Emergency Messaging with Social Media

Engineering & Public Policy Project
and
Social & Decision Sciences Senior Policy Analysis Project Report

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Disclaimer and Explanatory Note

Please do not cite or quote this report, or any portion thereof, as an official Carnegie Mellon University report or document. As a student project, it has not been subjected to the required level of critical review.

This report presents the results of a one-semester university project involving 22 undergraduate students from the Department of Engineering and Public Policy, the Department of Social and Decision Sciences, and H. John Heinz III School of Public Policy and Management at Carnegie Mellon University. In completing this project, students contributed skills from their individual disciplines and gained experience in solving problems that require interdisciplinary cooperation. The project was managed by graduate students and monitored by faculty advisors. An advisory panel of academic and industry experts provided suggestions, information, and expertise.

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Abstract

Social media serves as a tool in emergency messaging, but typically not a primary tool. As a tool in emergency messaging, it serves as a method to distribute pieces of information to a large population very quickly, but is not used as a primary alert system in emergencies. Traditional systems are still more effective in providing emergency alerts to the general public. Social media is used as a supplementary alert distribution method along with traditional emergency messaging systems like phone calls, radio, and television broadcasts.

A variety of social media are used in emergency messaging, but certain social media tools are more effective in emergency messaging depending on the state of an emergency. Before emergencies occur, social media sites like YouTube and Facebook are particularly useful in educating populations and preparing people for potential emergency situations. During an emergency, Twitter, Facebook, and SMS texting are seen as important supplementary tools in distributing alerts and instructions along with traditional legacy emergency messaging systems like phone calls, radio, and television broadcasts. After an emergency, Facebook and Twitter sites become particularly useful for people to communicate with one another and reach those who may have been affected in emergency situations.

1 Introduction

Facebook, Twitter, Google +, YouTube videos, blogs, and other forms of social media are becoming prevalent around the world. These classically defined social media are providing new outlets for information dissemination that have never existed before. With the advent of a society that is quickly becoming fluent in social media, information flow is nearly instantaneous and can update thousands, even millions of people in a few seconds. Although social media is currently used in an informal way to keep friends and families close over long distances, it also serves other purposes. Rebellions and protests have been organized, curious employers have begun performing background research on potential hires, and governments have been using social media to help locate potential problems. Intended or not, social media has evolved into a powerful and influential tool.

This paper explores a very specific usage for social media in society – as a tool in emergency messaging. Emergency messaging and management provides invaluable service to people all over the world. It is primarily responsible for providing information concerning disaster warnings and relief efforts to the people in distress and to emergency management organizations such as police, firefighters, and medical workers. In an attempt to tackle the question of how social media can be implemented as an emergency messaging conduit, the class was divided into three groups that investigated the role of social media in emergency situations from three different perspectives. While the groups have taken distinct approaches with various objectives, the combined data analysis suggests recurring themes. The knowledge gained from the present research provides insights into how social media may be used effectively to assist emergency messaging.

2 Social Media for Emergency Communications: The Emergency Responders' and Managers' Perspective

2.1 Introduction: Current Social Media Use in Emergencies

We interviewed staff members of emergency management and response organizations to ask how social media tools are used for information distribution ("push") and collection ("pull") during an emergency, and how government policies and regulations influence their usefulness. The report covers emergency management organizations for educational institutions, cities, regions, federal agencies, and non-governmental organizations (NGOs) in the United States. The majority of these authorities, other than the NGOs, considers social media as a supplementary tool of traditional communications methods, and do not see it as a substitute.

2.2 Literature Review: Current Use

2.2.1 Emergency Messaging at the College Campus Level

Social media is used by a majority of college students on a daily basis. Additionally, many universities are represented on online social media networks. For the purposes of gathering preliminary information, this literature review focuses on two universities in the United States: Carnegie Mellon University and Virginia Tech. Carnegie Mellon University was chosen because of its proximity. Virginia Tech was chosen because of the school's recent school shootings, and the use of social media in those incidents. Carnegie Mellon is a private school with a small campus, which is different than Virginia Tech, which is much larger and a public institution.

Carnegie Mellon University in Pittsburgh, Pennsylvania is active on multiple online social media networks: Facebook, Twitter, LinkedIn, YouTube and others. The University's website specifies that their presence on social media is to allow people to connect with classmates, be informed of social events or watch lectures (CMU Social Media, 2012). Online social media gives the university a platform with which to push information to students. Similarly, Virginia Tech has a presence on social media networks such as Facebook Twitter, YouTube and Foursquare (Virginia Tech Emergency Action Plan, 2012). Virginia Tech lists similar reasons for their

presence on online social media networks. Both universities do not use social media for emergency communications, and have other emergency communication methods.

Both Carnegie Mellon and Virginia Tech have “opt-in” text message (SMS) and email emergency alert systems. The “opt-in” plan allows students, faculty and staff to sign up for a voice, text, or both, alerts about “urgent news concerning the health and welfare of Carnegie Mellon students, faculty and staff” on their cell phones (CMU Privacy Policy, 2012). To send alerts, an authorized Carnegie Mellon staff member must activate the system, which is the only one in existence on Carnegie Mellon’s campus. Comparatively, Virginia Tech’s emergency notification system includes text message alerts, email alerts, and updates to the school’s website.

Virginia Tech used their emergency alert system during two campus shootings, first in 2007, and again in 2011. During the 2007 shooting, the school emailed students about the incident. Although studies have shown that students prefer email as a means of communication, it is unrealistic to assume students will be able to log onto their email accounts during a crisis (Mastrodicasa, 2008). During the 2011 shooting, the school distributed information through their website; however, due to an influx of people trying to gather information, the site crashed. The school then turned to their Facebook page to reach a wide audience (Page, 2011). Students also used social media to notify each other that they were safe, and to identify people that were missing.

Federal investigations in the aftermath of the two Virginia Tech shootings revealed how information can be pulled from social media. A report titled “Collective Intelligence in Disaster: An Examination of the Phenomenon in the Aftermath of the 2007 Virginia Tech Shooting” notes that “Universities are not necessarily the organizations pulling information off of Facebook, but rather students and other community members [are] pulling it from each other, as seen in the Virginia Tech Shootings” (Vieweg et al., 2008). After the Virginia Tech crisis, students made over 500 Facebook groups for community mourning and to let others know they were safe (Mastrodicasa, 2008).

Online social media additionally allows citizens to collectively gather information about an incident, sometimes well ahead of emergency officials. A report on the 2007 Virginia Tech shootings details how students were collectively able, with “socially-produced accuracy,” to list the names all of those who had died during the shooting attacks (Vieweg et al., 2008).

2.2.2 Emergency Messaging at the City Level

This literature review section focuses on the cities of New Orleans, Louisiana; Boulder, Colorado; and Pittsburgh, Pennsylvania, representing a range of sizes and locations. City-level government coordinates with both regional and national emergency management entities. For example, the Boulder Office of Emergency Management states their goal is to “[coordinate] with

state and federal partners, many city and county departments, public safety agencies, municipalities, non-governmental organizations and private businesses throughout Boulder County in order to facilitate coordinated planning and response to emergency situations" (Boulder Office of Emergency Management, 2012). Other city-level governments also highlight their role as a coordination center in times of crisis (The City of New Orleans: Emergency Preparedness Home, 2012). This is a natural role that cities play, especially in crises that require assistance from state and federal agencies. Depending on the type and scale of a crisis, city agencies may coordinate with other groups at the state level, such as the state National Guard or Governor's office, or groups at the federal level, such as the Federal Emergency Management Agency. The role other agencies play can range from providing funds to coordinating inter-state responses, again depending on the scope of the crisis.

Cities typically utilize online social media as an information push tool, in addition to traditional methods of contact, such as TV and radio. The Pittsburgh Office of Public Safety offers email alerts in emergencies (Pittsburgh Emergency Alerts, 2012) and New Orleans offers text message alerts in emergencies (NOLA Ready, 2012). These are opt-in services. Many cities have a Twitter or Facebook page, which are opt-in, where residents can follow emergency alerts. This is an attempt by city officials to inform their residents on whichever platform the resident prefers.

After searching the publicly available information on city-level crisis response institutions, no information could be found, for the cities that were mentioned, regarding any meaningful collection of information through online social networks.

2.2.3 Emergency Messaging at the Regional Level

In order to analyze the emergency management capabilities of different states around the country, five geographically dissimilar states were chosen, Pennsylvania, Colorado, Louisiana, Oregon, and California. These states collectively experience a wide range of emergencies caused by both anthropogenic and natural disasters. The Federal Communications Commission (FCC) has outlined regulations and guidelines for state governments to follow (FCC, 2012). States are required to follow the federal Emergency Alert System (EAS) but retain the ability to create a more robust system (CalEMA State Plan, 2009). While States follow the federal EAS, their organization can vary from which office follows the guidelines. Some such examples include a state level Departments of Emergency Management, Departments of Public Safety, Department of Military Affairs, and Departments of Homeland Security (State Offices and Agencies of Emergency Management, 2012).

The state of Pennsylvania has several different methods to alert residents in times of disaster. The state has built a comprehensive Emergency Alert System, which includes a satellite-based "EMnet EAS System" to relay emergency alerts to county television and radio stations licensed with the FCC. EMnet is primarily used to push information to the public in order to help provide instructions during disaster situations. The EMnet satellite system allows alerts to be given to

certain areas within PA to assist the current EAS and 9-1-1 centers (Warnings and Communication Systems, 2012). Unlike most systems, EMnet is capable of sending text-based as well as audio-based messages. The network can also deliver messages to specific radio and television stations for targeted emergency alerts. As of 2012, EMnet had 362 terminals, including 214 broadcast stations and 62 cable networks, for support and monitoring of emergency situations throughout Pennsylvania (Warnings and Communication Systems, 2012). The State is also exploring the integrations of social media for alert situations in the EMnet system. (Warnings and Communication Systems, 2012)

California is an example of a state that has used the FCC EAS guidelines and expanded upon them to better serve statewide emergency management. The state has developed the California Emergency Services Act (ESA) and the California Emergency Management Agency (CalEMA). Both serve to organize California's emergency response efficiently and distribute alerts as quickly as possible (CalEMA State Plan, 2009). Additionally, CalEMA is investigating the implementation of a Commercial Mobile Alert System (CMAS) that will be able to send alerts out via mobile phones (CalEMA Alert and Warning, 2008).

Colorado, Oregon, and Louisiana all have similar emergency management communication procedures along with the EAS system outlined by the FCC. These states split into districts to distribute emergency alert responsibilities (Louisiana, 2009: Wilson, 2010: Murray 2012). Federal regulations require that both radio and television frequencies be available for statewide EAS alerts (Lucia, 2002). However, these communication infrastructures are vulnerable since power lines, radio towers, and television broadcast towers are often destroyed or decommissioned during natural disasters. Currently, alerts are not always effectively disseminated during weather-related power outages, for example in hurricane prone areas of Louisiana (Louisiana, 2009: FCC, 2012).

The current EAS systems adopted by Colorado, Oregon, and Louisiana can pull emergency information from individual districts in the states concerning potential earthquakes, extreme weather conditions, and possible threats to homeland security. Each state has its own distribution station prepared to receive information from these agencies. Each state's distribution station is then responsible for sending the alert to affected districts or the entire state if necessary. Depending on the emergency, "messages may be initiated by either the Parish or state emergency management organizations" (Louisiana, 2009).

In all 5 states, the governor is relayed information concerning emergency warnings or alerts from the National Oceanic and Atmospheric Association, National Weather Service stations, United States Geological Survey earthquake detection centers, and/or other national organizations. This information is typically coded in an easily transmitted form that can quickly convey what the emergency is, where it originated, who sent the message, and when it was sent. The Governor's office and/or statewide Emergency Alert Center are then charged with the dissemination of a full

alert through available media and the current EAS system (Lucia 2002: CalEMA State Plan, 2009: Pennsylvania Emergency Alert, 2011: Louisiana, 2012: Murray, 2012).

Some states have well-planned methods of information distribution to all levels of state and local governments, like California. Others, such as Colorado, push alerts out to as many people as quickly as possible. States like Pennsylvania and California are also currently exploring ways to distribute statewide emergency alerts using new technologies like cell phones to potentially reach a larger fraction of the population faster (Warnings and Communication Systems, 2012).

2.2.4 Emergency Messaging at the National Level

We define the national level as being comprised of federal agencies and departments. Federal agencies and departments tend to use social media to make certain information readily available. While these agencies do not heavily rely on social media during a crisis situation, they have plans to integrate social media as additional methods of distributing information during crises.

