Haiti earthquake when Ushahidi's crowd-map[1] became a shared social disaster response tool for responders leveraging information from the "crowd" (Starbird, 2011; Abbasi et al., 2010). Crowdsourcing platforms enable the creation of different types of maps rapidly, thus facilitating the shift of existing limited resources to other tasks (Zook et al., 2010), as well as collection and analysis of information concerning damages in the area of the event (Yang et al., 2014). These platforms include two types of users – those located at the scene of the event (on-site) that perform rescue and management operations and need updated information, and remote users (off-site) that are able to perform different tasks in order to assist the on-site users, such as the information analysis and provision of updated information. This form of work may provide real-time or per-request information to the field emergency management personnel (Yang et al., 2014), and enable the creation of a virtual teams, or virtual operation support team (VOST), which can assist the response efforts (Denis, Hughes, & Palen, 2012).

2.8. Information categories

The public can assist during emergencies in classifying and sorting the large amounts of information flowing through SM, enabling simplification of its analysis and processing (White, Plotnick, Kushma, Hiltz, & Turoff, 2009). Information disseminating on SM can include updates regarding the writers' status, links to news sites, and emotional messages to those affected by the event, as well as humoristic messages (Skinner, 2013). Chew & Eysenbach, 2010 presented in their research that the public publishes 14 different types of information through SM – news, information or updates about the event; personal experiences; personal opinion and interest; jokes; marketing and advertising; spam and irrelevant information to the event; humor and sarcasm; joy; risk reduction; concern, fear, anxiety and/or sadness of the writers towards others; despair and anger; misinformation; and questions about the event/subject. Each piece of information on SM can be assigned to one or more categories as it includes both direct information derived from the text, as well as information derived from its analysis, such as the mood and attitude of the writer (Jansen et al., 2009). In contrast, another group of researchers (Imran, Elbassuoni, Castillo, Diaz, & Meier, 2013) stated that it is sufficient to divide the information during emergencies to two main categories – personal (relevant to family and friends of the writer) versus informative information (relevant to the public).

2.9. Location based information

Following a disaster, there is a significant demand and need for maps and spatial information, as presented after the Haiti earthquake in 2010. In order to implement an effective response, the emergency responders need to receive information as to the location of the afflicted population and how best to reach them promptly (Zook et al., 2010; Abbasi et al., 2010)

MacEachren et al. (2011) found that "social media is becoming increasingly geographic" and the potential use of this information in emergencies had been recognized by both academic institutions and the emergency organizations themselves (MacEachren et al., 2011; Palen & Liu, 2007).

Tweets and Facebook posts can provide two types of location based information. The first is Geo-location data which is clearly identifiable information that includes street addresses and intersections, city and county names, highways and place-names, whether precise or more general. This type of information not only aids those who access it, but also accommodates automatic retrieval of relevant information regarding a specific emergency event (MacEachren et al., 2011). The second type is Location-referencing which refers to information that uses one place as a replacement for another, or mention of location via a landmark. These do not contain easily extractable geo-location information, but rather data concerning the location of both individuals and the emergency (Vieweg et al., 2010). In events where the two types are not available, it is possible to extract the location of the user's residence from his personal profile, and assume that he publishes information from the same area. This assumption carries the risk of placing events in the wrong location, as the user might publish information while located in a different region/country completely (Earle, Bowden, & Guy, 2011; Hale et al., 2012). It was also found that analyzing tweets for geographic location according to language analysis is difficult, with low accuracy rates, and necessitates further research (Hale et al., 2012). The stage of emergency has an important effect on geo-location information, as during the initial warning/alert stage people do not as yet know the entities or locations that will be affected; these are crucial during the impact and recovery stages as there is a need for information regarding the locations of hazards, evacuation routes, availability of resources and efforts that are invested to manage the situation and provide relief to the population (Vieweg et al., 2010). There are numerous tools and platforms available that aim at locating, capturing and displaying geo-information based on SM (MacEachren et al., 2011). Social mapping platforms utilize crowdsourcing capabilities to map entire areas for roads, buildings and damage (Zook et al., 2010; Starbird, 2011). The resulting maps can be used to allow responding organizations to promote collaboration between them, share information and enhance coordination during implementation of their missions (Gao et al., 2011). Chatfield & Brajawidagda, 2012 presented that 47% of users included their location in tweets, a fact that enabled placing them on maps, while in the research of Vieweg et al. (2010) it was shown that the numbers are 40%. It seems that less and less users are adding their location to tweets, as can be seen in the research of Starbird, Muzny, & Palen (2012) where the numbers dropped to 0.23% out of all tweets. Hale et al. (2012) showed that approximately 16% of the users do not include information about their location in their personal profile. Local populations may recognize and refer to places and regions under different names, and in fact replace the official name with a known alternative. To resolve this issue researchers have developed an information system that analyzes information from Twitter in order to create a database of such names (Chan, Vasardani, & Winter, 2014). This information may assist emergency responders in identifying the places that the public uses without the need to mention the exact official address.