The Department of Homeland Security (DHS), the U.S. Coast Guard, U.S. Citizenship and Immigration Services, U.S. Customs and Border Protection, Citizen Corps, Federal Emergency Management Association (FEMA) and Transportation Security Administration, relay information and services through communications channels such as Facebook, Flickr, iTunes, Twitter, and YouTube. The DHS website shows that the department and its related agencies use social media as tools for information push. However, the website does not give much information on the engagement of these agencies in information pull (DHS Website, 2012). An online privacy group, Electronic Privacy Information Center (EPIC), is suing DHS for not following through on EPIC's request of DHS records on the agency's social network monitoring program (Katrandjian, 2011). The implications of current government use of social media with regard to privacy are an area that requires further research.

FEMA primarily uses opt-in text messaging capabilities, smart phone applications, blogs, widgets, and RSS/Data feeds, which allow users to share and view data feeds from various news sources, to provide information to the public about preparedness, disaster updates, and response. Additionally, FEMA started using Twitter, YouTube and Facebook in 2008-2009 to share information about disaster response, recovery efforts, and how different federal aid programs work. FEMA also has a "Challenge.gov" website which allows the public to respond and submit solutions to various challenges posted by FEMA and government agencies (Federal Emergency Management Agency, 2012). FEMA's regional Twitter account relays information about where to get more information during times of emergency (Federal Emergency Management Agency, 2012).

While the FEMA EAS works with officials at all levels of government, the EAS was originally designed for presidential messages to be received by FEMA's "followers" on social

networks. New usage ideas include "[creating] a public registry of photos of physically damaged property with geographic tagging" (McDonald, 2007) to identify needed repairs after the disaster and to push information to disaster victims about weather patterns via cell-phones similar to Twitter (McDonald, 2007 and Treadgold, 2007).

FEMA also uses the Integrated Public Alert and Warning Systems (IPAWS) as a "technical and operational interface between public safety/alert authorities and participating carriers with IPAWS OPEN authenticating alerting authorities" (FEMA website, 2012). IPAWS facilitates message aggregation, geo-targeting, and exchange of non-voice communications. Additionally, it consists of IPAWS OPEN web services and Primary Entry Point Expansion (PEP), which provide information for emergency management in order to coordinate between alerting authorities and responders before the public alert is distributed (Federal Emergency Management Agency, 2011). The Commercial Mobile Alert System (CMAS), FEMA, and wireless carriers use IPAWS OPEN to send three types of alerts: presidential messages, AMBER alerts, and imminent threats. However, participation is voluntary for the latter two.

Tyshchuk et al. detailed how government agencies and emergency management agencies such as FEMA, the Department of Justice, the Department of Homeland Security, and FBI use social media (Tyshchuk et al., 2012). According to the authors, FEMA and the FBI use Twitter mainly for keeping the public informed of current events. Twitter is also used to publish information that is not necessarily related to an emergency but is useful for learning more about the organization.

Dozier, an Associated Press correspondent, was able to go within a CIA facility to learn about the CIA's data mining of Facebook, Twitter, TV, radio, and other media. According to the CIA, OSNs (Online Social Network) are very useful in determining social opinion about many world events (Siegel, 2011 and Dozier, 2011). This data mining is highly guarded and very helpful for the understanding and accumulation of knowledge as it relates to different countries and cultures (Dozier, 2011). However, the major challenge is the validation of information. Dozier is concerned about the ability to keep the social media accounts private and saving them from hacking. He also observes that there is no real way to verify the authenticity of a post.

The CIA and the FBI seem dedicated to utilizing social networks for data collection. On January 19, 2011, the FBI released a document asking companies to create a system to pull public data from social networks, specifically Twitter and Facebook for news of interest (Giles, 2012). Bruce Lindsay discusses not only the implementation of such a plan, but the security and privacy needed to complete it (Lindsay, 2012). He also talks about current usage of social media and how governments could and should be using it as emergency responders. While it seems as though the FBI and CIA are trying to make this happen indirectly and without the user knowing it, Lindsay seems to think that a separate entity, which would directly connect clients to first responders, would be beneficial.

2.2.5 Emergency Messaging at the NGO Level

NGOs have started to be active in using social media in emergency situations in vastly differing ways, according to the literature found on this topic. Specifically, at the American Red Cross's website, people can register as "Safe and Well" or "Search Registrants" (American Red Cross, 2012). People registered as "Safe and Well" report on the Red Cross's website as being safe and unharmed. Specifics about their condition and those around them are searchable, allowing people see if family and friends are safe. However, the American Red Cross claims no responsibility for the authenticity of those messages and encourages users to dial 911 in case of emergencies (American Red Cross, 2012).

Gavin Treadgold's blog on Social Networking and Disaster Response discusses how NGOs like American Red Cross can expand the social networking to receive more accurate information (Treadgold, 2007). One suggestion was to "create geo-tagged photo groups to document damage" which would help the American Red Cross not only to know if the person responding is alright but would also help to monitor the condition of the disaster. The suggestions of connecting volunteers to those in need during a disaster and to pinpoint where those in need are located are ideas to expand the reach of social media in disaster situations.

An organization that has begun to capitalize on the use of social media is Humanity Road. On their "About Us" page, the organization specifically mentions using mobile communications in disasters. "Humanity Road's mission is to educate the public before, during and after disasters on how to survive, sustain and reunite with loved ones. Humanity Road volunteers are trained to use Internet and mobile communications technology to collect, verify and route information online during sudden onset disaster" (Humanity Road, Inc., 2011). Humanity Road is a volunteer organization that helps to enable people that already use social media become involved in their mission. Their main goal is to do crisis mapping through social media. Some examples of how they help in disasters are: Translating rescue phrases from English to Creole and English to Spanish; collecting, confirming and routing urgent needs to aid agencies and first responders; providing information to the public on where to find shelter and/or apply for aid; guidelines for tweeting during disaster and using the phone during disaster; and standard safety messages on what actions to take before, during and after disaster. In 2010, Humanity Road responded to events in 33 U.S. states and territories and 73 events worldwide (Humanity Road, Inc., 2011).

2.3 Methodology

In order to assess the current state of social media's role in emergency response in the United States we interviewed emergency response personnel from college campuses, city and local area authorities including first responders, state emergency response agencies, federal government agencies and large, nation-wide non-governmental agencies. In this section we report the current uses of social media in emergency response agencies at different levels of government and for NGOs.

Interviews were conducted using Skype© software. This allowed for phone interviews to be conducted with the ability to record the conversations for reference. To establish contact with each interviewee we used the introductory email shown in Appendix A.

Interviews were conducted following the interview script shown in Appendix B.[1] For respondents who were not available for a phone interview, the questionnaire was distributed through email.

Using source information obtained from a literature review and interviews with high-profile individuals currently employed in emergency management positions; an overview of social media's potential and current usage in emergency management was formulated. Table 1 below shows the interview respondents.

TABLE 2.3.1 – INTERVIEW RESPONDENTS

Interviews		
Name	**Organization**	**Title**
Educational Institutions		
Madelyn Miller	Carnegie Mellon University	Director of Environmental Health and Safety Department Director
Michael Mulhare	Virginia Tech University	Director of Emergency Management
Mark Bagby	Washington University of St. Louis University	Emergency Management Coordinator
Dave Bujak	Florida State University	Emergency Management Coordinator
City Organizations		
Mike McNutt	Department of Public Health, Columbus, OH	Public Relations Specialist for Center for Epidemiology, Preparedness and Response
James J. Stamatelos	City of Pittsburgh Emergency Management & Homeland Security	Emergency Management Specialist/Planner
Regional Organizations		
John Eline	Adams County, PA	Director of Department of Emergency Services
John Ambrusch	Bradford County, PA	Acting Emergency Management Coordinator of Department of Emergency Services
Mark Brammell	Westmoreland County, PA	Acting Director of Department of Public Safety
Mike McGrady	National Emergency Number Association	Chairman of Pennsylvania Chapter
Ronald Springer	Cambria County, PA	County Coordinator for Department of Emergency Services
Randall Gockley	Lancaster County, PA	Director of Emergency Management Agency
Cpt. Tommy Boyett	West Feliciana Parish, LA	Director of Office of Homeland Security and Emergency Preparedness

[1] The Internal Review Board at Carnegie Mellon University approved both the interview script and email.

Nick Piatek	State of New Mexico	Public Information Officer
Lisa Jatak	State of Georgia	Office of Emergency Management
Federal Organizations and Non-Government Organizations		
Koji Kadama	Texas Voluntary Organizations Active in Disaster	Communications Director
Liz Disco-Shearer	Texas Voluntary Organizations Active in Disaster	President
James Rollins	United Methodist Committee on Relief	Director of Marketing and Communications
Ivey West	Mercy Medical Airlift	Assistant to President/CEO
Megan Zabel Holmes	Mercy Corps (Portland, OR)	Online Marketing Officer
Charles B. Henderson	Society of Saint Vincent de Paul	National Communications Manager
Kelly Janowski	Lions Club International	Communications Specialist of Department of Public Relations and Communications
Chris Thompson	Humanity Road	President
Mickey Gomez	Virginia Voluntary Organizations Active in Disasters	Executive Director
Wendy Harman	American Red Cross	Director, Social Strategy
Savanna Brehmer	Federal Emergency Management Agency	Region 1 External Affairs Web Content Manager

2.4 Results

2.4.1 College Campus Level

The benefit of social media for emergency management on college campuses is hard to determine. While many students, faculty, and staff are active on social media, the online networks may not be the best way for officials to distribute information. The general consensus is that social media networks, primarily Facebook and Twitter, are useful as supplementary tools for emergency management, but could not serve as the primary method of distributing information. Figure 2.4.1 below shows the distribution of which social media are used for emergency management by colleges.

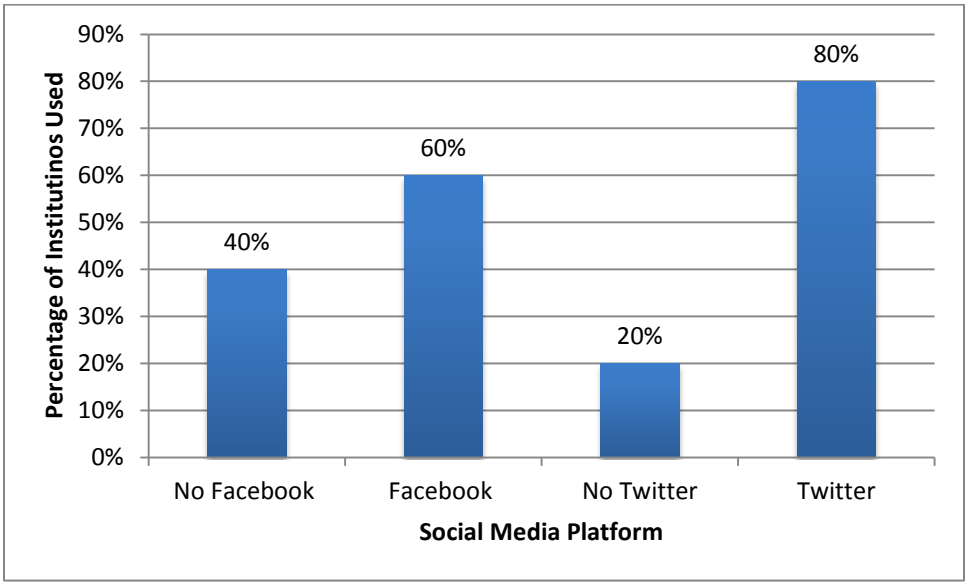

FIGURE 2.4.1: FACEBOOK AND TWITTER USAGE AT INTERVIEWED COLLEGES

Universities use multi-system approaches to their emergency management systems. Multi-system approaches allow for information to be dispersed as quickly as possible to the greatest number of people. Carnegie Mellon University, Virginia Tech University, Washington University in St. Louis, Florida State University and University of Texas at Austin all use SMS (text messaging) and email notifications in the event on an emergency. All of the schools, except for Carnegie Mellon University, also use alert systems such as outdoor and indoor sirens, desktop takeovers and public announcement systems. The benefit of the latter systems is that even those not subscribed to the SMS and email alerts, are still notified of an emergency. Another advantage of the multi-system approach is that even if one pathway fails, other methods of distributing information will suffice.

Whether or not the university has an “opt-in” or “forced-choice” system plays a huge role in how many people receive emergency alerts. An “opt-in” system requires subscribers to sign up to receive alerts on their own. By contrast, the “forced-choice” system requires subscribers to decide whether or not they want to subscribe to the system before they are able to complete a task such as registering for classes. Madelyn Miller, Director of Environmental Health and Safety at Carnegie Mellon reported that only about 60% of all students, faculty and staff on campus are subscribed to the “opt-in” SMS and email alerts. By contrast, Mark Bagby, Emergency Management Coordinator at Washington University in St. Louis, reported that 99% of people on campus are subscribed to their “forced-choice” system. Of the five schools within the scope of this study, only Carnegie Mellon University has an “opt-in” system.

A primary apprehension voiced about social media usage for emergency management is that OSN are all opt-in, and people cannot be required to use the networks, nor subscribe to the

appropriate pages. As a result, social media does not necessarily allow emergency management offices to reach more people.

Although online social networks are voluntary and participation may not be as high as desired, there may still be benefits to social media as an emergency management tool as opposed to legacy systems. One advantage of social media networks is that the systems are useful not just for pushing information, but for gathering information from related and relevant organizations as well. David Bujak from Florida State University said that he spends about an hour of his work day scanning his Facebook newsfeed for information from other organizations that may be relevant to students at Florida State. Bujak also noted that if he finds pertinent information, he shares the information on his page. Social media websites can also be used as an education tool. The FSUAlerts Facebook and Twitter pages also educated students about environmental safety, such as forest fires. Bujak noted that for social media networks to be successful and gain subscribers, they have to offer the subscribers information even when there is no alert. Otherwise, the sites lose relevance.

Although the niche for official social media networks in emergency management systems is uncertain, social media sites have been particularly useful for grassroots organization. As noted in the previous section, Virginia Tech students used Facebook during both the 2007 and 2011 school shootings to notify fellow students of their situations. A more recent example of grassroots organizing on social media networks is during the University of Pittsburgh's recent string over 100 bomb threats received in less than a month. As a means to collect and distribute information about the threats, Andrew Doe started a blog on Blogspot.com (stopthepittbombthreats.blogspot.com). The blog distributes information detailing the bomb threats, including how they were sent (email, phone call, hand written etc.), which buildings the threats were for, and what time of day the threats were received.

The blog was a means to disseminate information, at times faster than the official sources of the University of Pittsburgh. Doe attributes the speed at which he was able to collect and distribute information to the GoogleDoc that he set up in conjunction to the blog, which was constantly being updated by other people. Doe's main goal of the blog was to crowd source information about the bomb threats, and "provide information that might assist in flushing out the perpetrator" (Doe, 2012). Doe provides primarily "analytic observations" about what time the threats happen, and which buildings the threats are being sent to, with the hope of finding patterns.

The success of Andrew Doe's blog (over 850,000 views), sheds light on the success of non-traditional social media platforms (i.e. not Facebook or Twitter). Doe believes that BlogSpot was the best place to distribute information because the platform allows for information to be collected, analyzed and distributed very quickly. From Doe's perspective, Facebook and Twitter cannot be used for this kind of work because Facebook is better suited for sharing photos and

Twitter is a “non-stop information flow” (Doe, 2012). Blogs, on the other hand, provide a solid and constant platform for distributing data.

Despite the benefits of grassroots organization, there are challenges associated with using social media. David Bujak noted that in order for social media to stay relevant, the sites must remain social, that is allowing people to partake in conversations and comment online. However, by doing so, organizations must commit to monitoring the sites and quelling rumors if necessary. Many times, this requires an additional employee to manage all social media networks, which colleges may not have the funds for.

Even non-official pages, such as Andrew Doe’s blog require some level of moderation. Though Doe originally started the blog, he recruited a moderator to monitor the comments section. The comments on the blog came from three parties: students, parents and others in the community. The comments gave insight into the emotional state of all three of the aforementioned stakeholders.

College campus emergency managers did not express any policy or regulatory concerns with using social media. Madelyn Miller of Carnegie Mellon noted that she would expect students at CMU to be apprehensive about subscribing to the school’s Facebook page, because they would fear the school would start monitoring their pages. David Bujak at Florida State University said that while students subscribe to the FSUAlerts Facebook page, he does not monitor student’s Facebook pages.

Andrew Doe predicts that so many students and parents turned to his blog for information because the University of Pittsburgh did not distribute much information. Doe hypothesized that the University had regulations that required them to keep their lips sealed in this situation; so social media was the best way to get information distributed. He also noted that news sources, such as the Pittsburgh Post-Gazette and the Pittsburgh Tribune, faced ethical challenges when reporting on the bomb threats because their employees received some of the threats themselves (Doe, 2012). Though none of these ethical dilemmas seriously impeded what Doe was able to publish on his blog, he did express slight apprehension that perhaps his blog was helping the perpetrator. Some commenters noted that the perpetrator targeted the buildings that were mentioned in the comments section of the blog.

While online social media networks can be useful for grass-root organization, a few obstacles hinder the growth of these networks. First, universities currently have no way to mandate that students be active on social networks, nor can schools mandate that students subscribe to the alerts page. Looking forward, universities would need to develop a policy or initiative to change this status quo.

TABLE 2.4.1: KEY FINDINGS FROM COLLEGE LEVEL INTERVIEWS

Purpose for using Social Media	• Used for alerts and education • Offered as a place for students to interact
Information Push	• Primarily use Facebook and Twitter • Some YouTube use
Information Pull	• Follow important contacts on Facebook and Twitter • Do not follow, or cannot speak to following, students on OSNs
Use of Social Media	• Social media platforms used as a secondary mode of distributing information • Used by students as a place to interact and initiate grassroots organizations
Potential Obstacles to Expansion of Social Media	• No major privacy concerns • Social media is an opt-in system, so the networks can never be used as a primary mode of emergency notification

2.4.2 City Level

City governments currently use social media in a limited role. Different agencies at the city level of government perform different functions in an emergency, and their use of social media reflects this. Main concerns expressed by officials in city governments with social media include its limited reach with certain demographics and the public's limited engagement with governmental pages on social media platforms. Strengths of social media expressed by these officials include the instantaneous situation awareness of the information delivered by social media. To examine social media use at the city level, interviews were conducted with five professionals, from Pittsburgh, PA; Columbus, OH; Seattle, WA; Bothell, WA (Seattle metropolitan area); and Carlsbad, CA (San Diego metropolitan area).

To understand the emergency communication strategies employed by cities, it is important to understand exactly where responsibility falls among the levels of government in responding to emergencies. City agencies serve a primary role in disaster response, specifically with fire, police, and medical first responders. However for major emergencies other cities and even county, state, and federal agencies may be involved. As David Harrison, the Emergency Preparedness Manager for the City of Carlsbad stated, "Disaster response responsibility… rests with the local jurisdiction. [But] a lot of these disasters require more resources than any single local jurisdiction, such as a city, has" (Harrison, 2012). Cities have mutual aid programs set up to

pool resources during a crisis. And for larger crises cities coordinate with other levels of government to use county, state, and federal funds and staff to address an emergency.

During an emergency, cities designate one or more public information officers (PIOs) who are responsible for all communication with the public. This includes traditional methods of communication such as press releases and emergency radio broadcasts, as well as any social media communication tools. Among the cities that were interviewed, all stated that social media was used as part of their communication strategy in an emergency. However every city uses social media as a secondary tool to supplement its traditional communication tools. In terms of information push this means that posts to social media are done along with press releases and emergency radio broadcasts; in terms of information pull, this means that cities monitor social media for information during a crisis along with reports from first responders and the media.

In comparison to the other tools used in communication, social media communications have a number of strengths and weaknesses. Among the professionals we interviewed, the common opinion was that social media's greatest strength is its speed. A Facebook post or Tweet appears on a user's page the instant it is submitted. In comparison, it can take up to an hour to send information through traditional media such as television- from starting to draft a press release to the story going on air (Johnston, 2012). This speed can also be used in collecting information: monitoring publicly available information can be done in real time, as posts are made. For example, emergency managers observe trends on Twitter during a crisis to gather an idea of what the situation is from their workstation (McNutt, 2012). Again, compared to other methods of collecting information, such as reports from first responders or the media, social media is faster because the users are already present at the crisis location. According to Mike McNutt from the Columbus Office of Public Health, "[Social media's biggest strength] is that it's immediate information that helps start painting the picture of what's happening on the ground" (McNutt, 2012). Another strength of social media is that it allows direct communication to the public. By cutting out the middleman (i.e. news or radio station) emergency communications are more accurate with less chance of misreporting false information (Harrison, 2012). These abilities make social media a powerful tool in emergency communications.

Emergency managers at the city level identified several weaknesses of social media as a communication tool. The main concern was the limited reach of these platforms. In an emergency, responders attempt to reach as much of the population as possible, but not everyone is using social media. Compared to other platforms such as television and radio, far fewer individuals are regular users of Facebook or Twitter (Stamatelos, 2012). Additionally, very few of the registered users actively follow or "like" the pages of emergency responders (Harrison, 2012). When emergency managers do use social media platforms, they do not reach enough of the population. Another common concern with social media is that the information posted on those platforms may be incorrect or unconfirmed. Similar to 911 calls and other reports from the

public, information on these sites must be reaffirmed with other information from the public, and reports from first responders and the media (McNutt, 2012). Social media does a good job of providing another avenue of information flow, but does not solve the problem that information from the public may be unreliable.

Looking forward, the emergency managers that were interviewed expect social media use to continue as an emergency messaging tool. Most expected its use in this regard to grow as more members of the population join these platforms. All saw value in social media as a communication tool. However before its role can be expanded, the issues of limited reach and unconfirmed information must be addressed.

TABLE 2.4.2 KEY FINDINGS FROM CITY LEVEL INTERVIEWS

Information Push Use	• All use social media as secondary tool with traditional communication methods
Information Pull Use	• All use social media as secondary tool along with first responder reports, 911 calls, media reports
Strengths of Social Media	• Speed of communication • Direct to the public (without intermediate)
Weaknesses of Social Media	• Limited reach for push use • Unconfirmed data for pull use

2.4.3 State Level

In order to acquire a better understanding of what emergency management offices are using as social media outlets, information regarding social media was pulled from every state's emergency management page. Figure 2.4.1 shows what social media outlets are advertised on the states' emergency management homepage. Figure 2.4.1 shows that Facebook and Twitter are the primary social media outlets that are being used at the state level.

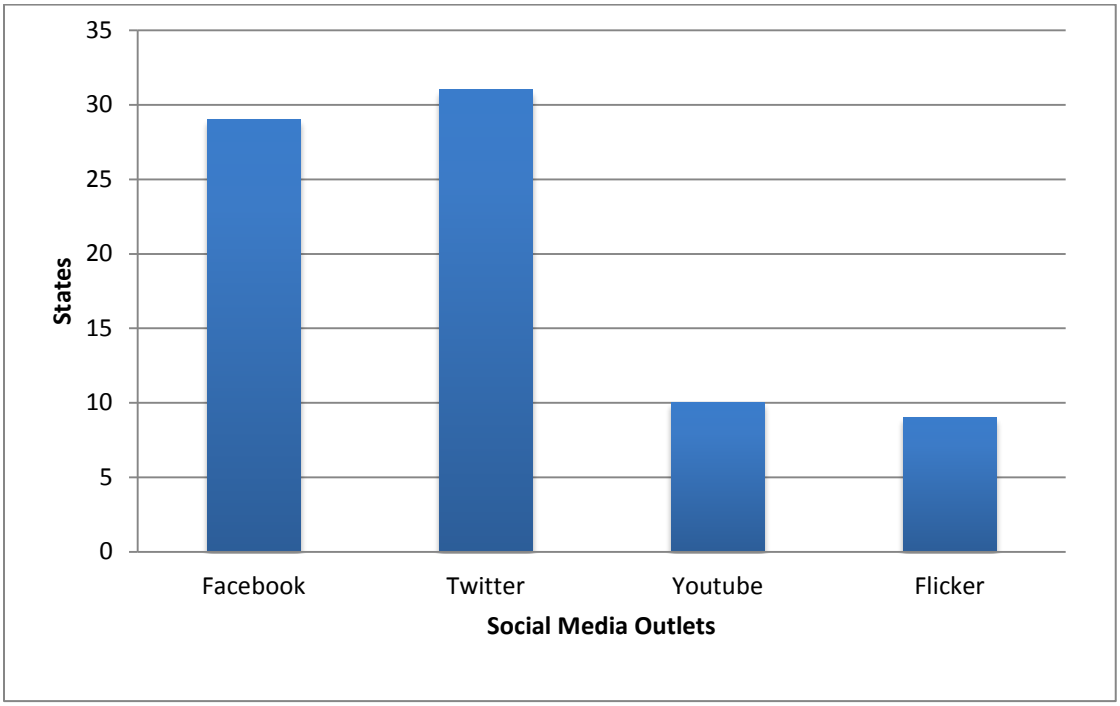

FIGURE 2.4.1: NUMBER OF STATES WITH EMERGENCY MANAGEMENT SOCIAL MEDIA OUTLETS

Figure 2.4.2 and Figure 2.4.3 shows the distribution of subscribers on States' emergency management Facebook pages and Twitter accounts. While there is a slightly higher number of "followers" on twitter than Facebook, twitter allows for entities and organizations to be followers. In addition, for both Facebook and twitter, the subscriber numbers are substantially smaller than the state populations. However, when looking through the followers on the states' emergency management Twitter accounts, we observed that nearly all of followers disseminate information, such as state and local journalists. Therefore, while many citizens may not be directly following the accounts, reporters and other entities that have the ability to receive updates that they can spread to their respective audiences.