2.10. Information dissemination

In the traditional disaster management model, information flowed from emergency organizations to the public (Low et al., 2010). After analyzing millions of tweets Shklovski et al. (2008) extracted and coded situational features on Twitter communication elaborating the standard information categories of emergency management (warning, preparatory activity, fire line/hazard location, flood level, weather, visibility, road conditions, advice, evacuation information, volunteer information, animal management, and damage/injury reports). The incorporation of SM tools has changed the traditional information dissemination pathways during emergencies. Today there are many more information providers and a higher involvement of the public using official and unofficial sources (Zook et al., 2010).

[1] Ushaidi's platform is based on Web 2.0 technologies which handle data integration from a variety of social media sources using crowdsourcing techniques to (Denis et al., 2012) create SA reports and cooperation (Gao et al., 2011).

The mechanism for spreading information during different disasters is similar, namely, users watch their friends' activities or their reported behavior, and through messaging actions, they make this information visible to their own fans or followers (Lerman & Ghosh, 2010). In a survey conducted by Bird et al. (2012), 97% of the respondents claimed to have communicated and forwarded directly the information they accessed from Facebook pages to their family and friends. In some instances, reports issued through SM tools appeared much earlier than through the news channels (Qu, Huang, Zhang, & Zhang, 2011; Lerman & Ghosh, 2010). SM tools present an excellent mechanism for information dissemination. In Twitter, re-tweeting can cause an exponential proliferation and dissemination of the information (Tamura & Fukuda, 2011).

A government organization that wants to use social tools during a crisis to communicate with the public should first define its policies, receive the support of the managers, define what information should be shared and through which channels (Kavanaugh et al., 2011).

During the 2011 floods in Queensland and Victoria, Australia, Facebook became the primary tool to disseminate information to the public. In the 24 h following the flash floods, the number of 'likes' to the Queensland Police Service (QPS) Facebook page increased exponentially from 17,000 to 100,000, and two days later it had more than 160,000 'likes'. Traditional media channels, such as radio and TV, relied on the information posted on Facebook, and reported it within minutes after it was published on the QPS page (Bird et al., 2012). In a different study, Taylor et al. (2012) found that although SM are popular, people are still likely to turn to the television for emergency information. Nevertheless, the research also shows that SM serve as a conduit, directing people "to official sources of information and amplifying these messages to a broader audience" (Taylor et al., 2012).

2.11. Disinformation and inaccuracy

The identity of users and accuracy of the information they post on SM sites cannot be guaranteed (Merchant et al., 2011). During emergency events, individuals are exposed to large quantities of information without being aware of their validity or risk of misinformation (Lu & Yang, 2010).

Zook et al. (2010) wrote that for recovery operations following a disaster, only "Good enough" geographic information can be sufficient, and that crowdsourced information is as useful as information produced by an expert. Zook et al. (2010) added that "with enough people working together, any errors by one individual can easily be corrected by another" (Zook et al., 2010).