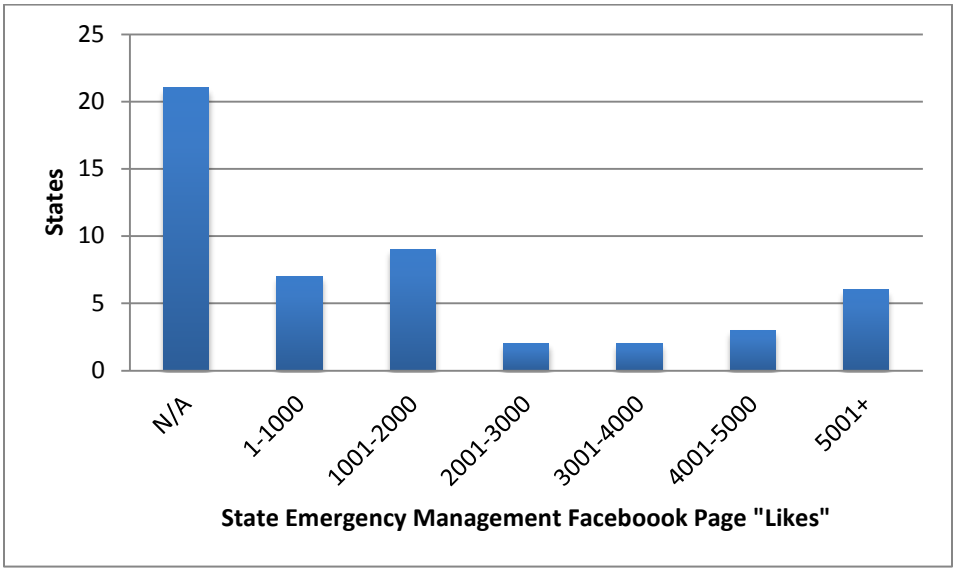

FIGURE 2.4.2: POPULARITY OF STATES' EMERGENCY MANAGEMENT FACEBOOK PAGES MEASURED BY THEIR NUMBERS OF LIKES

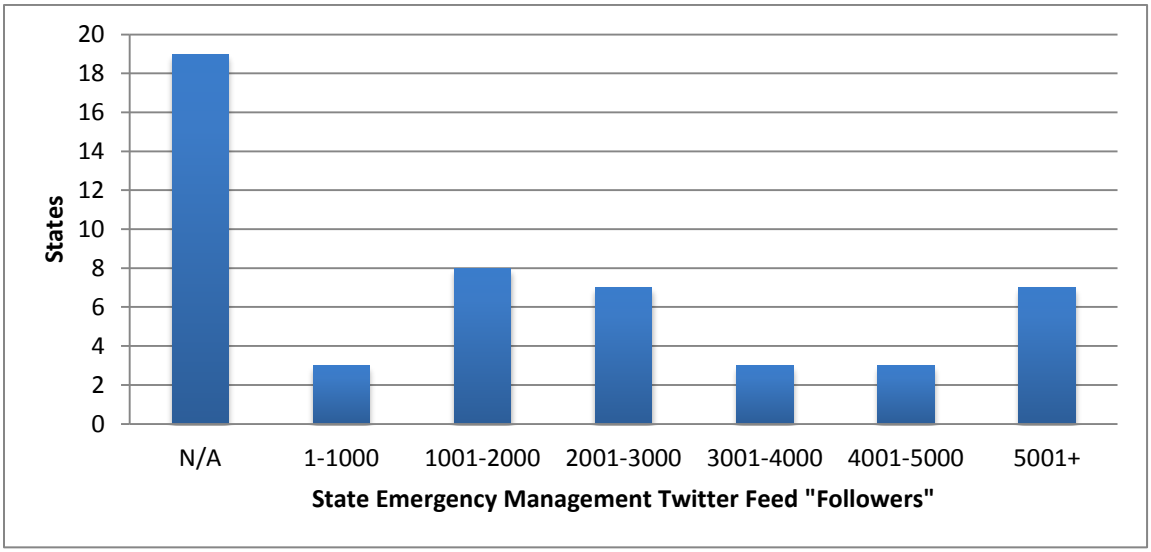

FIGURE 2.4.3: STATES' EMERGENCY MANAGEMENT TWITTER FOLLOWERS

Interviews conducted with people involved in emergency management at a regional level provided further insight into how social media can be utilized in emergency response. The social media outlets Facebook and Twitter are used by many emergency management organizations at the regional level, but are not often used as a primary tool in emergency management. Legacy systems involving the Federal Communications Committee's outlined Emergency Management Services (EMS) are still the dominant communications method at the regional level.

The current EMS system involves radio and television broadcasts that are able to send small pieces of data alerting the public of an emergency. All personnel interviewed stated that the current EMS is an effective tool in emergency response and would never be replaced by social media outlets such as Facebook and Twitter in the dissemination of emergency alerts. The reason given was that the current EMS system is effective and can reach a large portion of the public very quickly. Randall Gockley, the Director of Emergency Management Agency in Lancaster County, Pennsylvania, estimated that immediately after receiving a potential emergency report, it takes approximately five minutes to get a message out to the public via the current EMS system. He also stated that social media could provide a faster method to send out emergency alerts, but that there would be complications in adopting social media that will be discussed in detail later (Gockley, 2012).

Many respondents have stated social media could be an effective tool in emergency management. John Ambrusch, the acting Emergency Management Coordinator in Bradford County, Pennsylvania, stated that social media could be an effective tool when existing infrastructure is rendered useless by disasters. He cited a recent flood in Bradford County as an example where existing legacy systems failed and social media served as in an emergency messaging context. When power in flooded areas went out, his staffers were still able to receive information from the area by monitoring the affected communities' Facebook and Twitter pages from their mobile phones. This allowed the County to send up-to-date alerts out to surrounding areas. While Ambrusch did not state the pulling of information from staffers' smart phones as an official tool, it does have a use in emergency messaging (Ambrusch, 2012).

Another example of social media usage being used to pull information in emergency situation contacts comes from Cambria County, Pennsylvania. Cambria County's Department of Emergency Services "regularly uses Facebook to send out general alerts" (Springer, 2012), but more effectively pulls information on suspected criminals from Facebook. Ronald Springer, the County Coordinator for the Department of Emergency Services, stated that Facebook usage is not only helpful to his department, but also to local law enforcement when looking for criminals. While Cambria County has begun to use social media as a tool in emergency messaging, there are still certain boundaries in using social media that they would like to cross. The example given was the inability to communicate with the public via SMS messaging, or texting to mobile phones (Springer, 2012).

TABLE 2.4.3 KEY FINDINGS FROM STATE LEVEL INTERVIEWS

Purpose for using Social Media	• Alert distribution • Education and awareness
Information Push	• Primarily use Facebook and Twitter • Next Generation 911
Information Pull	• Does not rely heavily on pulled data • Data useful when locating exact positions of large scale disasters
Use of Social Media	• Social media platforms used as a secondary mode of distributing information • Provides instructions for emergency situation readiness
Potential Obstacles to Expansion of Social Media	• Privacy a concern when dealing with publication of 911 emergency situations (Next Gen. 911) • Infrastructure does not exist at the regional level to fully handle data pulled from social media • Hard to keep content on social media sites updated constantly due to staffing

There are restrictions preventing social media from becoming a main tool in emergency management. Randall Gockley, the Director of Lancaster County, Pennsylvania's Department of Emergency Services expressed concerns in using social media as an effective tool in emergency messaging. In Lancaster County, legacy systems are used mainly in emergency response and warning. In addition to current radio and television alert distribution, Lancaster County uses a technology called reverse 911 where alerts are sent to small communities via telephones. The reverse 911 system is relatively fast, but encounters problems when attempting to contact large amounts of people. Gockley provided an example where a town with a university in it had to be warned of an incident. His department attempted to use the reverse 911 system, but it failed as the local university had been tying up the phone lines. The reverse 911 system ended up crashing for around three hours, which would have been disastrous in a large scale emergency. Because data streaming from social media can cause systems to crash when sent out in bulk, Gockley feels that social media should not become a main tool in emergency messaging. However, he does feel that it could prove useful in reaching larger populations. He is quoted as saying "[Phone, television, radio, and social media are] all just tools in the toolbox," when it comes to emergency response (Gockley, 2012).

As stated above, infrastructure concerns pose a problem to the widespread adoption of social media as a tool in emergency response. Systems such as reverse 911 are vulnerable as large amounts of data distributed to the population causes system flooding and system failures (Gockley, 2012). Other legacy systems rely heavily on the ability to use broadcast towers and

need electricity in a disaster stricken region not to fail. To address infrastructure concerns, new technologies are being explored. These new technologies should have the ability to facilitate social media usage in emergency messaging much better than current systems. Next Generation 911, as described by Mike McGrady, the Pennsylvania Chapter Chairman of the National Emergency Number Association (NENA), will provide tools and the infrastructure to make social media a valuable tool in emergency messaging.

2.4.4 Federal Level

Social media at the federal level is considered useful by several organizations that are involved in emergency management. In an ever increasingly interconnected world, these organizations recognize the value of being present on various social media channels. Nevertheless, for the most part, social media remains a supplementary method for information sharing for these federal agencies. For this report, officials from four agencies were interviewed: Federal Emergency Management Agency (FEMA), Centers for Disease Control and Prevention (CDC), Department of Homeland Security (DHS), and the U.S. Geological Survey (USGS). The federal agencies interviewed use social media for a number of reasons ranging from, informing the public about disaster preparedness, response, and recovery efforts to public health messages and organizational awareness.

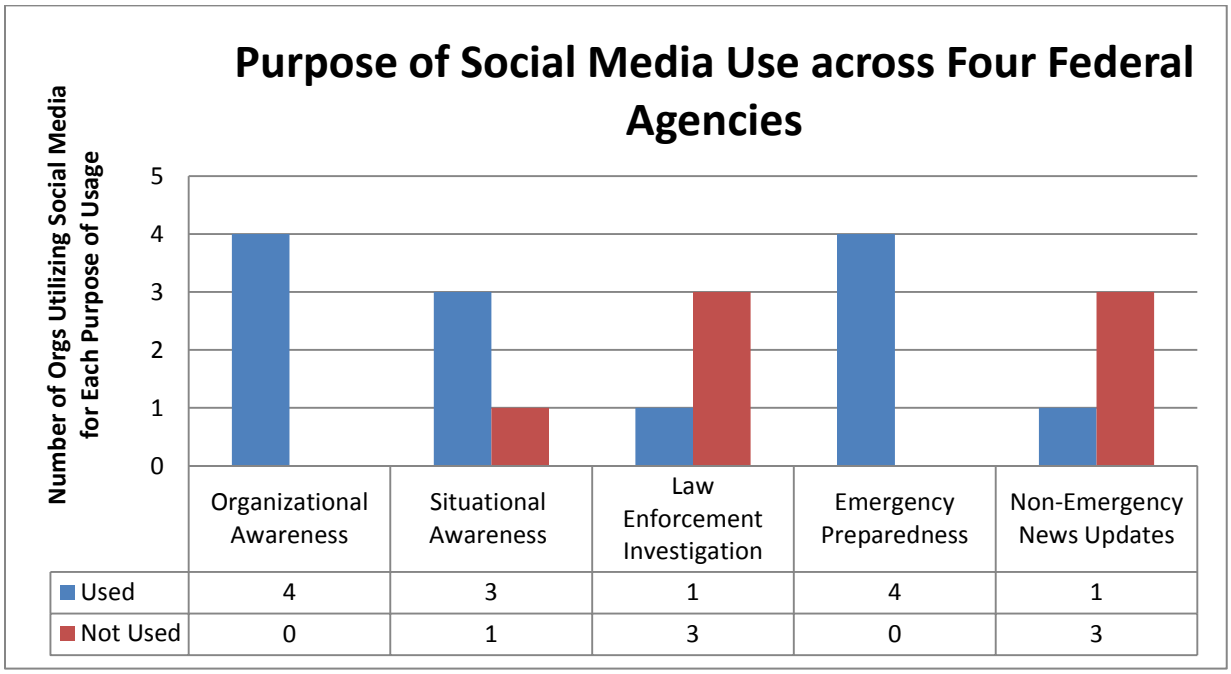

FIGURE 2.4.4– PURPOSE OF SOCIAL MEDIA USE ACROSS FOUR FEDERAL AGENCIES

According to Mary Ellen Callahan, Chief Privacy Officer at the Department of Homeland Security (DHS), the DHS uses social media in three distinct ways: to communication with the

public and between the department, to enhance situational awareness of events, and for operational use with appropriate law enforcement investigations (Callahan, 2012).