Even though rumors and inaccurate information can be disseminated during the peak of a disaster, users are usually swift to correct them, thus making the SM "self-regulating". More so, official authorities publish corrections to disinformation and rumors using their own SM sites (Bird et al., 2012). In their work, Mendoza, Poblete, & Castillo, 2010 followed the propagation 'confirmed truths' and 'false rumors' on Twitter after an earthquake in Chile. They found that approximately 95.5% of tweets validated the 'confirm truths', and only 29.8% validated the 'false rumors'; while more than 60% denied or questioned them (Mendoza et al., 2010). According to Taylor et al. (2012) research found that only a very small percentage (6%) of the population will rely solely on SM for information, resulting from their suspicion of the validity of information. It was also stated that in order to maintain integrity and trust, the administrators of the SM pages must identify and ban as early as possible 'trolls'[2] and other disturbances. It should though be taken under consideration that maintaining trust and rebutting misinformation, requires a high level of active management that can be challenging to community-based SM channels (Taylor et al., 2012).

In their research, Latonero & Shklovski, 2011 presented that validating information accessed from the public poses a big challenge to the emergency organizations that need to decide whether or not to commit resources, based on the information supplied. According to their findings, the emergency management professionals that review the SM must use intuition, experience and traditional means of communication rather than innovative technological solutions (Latonero & Shklovski, 2011). As the information flow increases, emergency authorities have less control over it, and might be pressured to validate and authenticate the information generated by the public (Zook et al., 2010)

2.12. Emergency responders and social media

Only limited scientific literature focus on emergency responders and their use of social media. Nonetheless, many researchers have noted the potential use of this media by emergency responders, and stated that if used, their ability to reach larger crowds faster will increase significantly (Denis et al., 2012). The London Police started using social media as an additional communication channel with the public during the riots of 2008 (Crump, 2011), and again in the riots of 2011 (Denef, Bayerl, & Kaptein, 2013). Since the 2010 earthquake in Haiti, emergency responders around the world have adopted social media as an important additional communication channel with the public (Bird et al., 2012; Sarcevic et al., 2012). Hurricane "Sandy" in 2012 was a turning point where the majority of emergency authorities and first responders from the East Coast in the United States adopted social media as the main communication channel with the public (2013). In Kenya, all of the first responder organizations use social media as the major communication channel with the public during emergencies, as manifested in the Westgate Mall terror attack in 2013 (Simon, Goldberg, Aharonson-Daniel, Leykin, & Adini, 2014).

Rapid assessment of critical information, such as the affected area, distribution of damage, locations of the population and potential areas where search and rescue missions are likely to be required, are of high priority in DM (Durham, Johari, & Bausch, 2008). Emergency authorities must verify the information they publish, so there is an eventual delay until it is delivered to the public (Bird et al., 2012), but it will be needed and requested on a near real-time basis (Zook et al., 2010).

The decision making process for official emergency response that is provided by the various organizations are part of the government's responsibility; political considerations may make large-scale adoption of technologies complex (Latonero & Shklovski, 2011).

Emergency authorities are often structured in hierarchical, rank-based organizations which operate according to specific "silos" with particular expertise, as described by Yates & Paquette, 2011. During the Haiti earthquake in 2010, the US Government and Armed Forces relied almost completely on organizational SM tools (Microsoft SharePoint) to coordinate knowledge and actions between cooperating response agencies (Yates & Paquette, 2011). The traditional risk and crisis communication was one-way from the emergency organizations to the public through the news media (TV and radio), acting as intermediaries. Although these channels remain the primary means of communication, integrating SM provides the potential for "interactive, participatory, synchronic, two-way communication" (Latonero & Shklovski, 2011; Palen & Liu, 2007).

A government organization that wants to use social tools during a crisis to communicate with the public should first define poli-

[2] A 'troll' is internet slang for those who provoke other users and disrupt discussion (Taylor et al., 2012).

cies, receive support of the management, define what information should be shared and through which channels (Kavanaugh et al., 2011).

It has been recommended that every organization utilizing technological solutions and integrating SM for emergency response, should incorporate professionals with Information Technology (IT) expertise, as Public Information Officers (PIO) and technology 'evangelists' (Latonero & Shklovski, 2011), SM moderators (Bird et al., 2012; Qu et al., 2011), or a Communications and Information Technology expert to configure SM tools (Yates & Paquette, 2011). Nevertheless, emergency managers also do not want to be distracted by too much information that might be irrelevant or not-critical (Bharosa et al., 2010).