TABLE 2.4.4 – KEY FINDINGS FROM FEDERAL LEVEL INTERVIEWS

Purpose for using Social Media	• Organizational Awareness (Marketing) • Emergency Preparedness • Non-Emergency related News Updates (Public Health Issues, prominent events) • Increasing Situational Awareness • Assisting in law Enforcement Investigations
Information Push	• Major social media platforms used Facebook, Twitter, YouTube and Blogs • Relay information and communicate with public
Information Pull	• FEMA, DHS and USGS use twitter search for situational awareness • CDC reviews information from key journalist blogs • All agencies use platforms help direct people to appropriate resources
Use of Social Media	• DHS, FEMA and USGS use social media as supplemental tools • CDC uses social media as a primary and supplementary tool on a case by case basis
Potential Obstacles to Expansion of Social Media	• With respect to privacy concerns, federal agencies are required to operate within a legal framework • Infrastructure issues with social networking sites and with making changes to 911 system on a national scale require more time

With respect to communications with the public, DHS operates on several social media channels including Facebook, Twitter and YouTube. Within this category, DHS differentiates between two types of outreach strategies. One type consists of interactive platforms where Department officials have their own profiles, can relay information to the public about DHS services and interact with the public by enabling users to post on their profiles. The second type consists of more broad range applications such as applets and widgets that provide real time information through SMS, video streams and RSS feeds (Callahan, 2012).

Because National Operations Center (NOC) of DHS has a responsibility to provide situational awareness, the organization has come to rely on both traditional media and social media to increase situational awareness during disasters and threats to national security. Social media channels are used in order to create a more complete picture of what is going on during breaking events. The DHS maintains a strict rule of reviewing information on these social media sites

without taking any personally identifiable information, with the exception of a few instances (Callahan, 2012).

Lastly, DHS uses social media in situations where the organization needs to access specific information on social media or a person's profile for authorized investigations. This third category stems from the fact that a number of DHS component organizations may require online information for law enforcement. Such operations require the appropriate authorization and must adhere to the legal framework that is in place for the operational use of social media. In short, the DHS values social media for the role it plays in situational awareness, law enforcement investigations and regular information push about DHS services and information (Callahan, 2012).

In the case of FEMA, Shayne Adamski, the Senior Manager for Digital Engagement at the agency emphasized the supplemental role of social media stating that "Our strategy is that social media is one part and one tool in the digital communications toolkit and digital communications is one tool in our overall communications toolkit… we use it to push messages and communicate with a wide range stakeholders all the way down to disaster survivors, private sector folks, individuals" (Adamski, 2012).

Scott Horvath, the Web and Social Media Chief at the USGS states that social media is useful in emergency situations such as earthquakes. Horvath notes that sometimes it takes a while for instruments to relay information about earthquakes back to scientists. People on Twitter often start to "rumble" about an earthquake before scientists are aware of it through their instrumentation. Horvath emphasizes that Twitter is "not an early warning system but just a heads up" especially when earthquakes occur in locations where there are not many instruments (Horvath, 2012). According the Horvath, because the USGS is an organization that people tend to turn to for support and is considered being responsive to natural disasters, social media is helpful in terms of broadcasting, education and customer service.

All the people interviewed stated that social media is definitely valuable. Bernadette Burden, a Senior Public Affairs Specialist at CDC stated that "when it comes to very rapid and immediate information it is very much an asset to have the social media tools because we are able to look at and update in some instances instantaneously with a Twitter feed". The ability to get real time updates and collaborate with partner agencies through social media is considered a common benefit for all agencies. Adamski also noted that "there's great value… we're a lead coordinating agency for the federal government working closely with local state so we are not traditional 911 or traditional first responders but it is still important for us to be cognizant and aware of things that are going on working closely with our local state partners" . Moreover, Brehmer commented on how social media is valuable to FEMA because it helps the organization cover its bases in terms of groups that it previously did not reach. For the USGS, social media is relevant because

there is a wealth of information and many ways to educate people about science, earthquakes and climate change.

In addition to pushing information to the public, all people interviewed stated that their organizations are involved in information pull although the manner in which this is done varies across organizations. According to Horvath, USGS conducts a general search of things related to USGS which is standard protocol. The reasoning behind this is to understand what people are saying about a particular topic and help direct them to the website or appropriate source. Horvath highlights that reviewing the information on social media is more about customer service rather than monitoring.

In the case of FEMA Adamski and Brehmer mentioned Twitter searches for the purpose of gaining situational awareness. Adamski explained that "within public affairs… we do monitor hashtags and keywords for the benefit of what we call situational awareness... if we saw let's say for example CNN or we saw online there was an explosion or a tornado… or an earthquake… we would go and we would start entering a couple of search terms in there to see if people in the area are posting information publicly" (Adamski, 2012). He said that these Twitter searches are similar to going to a town hall except in this case, FEMA is going to where a public forum is happening. According to Adamski, FEMA will review information on Twitter and Facebook and look at traditional media sources such as new articles as well to make sure that the information is being communicated properly and accurately

With respect to CDC, Burden described how the CDC will review social networking sites to obtain a more "solid understanding of not only what's out there in the social media realm but [of] those that are newsmakers, those that are seeking out the type of information that the CDC has to provide". She added, "we utilize various media monitoring services because we are focused on public health science and medicine focused websites blog sites etc. and so we identify and pay attention to… general service media because we know the audiences we are trying to meet or target… we like to know… how our social media set can be effective and really who we should be targeting and approaching in terms of our information".

Most of the organizations interviewed cited no distinct plans for an expansion of social media. Brehmer commented that geographical information system would be highly useful if integrated with social media, especially in enhancing situational awareness. Horvath notes that the USGS uses social media in a supplementary manner but would like to explore more operational types of function in the future. Horvath further states that it is definitely possible to use social media in an emergency situation and that the organization is still looking for how social media can be used with the information they provide. One challenge that he notes is that social media service may not always be functional when you need it to be; therefore he suggests that with careful planning social media can be used more effectively in emergency management. On the other hand, Adamski points out a challenge of a different kind: "when it comes to the infrastructure of the

911 system in order for 911 systems to be able to accept text messages or to be able to accept another piece of information incoming… would be a change to the system as far as the infrastructure as well as training as well as then having that be applied to every 911 system so… it would still take time to get that infrastructure built into the existing 911 center as well as getting as those 911 dispatchers trained". In contrast, Burden stated that depending on the response needed, the target audience as well as other factors, the CDC would respond appropriately. She noted that, "We always take the time to assess and whatever the needs are we attempt to meet those in earnest and if those need to be amped up because of the impact or because of the emergency itself then we take the time to do that… If you are looking at it from an emergency preparedness perspective, it really depends on the need of the response… our role is to be as supportive as possible, and to provide as much assistance and guidance as possible and if that means an expanded role to support various social media outreach then we work towards that goal" (Burden, 2012).

In essence, many of the federal level agencies see great value in using social media. Various social media channels allow these agencies to reach a larger subset of the population and therefore raise awareness of what the different agencies are doing. However all the organizations interviewed made a point to say that any information that they make available through social media is also visible on their website. This indicates that social media is mainly seen as supplementary method and may not be appropriate as a primary method at the federal level. Privacy is also a serious concern for all agencies involved in social media at this level. There are legal frameworks in place at agencies such as DHS and FEMA that specify how these agencies can review information on social media websites. The privacy concern highlights a deeper issue of the role of federal agencies and public information. Mary Ellen Callahan stated "we don't want to be big brother", touching upon the inherent problem with balancing the need to use social media sources for various purposes while respecting privacy and individual rights at the same time. With privacy remaining an important concern for federal level agencies, expansion of social media in the future seems limited.

2.4.5 Non-Governmental Organizations

Non-Governmental Organizations (NGOs) use social media in a varying amount. Some NGOs depend heavily on social media. The two NGOs that were interviewed heavily used social media, and did not even have a physical location. Others barely use social media; they just have accounts because they see a trend of emergency communications moving toward social media. However, most of the NGOs that were interviewed, are somewhere in the middle. They see the value of social media, but do not think that it should be the only way to communicate, especially, in a disaster. One reason that was given by some of the interviewees as to why social media is not the primary source of communication is that they believe that the older generation would be left out if there were a shift to complete social media use. Representatives of 10 NGOs were interviewed for the purpose of this research, Medical Mercy Airlift (MMA), the Volunteer

Center serving Howard County in Virginia (Volunteer Howard, henceforth), Humanity Road, United Methodist Community on Relief (UMCOR), Lions Club International, Society of St. Vincent de Paul (SVDP), Mercy Corps, the American Red Cross, Texas Voluntary Organizations Active in Disaster (Texas VOAD), and Standby Task Force.

Two organizations mentioned that social media is their primary source of communication. However, the rest of the NGOs that were interviewed mentioned that they use some form of social media in their organizations as well as during disasters and want to learn more, as seen in Figure 2.4.5.

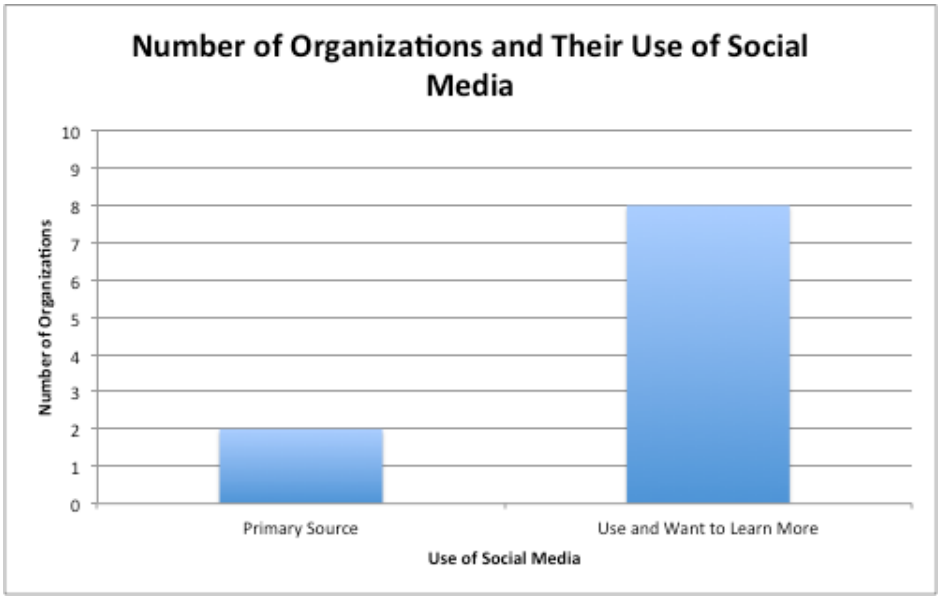

FIGURE 2.4.5 – NGO ORGANIZATIONS THAT WERE INTERVIEWED AND THEIR USE OF SOCIAL MEDIA.

The NGOs that were interviewed for this paper use social media for a variety of purposes including disaster management, marketing, and connecting with volunteers. When asked about how he sees social media's role in disaster situations specifically for NGOs, Ivey West, the Assistant to the President/CEO of MMA, stated "There is almost too much information on how to use social media out there". Although there is an abundance of information on the Internet about how to generally use social media, one cannot always see the trend of social media use. NGOs are trying to get a sense of what is out there and marry it with some creativity to best capitalize its added value for their organization. Charles Henderson, the National Director of Communications of the National Council of the United States (SVDP) (Henderson, 2012), agreed with having to be conscious of social media trends. He emphasized the importance of knowing how people are using social media in different ways, especially if an organization has found a way to effectively integrate social media into an existing organization for disaster situations. West emphasized that the added value of social media hasn't been seen yet,

specifically for MMA. "I think that goes back to, we haven't figured out where our place is… we don't know what we should be doing" (West, 2012). NGOs know that they want to capitalize on the strengths of social media. Henderson stated, "[social media] creates sort of a larger community. One of the hallmarks of the organization is that there is a concept of friendship. You are coming together to do charitable work. But there is also a component of camaraderie that is supposed to be inherent in that endeavor. I think our work would to be to help enhance that community among our members." Social media, at its essence, is a platform where people can connect to share ideas. NGOs are organizations that also connect people and share ideas, so it would seem a natural combination.

We specifically concentrated on how NGOs used social media during a disaster situation. Social media is a way to quickly spread and access information, and the NGOs that were interviewed recognized how useful it would be during an emergency. Wendy Harman, the director of Social Strategy at the American Red Cross commented on the use of social media: "When there's been a major disaster, or at least a high profile one, there's almost an insatiable hunger for information. So we try to update [the American Red Cross's social media] as often as possible, and try to share in real time what we are doing to set up a relief operation in real time. The first step that I normally take is to acknowledge that something happened [on social media]. At this point, I normally have no information, but I say something like, 'a disaster has just happened; our hearts go out to those affected. We will keep you updated as we get more information". Harman also stated that in one emergency situation, she heard about a disaster on social media 20-30 minutes before she heard about it through more traditional methods. Some NGOs decide in a disaster to push information out to the general public through a third-party platform that uses the same message, while others tailor the message to the type of social media. Koji Kadama, the Communications Director of Texas VOAD stated that what social media they use depends on the nature of the message they need to send out. He also stated, "Not everyone has a smartphone, so we do redundant layers of [messaging]". Some people are not as familiar with social media and would not turn to it in a disaster situation, so redundant layers of different types of messaging is a route that ensures as many people as possible are notified. Kelly Janowski, the Communications Specialist of Public Relations and Communications to the Lions Clubs International, expanded on this idea specifically for the Lions Club International. "In an emergency, I think a familiarity with social media prior to that event predicates whether or not a club will use it. Chances are, in any type of disaster, they're not going to proactively seek out social media if it's not something that's already familiar to them".

Using social media has a variety of strengths and weaknesses. Social media is a good way to get information out to the public about what is going on quickly. However, that information cannot be deemed a reliable source of information because it is not crosschecked with any other sources of information. West does not believe that social media's lack of reliable information completely invalidates its use. He stated that social media has the most up to date information.

It's a good source to "realize the scope of a disaster," without necessarily having to verify the information. Through social media, you can get a sense of where the epicenter of an earthquake is before news sources are able to cover the disaster, because of where the social media messages are coming from. When being involved with an organization that's mission is to help in disaster prone areas, "you need to be constantly in touch with what's going on," states Elizabeth Disco-Shearer, the Texas VOAD President and Associate National Executive Director-South Central Region of Society of St. Vincent de Paul, USA. The main strength of social media that many of the interviewed NGOs articulated was its ability to communicate with people quickly. "It's a great communication tool to help us disseminate information about goals that are important to our organization. It's a great public relations tool because it helps us publicize the things that are important to us. It helps us learn about [what our organization is] doing around the world, because we serve such a diverse geographic region as well as clubs that are involved with all sorts of activities, it helps us collate these comments and bring together ideas and people. It's a very multi-faceted tool for us". For example, UMCOR is an international organization and often works in war torn areas. James Rollins, Director of Marketing and Communications for UMCOR stated "With the amount of smart phones that people have, I could see [social media] being a value in the US, more than currently in the more remote places in Africa, where people usually have phones, but don't normally have smart phones. It's a great difficult for social media to be helpful on an older cell phone, or a non-smart phones… I think the technology is becoming cheap enough, that we will start seeing social media taking over in some of these countries. And then you will see social media having an added value… as the technology is provided to more of the world, social media will start to have a greater value".

Many times, however, strengths and weaknesses go hand in hand. Rollins stated that there is a benefit to social media in that the world is at your fingertips. The detriment of social media is that it can be at everyone else's fingertips as well. In a war torn area, "social media can be a detriment. Some information, you don't want readily available. We want the help to still get to the people who need it. And if the government, necessarily, knew whom we were working with, they could shut them down. And that would shut down [UMCOR's] work". "Another weakness of social media is that it has to rely on the Internet as its backbone". Some areas around the world do not have the current infrastructure to support social media, as stated by Megan Zabel Holmes, Mercy Corps' online marketing officer in Portland. Besides physical restrictions, some NGOs are hesitant about making social media their primary source of disaster communication because of other repercussions. "You can't necessarily control the conversation, but you can become an active participant. But what's exciting about social media is that you are getting genuine response from people. But that's also a challenge, because that genuine feedback might not always be positive". Holmes added to that by saying that there are repercussions of social media because you cannot take anything back. It is always out on the Internet even if you delete it. Harman agreed and expanded further. Because social media is not necessarily a reliable

source, at least not yet, organizations do not want to be held liable for accidentally spreading false information about an emergency.

Another drawback of moving towards using more social media for NGOs is missing a very important demographic of people from emergency messaging – the older generation. "Some of the older people don't want to [use social media]. They still want to do everything by regular mail and telephone. But I think that's changing. I think we are seeing more, and more people, especially through Facebook because it is pretty user friendly and attractive [compared to Twitter and LinkedIn]. Twitter is for a different world… if you have all day long to look at something, Facebook is more user-friendly. Twitter is just words, and you have to know the lingo as well. It's language specific, and it's like learning a new language. From a sensory standpoint, it's something new to get used to". Holmes expanded by saying that older people may tend to not participate, but that is changing. It doesn't affect the older generation much because most NGOs still use their more traditional methods. It hasn't been a complete shift towards social media (Holmes, 2012). They are seeing a shift though as older people are using social media more. Not all of the NGOs interviewed mentioned this phenomenon of excluding the older generation when moving towards social media. Most of the NGOs stated that there is a generational gap, a few did not mention it either way, and two – Humanity Road and Standby Task Force – believed that there was not a generational gap. These two organizations are discussed further later in this chapter. Figure 2.4.6 shows the number of organizations that mentioned the older generation gap.

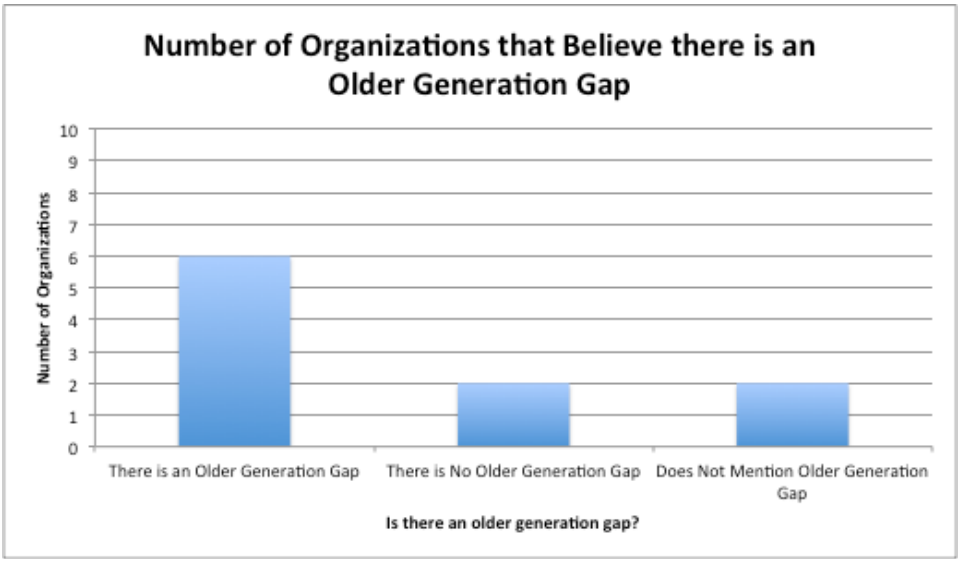

FIGURE 2.4.6 – NUMBER OF NON-GOVERNMENTAL ORGANIZATIONS THAT MENTIONED THE OLDER GENERATION GAP

Of the NGOs that were interviewed, all specified that they want to expand social media as much as they can. To reiterate West's comment, NGOs haven't figured out where their place within

the social media world is yet. They don't necessarily know what they should be doing with all of the information. With some creativity and time for new ideas on how to use social media are allowed to disseminate, organizations will soon be able to increase social media's presence in the NGO world. Mickey Gomez, the Executive Director at Volunteer Howard, already has an idea. Gomez mentioned that she would love to have an application on a phone or tablet that would allow people to see what the community's needs are and to connect with those needs in whatever way they are able. Table 2.4.5 shows a summary of the findings of organizations that do not primarily use social media, of the ones that were interviewed.

TABLE 2.4.5 – KEY FINDINGS FROM ORGANIZATIONS THAT DO NOT PRIMARILY USE SOCIAL MEDIA

Purpose of using for Social Media	• Use social media because of its communication enhancement to traditional methods
Information Push	• Use social media in addition to traditional methods
Information Pull	• Some use solely social media to pull information • Some use in conjunction with traditional methods
Use of Social Media	• See social media as a supplementary tool to traditional methods
Potential Obstacles to Expansion of Social Media	• Infrastructure issues • Not reaching the whole population (i.e. the older generation gap)

Humanity Road and Standby Task Force are volunteer organizations that offered an extreme and differing perspective on using social media during emergency situations from the other NGOs that were interviewed. Additionally, both of these organizations do not have any physical offices; the organizations are completely online. These two NGOs that use social media to crisis map all around the world. The crisis maps help deploy first responders in the wake of an emergency to the locations that need the most assistance, as mentioned by Melissa Elliott, Standby Task Force, Corps team member and reports team manager as well as Humanity Road Volunteer. The difference between the two is that Humanity Road activates itself in the wake of a disaster, whereas Standby Task Force must be activated by another organization that with which they would be working. These two organizations run in parallel to, or shadows, first responders. Specifically mentioned by Christine Thompson, President of Humanity Road, they

help connect people who fall outside of the tradition network because they couldn't get through to the help that they need.

Both of these organizations not only use social media; rather they depend on its existence. For all intents of purposes both of these organizations use every social media platform that is available; including, but not limited to Facebook, Twitter, Google+, email, texts, phone calls, Skype, YouTube, Flickr, FourSquare, LinkedIn, and blogs. Humanity Road used a platform, called TWUFF, to distribute information and Standby Task Force also used a platform called Ning, to collect as well as distribute information. Humanity Road "volunteers are actively monitoring key words by geography to identify urgent needs, where folks don't know how to ask for help, they are just broadcasting a message that we are identifying that type of information through active monitoring. As social media is growing, both Humanity Road and Standby Task Force will most likely adopt the new mediums to continue to expand their reach. However, "the reach for the messaging is much broader [than simply likes and followers on social media sites] because the public uses "hash tags" to follow an event. So it's difficult to quantify the reach".

Both Christine Thompson and Melissa Elliott mentioned social media and how it relates to elderly people. Their statements were strikingly different than the other NGOs interviewed. Thompson mentioned that they have helped elderly people through non-traditional methods, like social media, who could not contact the emergency responders through traditional methods due to an influx of information. She has also seen a trend of people using social media as a natural second step, since they already use social media for personal reasons, when they cannot reach traditional 911-call centers. Social media is "another tool in the toolkit of collecting situational awareness". Elliott also mentioned that the only people who would be excluded by using social media would be people that do not have a computer. They have a lot of older people working on Standby Task Force that are retired that are good at data mining, since they have a lot of time. Therefore, she does not think that the older generation is being excluded by using social media as a form of emergency communication.

Thompson and Elliott stated specific strengths of using social media. Thompson specified that by using the Internet, it is an equalizer for communications. She went on to say, "the communication tools are international and so there are standardized global communication tools that are already being used by the general public for various purposes for communicating .... For the aid agencies, it's an equalizer because … when you have hundreds of aid agencies flooding into a geography, you can either prefer the traditional networks of United Nations activations, or your non-traditional activations where they self-deploy. They don't have a common communications platform, and the general Internet provides a common communications platform". Elliott added that the immediacy of information is a great strength of communicating via the Internet. The Internet may seem like a vulnerable source of communication in disaster prone areas, especially if it becomes the primary disaster communication. However, Thompson

refuted that idea by saying, “If [the affected people] are unable to use a phone or internet enabled device at all then you are unable to collect any information online […]. However, that in itself is situational awareness that can confirm the need for help […]. The absence of information coming on the internet sometimes is as valuable as the presence of information.”

Thompson and Elliott also addressed similar weaknesses that they see with using social media. The Internet is not a secure network. Everything that is said on a common social media platform is visible to the entire world. The general public as well as agencies may not feel comfortable sharing that much information on the Internet. Another drawback is the people “who are either intentionally or unintentionally, providing misinformation. And since it is not easy to distinguish misinformation from accurate information that can cause a misallocation of resources, when misinformation is presented and then spread”. Table 2.4.6 summarizes the findings of Humanity Road and Standby Task Force.

TABLE 2.4.6 – SUMMARY OF SOCIAL MEDIA USE FOR HUMANITY ROAD AND STANDBY TASK FORCE

Purpose of using for Social Media	• Crisis mapping • Pushing and pulling information in emergencies
Information Push	• Use social media in every way they can
Information Pull	• Social media is preferred over traditional methods that can be too slow
Use of Social Media	• Crisis mapping • Primary way to contact and get information • Vital to these two organizations

Non-Governmental Organizations are unique organizations that were explored during this research in that they showed the most excitement in using social media during disaster situations compared to the other levels that were explored. While only 10 NGOs were interviewed, we found that they are leaders in social media use for emergency situations, though the range of its use is wide. One piece of information that multiple organizations mentioned is the fact that the older generation may be left out when moving towards using social media as an emergency response tool. The current solution to resolve this issue is to continue using more traditional methods of communication as an additional tool to communicate events to the general public. This piece of information did not surface when interviewing the other levels of communication. The NGO level seems to be more invested in using social media than the other levels of communication that were researched.

NGOs that were interviewed have found success in reaching people during an emergency. From the interviews that were conducted, we recommend NGOs moving toward expanding their social

media use. We do not see social media becoming a primary source for existing organizations but can see it helping to reach out to those that may be left out from traditional methods of emergency communication. Social media has shown to be a good way to get a sense of what is going on before confirmation of an emergency may be available. However, its use can be seen from the NGOs that are expanding social media's role in their organization. NGOs seem to be leading the use of social media, compared to the other levels we looked at from the interviews, and may be the organizations that will be able to expand social media's use in emergency situations most effectively.