Understanding the "overall picture" during a disaster may be difficult as the ever-growing information flow is being updated constantly, while large portions of it are redundant (Qu et al., 2011). Kavanaugh et al. (2011) stated that emergency managers can "detect meaningful patterns and trends in the stream of messages and information flow", and emergency events "can be identified as spikes in activity, while meaning can be deciphered through changes in content" (Kavanaugh et al., 2011).

2.12.1. Budget and training

Using SM entails two types of costs that should be considered. The first is the cost of training employees that will operate and publish information through SM tools, although it has been shown that most government employees have a profile on at least one SM tool. This might reduce costs and shorten training programmes. The second is more covert, referring to the return-on-investment (ROI) of using SM tools (Kavanaugh et al., 2011). Latonero & Shklovski, 2011 presented in their case study that emergency organizations leveraging SM do not train their PIOs, relying solely on their self-learning skills, and depending on "their ability to utilize social media effectively". Furthermore, Denef et al. (2013) stated that as SM are novel communication channels for the emergency responders and there are almost no available guides or procedures, they are required to practice their use. There are guiding principles that emergency organizations provide to their employees regarding the need to separate their personal profile from their organizational presence (Beneito-Montagut, Anson, Shaw, & Brewster, 2013).

To effectively use SM tools in disaster situations, they should be utilized by the involved parties during routine times and incorporated in daily activities. In the last three years, disaster simulation games were encouraged in order to test the ability to collect information from SM tools during different stages of a disaster. During these exercises, people posted messages through SM tools and took part in crowdsourcing tasks (Abbasi et al., 2010). Another exercise leveraged social media tools in response to an earthquake. The exercise was performed by actual first responders who used social media, on top of in addition to conventional communication technologies, to improve their search and rescue operations (Simon, Adini, El-Hadid, & Aharonson-Daniel, 2013). In the last few years, the organizers of the Great California Shakeout Drill have used social media to enhance communications prior to and during the drill, as well as to extract feedback from participants. The use of social media enables the organizers to reduce the number of resources required (Wood & Glik, 2013).

2.13. Challenges to data analysis

On August 22nd, 2012 Facebook revealed some statistics regarding its daily information flow. Facebook ingests daily more than 500 terabytes of data, 2.5 billion pieces of content, 2.7 billion 'likes' and 300 million photo uploads (Constine, 2012). Twitter has more than 400 million tweets daily, and above 140 million active users, most of which use Twitter via mobile devices (Farber, 2012). SM sites constantly produce vast amounts of information, both relevant and irrelevant. Using filtering and pattern recognition on the data streams, emergency managers can access important and meaningful information in real-time, and be able to provide an immediate response, and understand events as they unfold (Abbasi et al., 2010; Kavanaugh et al., 2011; Sheth, Purohit, Jadhav, Kapanipathi, & Chen, 2011). Over time, the detected patterns can provide responders with perceptions and trends of communities. Conducting surveys via phone or mail requires substantial efforts prior to and during data collection, as well as substantial funding. Analyzing the results often takes months to complete. Information flow through social tools is a much more effective and economical method to gather data in real time. In 2009 the American Red Cross conducted a survey which presented that 75% of the population reported that they will use SM during a crisis situation; approximately 50% would let others know that they were safe through SM; 86% would use Facebook; and 28% would use Twitter (Kavanaugh et al., 2011).

Studying Twitter communication during emergency events is challenging as access to tweets is short-lived, requiring quick decisions regarding what information to collect while the event is still in progress, but before its scope and data produced are fully understood (Vieweg et al., 2010).

SM sites continuously create large amounts of information with different degrees of relevancy. For example, during hurricane "Sandy", approximately 20 million tweets were published on Twitter, and about 10 photos related to the storm were uploaded to instagram every second. Numerous entities, both official and non-official, publish information simultaneously, including civilians, government or private organizations, journalists, news sites and others that create an information overload during emergencies, making it difficult to find, organize, understand and act upon it (Hagar, 2013; Verma et al., 2011; Kavanaugh et al., 2011).