2.5 Conclusions

Social media is used across all levels of emergency management, though its relevance varies between the levels. From the interviews conducted with emergency managers, directors and coordinators at non-government organizations, the Federal government, state, county, and city level governments, as well as college campuses, some overall conclusions can be made about the status of social media as an emergency management tool.

Non-governmental organizations seem to use social media the most, followed by educational institutions. Across all levels of management, organizations are using OSNs primarily to distribute information. NGOs and college campuses use their social media networks as an educational and informational tool, rather than just for emergency alerts. On the contrary, city and state level management organizations generally use social media solely for alerts during an emergency.

Twitter and Facebook are the most common social media platforms used. Figure 2.5.1 shows the proportion of organizations that consider Twitter and Facebook to be useful tools.

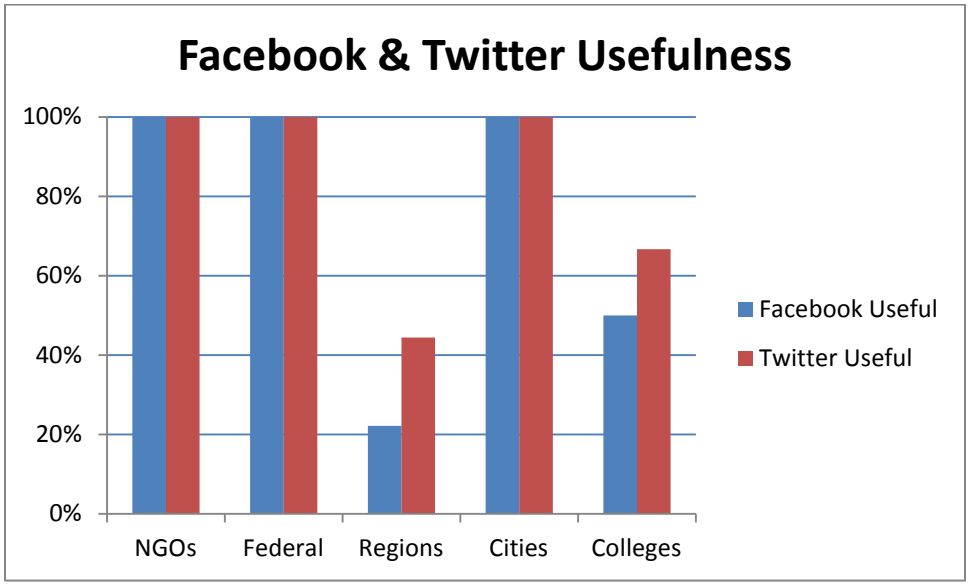

FIGURE 2.5.1 – USEFULNESS OF FACEBOOK AND TWITTER

Those interviewed reported that Facebook was commonly used because so many people are active on the site. Facebook is also visually appealing and has strong photo sharing capabilities. Twitter is commonly used because the site allows for quick bursts of information to spread quickly. College campuses reported using Twitter because the message length is comparable to the length of SMS alerts used in most college emergency plans. Twitter is also a good site for gathering information, as organizations can track a certain "hash tag"[2]. Most organizations reported that they do not pull information off of social media networks regularly. Those who did gather information were either from NGOs or college campuses.

One drawback to using social media is that to use the networks to their full advantage requires organizations to have employees whose job is to monitor the sites. David Bujak from Florida State University noted that in order for social media to be successful, the sites must be social—that is allowing subscribers and followers to partake in conversation. The negative aspect of the social element is that some level of monitoring is required to make sure disseminated information is correct and that rumors do not get started. The organizations that do not currently use social media reported that not having the staff to keep the sites updated was the primary reason for not using OSNs.

Another reason social media is not used by organizations is because the sites do not solve the problems and inefficiencies of the legacy systems. A primary problem of all emergency management systems is that people must subscribe to the system, and not everyone has access to social media or wants to be active on the sites. For example, elderly people and poor people may

[2] For example: #Emergency

not be as active on social media as teenagers. Social media do not necessarily allow the organizations to reach a wider audience.

The limitations of social media network's reach are just one of the reasons why the growth of social media for emergency response has been slow. Additionally, technology is not quite at the point that satisfies the organizations. At all levels of management people noted the difficulties in constantly updating an OSN, whether it is during an emergency situation or not.

While there are multiple arguments for or against the future growth of online social media networks during emergency situations, the most telling is that organizations, besides NGOs, expressed that they do not want social media to be their primary method of distributing information.

A minority of emergency management institutions investigated use online social media networks for information dissemination or collection. The exceptions are the CIA, FBI and the American Red Cross. The American Red Cross has used social media during past emergencies to notify people who may be in danger. It is understood that the CIA and FBI have data mining capabilities, though reviewed literature does not specify exactly the agencies' purpose for OSN data mining. College campuses and cities have social media networks, though they are primarily used for non-essential information push.

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2.7 Appendix A. Current Use: Letter of Inquiry

Following email was sent out to the potential interviewees of selected organizations or agencies.

> Dear Mr./Mrs. _____,
>
> My name is [Interviewer name was included here] and I am part of a research group led by [Principal investigator name was included here] of Carnegie Mellon University. We are studying the use of social media as an emergency response tool. We are contacting you because of your involvement in emergency management systems. We obtained your contact information from _____.
>
> The purpose of this study is to find to what extent social media is being used currently in an emergency response situation. The purpose of this email is to ask your time and availability to participate in a phone interview focused on how your organization manages emergency situations, to what extent social media is or could be used to improve emergency response, and your general opinion on social media as an emergency management tool. The interview will take an estimated time of ten minutes.
>
> Should you require further information regarding our research, please do not hesitate to contact our principal investigator (contact information below). We would appreciate your reply as to whether you are or are not interested to participate in the study.
>
> Looking forward to hearing from you.
>
> Kindest regards,
>
> [Interviewer's contact information was included here]
>
> [Principal investigator's contact information was included here]

2.8 Appendix B. Current Use: Interview Script

Following is the interview script, that was approved the Internal Review Board at Carnegie Mellon University, and was used as a reference for the conducted interviews.

Good Morning/Afternoon,_____,

My name is ____ and I am part of a research group led by [Principal investigator name was

included here] of Carnegie Mellon University. We are studying the use of social media as an emergency response tool. We are contacting you because of your involvement in emergency management systems. We obtained your contact information from _____.
I wanted to ask you a few questions about your emergency response system that should not take more than 30 minutes.

Do you use social media within your organization?

Yes, Social Media Used

What social networks do you utilize to communicate information?

- Facebook?
- Twitter?
- E-mail?
- Texts?
- Phone calls?
- Other?

Do you use an alert system, i.e. to push information?

- If there were to be an emergency situation, how does your organization alert people of the situation?
- In this hypothetical emergency situation, how does your organization provide instructions to people?
- What role do you see the social media used in your organization in the alerting or instructing of people?

- How many members of the general population use your online social media communication tools? (e.g. how many "followers" or "likes"?)
- How long has your organization been using online social media?
- How frequently is your organization's social media used to push information? To pull information?
- What are the strengths/weaknesses of your online social media communication tools?
- Do you think social media is an integral part of your organization?
- What added value do social media, above your normal methods of communication, bring to your organization?
- What do you use as your primary source of communication?

Do you generally use them equally, or do different situations call for different systems?

- If there were to be a natural disaster, would your organization take time to call each person involved in the disaster? First responders? Other emergency managers? Blanket coverage to a specified region?
- If there were to be a human event disaster, would your organization contact each person/individual involved in the disaster? First responders? Emergency managers? Blanket coverage?

- These last two questions would depend on the constituents or the main audience for the organization being organized. For instance, individual contact would be for universities, industry, etc. First responders could be either regional or city. Emergency managers could be regional or national as well as blanket coverage.

Do you have any methods of gathering information, i.e. to pull info? Specifically social media?

- As an organization, how do you gather information in a natural disaster? Human disaster?
- Would you consider your organization's use of social media a viable option to collect information during an emergency?
- If not:
  - Why wouldn't you use social media? Is it too expensive, impractical, etc.?
  - (Possibly suggest a solution?)
- If yes:
  - What are the ways you use social media that make it possible to collect information during an emergency?
- What social networks do you monitor? – This should be answered after asking the above questions.

Do you plan on expanding your use of Social Media?

- Where do you see, in your organization, social media playing a larger role in emergency messaging?
- Would giving social media a larger role in emergency messaging even be possible? Do you think there would be benefits/value to doing so?
- If yes:
  - What role do you see social media playing in your organization?
- If no:
  - Why isn't this possible? Are there guidelines or policies in place that inhibit the expansion of social media in your organization?
- What is your organization's policy on social media?
- What, if any, form of informed consent do the users give?
- Do you use a platform other than the standard user interface (e.g. special information collection software)?

Do you have any other suggestions on people we could talk to?

Have you lost any people by moving towards social media?

If no social media used:

Can you describe your current system:

- What systems do you use to distribute information?
- To collect information?
- How many members of the general population use your non-online social media communication tools?

What are the strengths/weaknesses of your non-online social media communication tools?

- How resilient is it against a disaster? What disaster would cause it to be least useful?
- What is the capacity of your system?
- What is the reliability of your system?
- How frequently is your communication tool used to pull information? To push information?
- How many people use your organization's communication tool?
- What laws/rules/policies exist regarding your information distribution? Information collection?

I am going to ask you a couple of questions about how your system would respond in a specific natural disaster.

- If there were to be a natural disaster, would your organization take time to call each person involved in the disaster? First responders? Other emergency managers? Blanket coverage to a specified region?
- If there were to be a human event disaster, would your organization contact each person/individual involved in the disaster? First responders? Emergency managers? Blanket coverage?
    - These last two questions would depend on the constituents or the main audience for the organization being organized. For instance, individual contact would be for universities, industry, etc. First responders could be either regional or city. Emergency managers could be regional or national as well as blanket coverage.

Do you have any methods of gathering information, i.e. to pull info?

- As an organization, how do you gather information in a natural disaster? Human disaster?
- Would you consider social media as a viable option to collect information during an emergency?
- If no
    - Why wouldn't you use social media? Is it too expensive, impractical, etc.?
    - Are there policies in place that make it less of an option for your organization to consider it? Which ones?
    - (Possibly suggest a solution?)
- If yes:
    - What are the ways you use social media that make it possible to collect information during an emergency?

Do you plan on using Social Media in the future?

- Would giving social media a role in emergency messaging be possible for your organization? Do you think there would be benefits/value to doing so?
- If yes:
    - What role do you see social media playing in your organization
- If no:
    - Why isn't this possible? Are there guidelines or policies in place that inhibit the expansion of social media in your organization?

How many members of the general population use your non-online social media communication tools?

Do you have any other suggestions on people we could talk to?

Thank you for your time to answer our questions. If you have any further questions or concerns about what we are doing, we would be happy to email you our Principal Investigator's contact information. Again thank you for your time, and have a great day!

These were the questions emailed out to interviewees if they preferred an email questionnaire.

Do you use an alert system, i.e. to push information? Guiding Questions:

- If there were to be an emergency situation, how does your organization alert people of the situation?
- In this hypothetical emergency situation, how does your organization provide instructions to people?
- What role do you see the social media used in your organization in the alerting or instructing of people?

What social networks do you utilize to communicate information?

- Facebook?
- Twitter?
- E-mail?
- Texts?
- Phone calls?
- other?

- How many members of the general population use your online social media communication tools? (e.g. how many "followers" or "likes"?)
- How long has your organization been using online social media?
- How frequently is your organization's social media used to push information? To pull information?
- What are the strengths/weaknesses of your online social media communication tools?
- Do you think social media is an integral part of your organization?
- What added value do social media, above your normal methods of communication, bring to your organization?
- What do you use as your primary source of communication?

Do you generally use all of your methods of communication equally, or do different situations call for different systems?

- How many members of the general population use your non-online social media communication tools?
- If there were to be a natural disaster, would your organization take time to call each person involved in the disaster? First responders? Other emergency managers? Blanket coverage to a specified region?
- If there were to be a human event disaster, would your organization contact each person/individual involved in the disaster? First responders? Emergency managers? Blanket coverage?
    - These last two questions would depend on the constituents or the main audience for the organization being organized. For instance, individual contact would be for universities, industry, etc. First responders could be either regional or city. Emergency managers could be regional or national as well as blanket coverage.

Do you have any methods of gathering information, i.e. to pull info?

- As an organization, how do you gather information in a natural disaster? Human disaster?
- Would you consider your organization's use of social media a viable option to collect information during an emergency?
- If not:
    - Why wouldn't you use social media? Is it too expensive, impractical, etc.?
    - (Possibly suggest a solution?)
- If yes:
    - What are the ways you use social media that make it possible to collect information during an emergency?