Approximately 300 million users publish hundreds of millions of tweets daily (Hale et al., 2012). Manual analysis on such amounts of information is not possible, especially in times of stress during emergency management, and thus automated systems that enable real-time monitoring of the flow of information are required (Pohl, Bouchachia, & Hellwagner, 2012). At the same time, there is a need to prevent cognitive overload of the commanders and decision makers by flooding them with such unlimited information (Blum, Eichhorn, Smith, Sterle-Contala, & Cooperstock, 2013). The writing style of tweets, due to the length constraints and the use of natural language, complicates the automatic analysis capabilities, such as different names people assign to events and locations (Chan et al., 2014).

2.14. Global social sensors

SM that connect millions of users worldwide and enables rapid communications can be leveraged as an effective mechanism to transfer information without delay (Chatfield & Brajawidagda, 2012). Furthermore, the internet and SM tools enable health professionals to transform the ways in which disease outbreaks and other disasters are tracked and responded to (Schmidt, 2012; Cookson et al., 2008). It was even shown that using Twitter, H1N1 outbreaks and activity can be identified in real-time, 1-2 weeks prior to detection based on the Centers for Disease Control and Prevention's (CDC) surveillance system (Signorini, Segre, & Polgreen, 2011).

The US Geological Survey (USGS) has reported that 75% of earthquake detections through tracking tweets containing the word "earthquake" were made within 2 min of the origin time. This represents a much faster identification than seismographic detections in many regions in the world, and has a low rate of false triggers (Earle et al., 2011).

The first indication of a number of emergencies throughout the world was published on Twitter, which enabled the publication of information to large crowds in real time. The World's first posts on two terrorist incidents in 2013 were published initially via Twitter: the Boston Marathon bombing (Cassa, Chunara, Mandl, & Brownstein, 2013), and the Westgate mall terror attack in Nairobi, Kenya (Simon et al., 2014).

On August 8th, 2014 the World Health Organization (WHO) declared the Ebola epidemic outbreak in West Africa as an international emergency (WHO, 2014). From reading traditional media websites, it is clear that social media takes an active and important role, whether in the dissemination of news and information by government agencies (Murphy, 2014), and in the spread of rumors and misinformation that might even put the lives of their readers at risk (Blair, 2014). Crowdsourcing platforms are also active in tracking the Ebola outbreak on social media, and assist in locating suspected Ebola cases (Morgan, 2014). The research papers that have been published to date, focus mainly on the risks of rumors and misinformation spreading on Twitter (Oyeyemi, Gabarron, & Wynn, 2014).

3. Conclusions

SM tools are integrated in most parts of our daily lives, as citizens, netizens, researchers or emergency responders. Lessons learnt from disasters and emergencies that occurred globally in the last few years have shown that SM tools may serve as an integral and significant component of crisis response.

Emergency managers who were formerly used to one-directional dissemination of information to the population are now exposed to vast amounts of information, originating from the public. This crowd-information precedes any other formal available information and exposes emergency managers to a large influx of information.

The innovative usages of SM tools during disasters were initiated by resourceful individuals and then incorporated by the public for their own objectives. During and mostly after a disaster, new ways of utilizing SM tools to collect, share, and disseminate information, were witnessed. Emergency authorities, NGOs and governments were "coerced" by the public's demands and needs to use the SM. Researchers from different academic professions, such as sociology, psychology, computer sciences, health sciences, emergency management and communication strive to develop new tools to analyze trends in the extensive data flows and transform them into knowledge.

Four main types of SM users during disasters have been identified including: (1) Innovative – users who improve and adjust SM for their special circumstances; (2) Reactive – users who try to respond and assist the afflicted population using SM tools for the first time; (3) Responsive – emergency responders that use SM tools regularly, but step-up and leverage them during disasters; (4) Proactive – users or emergency organizations that use SM tools to promote preparedness in routine and are able to leverage them during emergencies.

Twitter is currently the most widely researched SM tool, probably due to the ease of extracting information, while Facebook does not provide an effective option to search or collect information from its pages. These differences might cause a "selection bias" in the research, thus not representing the population's true SM behavior during emergencies.

Further studies of the potential utilization of the social media by first responders and governmental agencies prior to and during disasters, are highly recommended.

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