What social networks do you monitor?

- What added value do social media, above your normal methods of communication, bring to your organization?

Do you plan on expanding your use of Social Media?

- Where do you see, in your organization, social media playing a larger role in emergency messaging?
- Would giving social media a larger role in emergency messaging even be possible? Do you think there would be benefits/value to doing so?
- If yes:
    - What role do you see social media playing in your organization?
- If no:
    - Why isn't this possible? Are there guidelines or policies in place that inhibit the expansion of social media in your organization?

Do you have any other suggestions on people we could talk to?

Do you use a platform other than the standard user interface (e.g. special information collection software)?

3 Public Preferences

3.1 Introduction

The many variations of social media, including but not limited to Facebook, Twitter, LinkedIn and even SMS/Text messaging, have taken on an increasingly dominant role in everyday communications and event organization. Nowadays, it is possible to organize and mobilize large crowds through a few simple social media posts, which can be pushed to a multitude of different electronic devices, allowing a new level of efficiency for large-scale communication (Foot and Schneider, 2004). In an effort to narrow down the expansive field and possible avenues of social media usage, we focus on the implementation of social media in the context of emergency alert systems and as a tool for emergency victims and emergency responders. Before any practical applications for emergency messaging can be made however, the limitations and assumptions associated with social media and its users must be well defined.

More specifically, one limitation of this new communication frontier is the necessity that one must be "plugged in," or have access to electronic media compatible with social media, to participate in the overall social media conversation. This connection can be defined in a variety of ways, including account registration on one or several social media sites, paying for texting capabilities on a mobile device and, more generally, access to the Internet. We must also assume that registration with one social media site does not guarantee participation in another site, and registration itself does not guarantee active participation in the absorption and creation of social media content. Some potential users of social media may object to privacy concerns related with having a social media account or they may not have regular access to necessary mediums for social media. In light of these limitations, we must define public preferences and usage tendencies for social media in order to better understand its potential capabilities and additional efficiency roadblocks. Our work addresses some of these implications by determining the preventative features of social media and their current usage trends.

Our research explores specific aspects of social media, including usage tendencies and user preferences with respect to social media usage in emergency situations. We conducted this investigation in the form of a public survey and analysis. With a survey population based in Pittsburgh, Pennsylvania, we have explored and defined the city's tendencies and preferences for privacy and usage of social media, including questions placed in the context of plausible emergency situation scenarios.

Through this work, we have expanded the conversation on useful and effective social media applications, specifically at a time when their efficiency and effectiveness is at an all-time high. With a better understanding of the current relationship between social media and its potential users, the possibilities and boundaries for this ground-breaking means of communications can be

further explored and pushed to their most useful and potentially life-saving capabilities. In the next section we will discuss related work, followed by the methodology of our survey, results, and the conclusions we've drawn from our work.

3.2 Related Work

In the event of an emergency, quick and efficient communication between parties is essential. With the increasing popularity of social networking sites and media, there has been a growing interest in turning to these sources as a means to facilitate communication and connect parties in need of information or assistance. Generally, there is support for the idea of sending and receiving notifications and information during emergencies via social media platforms such as Facebook, Twitter and text messaging. According to Wendy Harman, the director of social strategy for the American Red Cross, "social media is becoming an integral part of disaster response" (American Red Cross, 2011). This includes messages from emergency responders to the general population, messages from individuals to emergency responders, and messages sent between individuals. This has been seen through the prevalence of social media usage in previous emergencies (both natural disasters and man-made emergencies such as terrorist attacks) (Burke et al., 2010; Foot and Schnieder, 2004; Sutton et al., 2008). Despite these successes, there are some issues that prevent social media form taking over the communication process in the event of an emergency situation. A significant roadblock includes privacy concerns, such as a reluctance to share personal information via social media. If a large portion of the population is unwilling to share information that could be essential to providing needed emergency assistance, the effectiveness and efficiency of social media as a tool for emergency communication and assistance may be compromised (Consolvo et al., 2005).

In our proposed study of emergency messaging with social media in Pittsburgh, we aim to determine public perception of social media and how it may be utilized in times of emergency. We explore the usage tendencies and privacy preferences for social media in the Pittsburgh area through the dissemination and analysis of an online and paper survey. To increase our understanding of the issue at hand, we have reviewed a series of social media studies related to emergency situations. Our review tackles a variety of topics, including social media usage in previous case studies and the development of user privacy concerns and preferences.

3.2.1 Usage Preferences

Foot and Schneider (2004) discuss the role of different media in the aftermath of the terrorist attacks on September 11, 2001. When referring to a 2001 study by R. Goldsborough entitled "In a Crisis, Old Media Trump New Media," they write,

> *"Although Goldsborough argued that television trumped the Internet in delivering breaking news in the immediate aftermath of the attacks, he noted that the web provided several distinct advantages: more depth, a greater number of*

perspectives, archives of visual images, and more firsthand accounts through personal websites or blogs." (Foot and Schneider, 2004)

This research primarily shows that in the event of an emergency, traditional media, such as television, is used most frequently in the immediate time following an emergency (Foot and Schneider, 2004). However, social media and the Internet serve as better tools for communicating in the time after the emergency has occurred. In our research, we are interested in user preferences for social media and traditional media in the context of localized and large-scale emergency situations. While Foot and Schneider limit the discussion to preferences in the September 11th terrorist attacks, we intend to bring new insight by surveying only Pittsburgh residents. Our survey will also explore how user preferences change for different types of emergencies.

Burke et al. (2010) conducted a study regarding the behavior and actions of musicians during the aftermath of Hurricane Katrina with respect to communication and the Internet. Specifically, they studied musicians that lived in New Orleans who ultimately left following Hurricane Katrina. They monitored the frequencies in which different types of media were used during the immediate aftermath as well as in the weeks and months that followed. While the study focuses mostly on the behavior, feelings, and effects of the hurricane on the musicians, it also monitors the preferences of a group of people directly involved in Hurricane Katrina. The researchers found that cell phones were mostly used by the musicians in the immediate aftermath to call or text family and friends that were stranded in the city (Burke et al., 2010). Cell phones were a greater resource than the traditional television news media at this time. At this point, new media (e.g. blogs, MySpace, online maps, etc.) also served as a way in which the musicians could directly see what was going on within the city and the overall state of the city. In the time following Katrina, most people were not allowed to return to the city, however these new mediums granted citizens insight as to how the environment looked and functioned. For example, those who were stranded could post pictures of the devastation. This study gives us a good starting point for identifying the different types of emergency situations that affect social media and Internet usage.

In addition, Pavic Juric of Louisiana State University (LSU) studied the differences in media use between American and international LSU students following Hurricane Katrina in New Orleans (Juric, 2006). Specifically, Juric conducted a survey of over 350 students to determine students' main sources of information after Hurricane Katrina, which sources of information the students believed to be the most reliable, and to compare media usage between genders (Juric, 2006). International students were surveyed in their mandatory English classes (Juric, 2006). Questions on the survey required students to name their sources of information during Hurricane Katrina (including TV, Internet websites, mobile phones, text messages, etc.), to rate how well the sources relayed information, and how valid the information was (Juric, 2006). Students were also

asked if their household was out of power during the hurricane, how long their house was out of power, and what alternative media sources were used in this situation. The paper concludes that television was the primary source of information for both American and international students; however, in cases where students did not have power, the primary media source was battery-operated radio. Our survey aims to obtain information in a similar fashion as this survey in the form of hypothetical questions about user preferences in specific emergency situations that could occur in the city of Pittsburgh, such as floods and snowstorms. However, instead of just surveying college students as Juric did, our survey population is comprised of a wider demographic of Pittsburgh residents. While a large number of respondents are in fact students, we were certain to differentiate them from non-student Pittsburgh residents. With this differentiated information, we were able to further compare the social media preferences of college students with those of the general Pittsburgh population.

Sutton et al. use the case study of the 2007 Southern California wildfires to illustrate the fact that community information resources and other types of backchannel communication via social media were widely used during these wildfire emergencies. Backchannel communication is defined as peer-to-peer communication, in contrast with official or formal communications to the public (Sutton et al. 2008). Backchannel communication allows the public to actively create information rather than passively reading about it. This ability is realized commonly in the form of flexible social media technology. While this case study of wildfires is prevalent to Southern California, our survey evaluates public preferences of social media usage in emergencies prevalent in Pittsburgh, ranging from a large-scale snowstorm to nearby shootings. This range of emergencies allows us to gauge whether or not social media could be effectively used in a variety of emergency scenarios. Based on the ability of backchannel communication to enable people in the wildfire emergencies to be creators of information, our survey specifically explores how many of our Pittsburgh participants in classify themselves as content creators, content viewers or perhaps a combination of the two.

In exploring how social media can be used in emergency situations, Prentice and Hoffman (2008) specifically explored how these tools can assist emergency management organizations in their communications with people. The paper first describes how social media has changed through the years, the different uses of the various social media platforms that are available, and the significance of user-generated content. Prentice and Hoffman stress the importance of social media by highlighting how a social media presence can bring legitimacy to an organization by generating a public following, how social media can ensure that communications are received, and how social media is a highly efficient method of communication (Prentice and Hoffman, 2008). To help convey how effective social media is in spreading information about emergencies, the authors include a case study illustrating how social media helped inform a city in Florida about a prison escape emergency. Prentice and Hoffman also suggest ways emergency management organizations can use social media to effectively communicate with the public and

media, namely through establishing and monitoring their own “emergency incident blog,” complete with pictures and videos (Prentice and Hoffman, 2008).

One popular social network that has been used during emergency situations in recent years is Twitter. This platform was used as a focal point for a study done by Hughes et al., which indicates that Twitter messages sent during emergencies effectively disseminate information and support information broadcasting. Tweets included more usage of URLs as compared to previous emergencies, suggesting that people were directing followers to sources of information (Hughes et al., 2010). Those who start using Twitter during an emergency are also more likely to continue using Twitter after the emergency situation has passed, including using it for future emergencies (Hughes et al., 2010). This provides evidence that social media may be an effective tool for social media users of Pittsburgh to disseminate information in the event of an emergency situation. To explore this point, our survey asks participants whether or not they are current social media users, as well as the likelihood that they would use various social media platforms to communicate information in the event a various emergency scenarios.

The American Red Cross conducted a survey in 2011 asking 1,011 telephone respondents and 1,046 online respondents about their preferences in regards to social media and social media usage in emergency situations. The results showed an increase in actual social media usage compared to earlier studies (American Red Cross, 2011). Other results indicated that individuals consider the Internet as their third source of information and updates, behind television and radio during emergencies (American Red Cross, 2011). We included this question in our survey in order to see if this holds true for Pittsburgh residents as well. Another interesting finding is that a majority of respondents think both local and national emergency response organizations should monitor social media sites and their own websites for individuals posting in need of urgent attention (American Red Cross, 2011). This demonstrates a desire for users to not just be able to receive information and news updates from response organizations, but to have two-way communication as well.

After looking at a the usage of various social media platforms by a number of non-profit organizations, David Miller of Grand Valley State University conducted a survey in 2010 to gauge the effectiveness and impact of the groups’ attempts at outreach through social media. Over the course of 600-respondent survey, Miller’s main goal was to find the most efficient tools and approaches that non-profits could utilize in order to have the most impact on the Internet community (or any organization for that matter) (Miller, 2010). Miller also made several recommendations to organizations looking to increase their effectiveness in education and outreach through the medium of social media (Miller, 2010). Miller’s survey asked questions related to non-profit organizations outreach through social media, as well as user consumption of said outreach and information (Miller, 2010). This survey and analysis is relevant to our study, as it looks at not only the user’s preferred social media platforms, as our study does, but also the

effectiveness of its content. By combining Miller's results that indicate the effectiveness of a given social media platform's content with the preferred platforms of social media users in an emergency situation (indicated by our survey results), we are better positioned to determine the most effective social media platform for content consumers and creators alike, in the event of an emergency scenario.

3.2.2 Privacy Preferences

Another aspect of our study deals with user privacy preferences in case of emergencies. For example, many observers of social networks have noted the existence of what has been termed the "privacy paradox" (Barnes, 2006). This is described as a large difference in what people's attitudes towards privacy are compared to how they actually behave in the context of sharing over social media. Though people have many different definitions and interpretations of what privacy means, most tend to want to share information with people that they know, while avoiding disclosure to potentially harmful or unknown people and organizations (Barnes, 2006). Nonetheless, the distinction between private and public data is unclear. Many are surprised to learn how much of what they share online is actually public. As of the 2006 publication, Barnes found that, "Social responses to privacy in social networks do not tend to deal with the potential misuse of personal information. Instead the response is based on the protection of children against predators, which is only one aspect of the privacy paradox" (Barnes, 2006). A major challenge when considering policy options regarding social media is identifying what information people are currently comfortable with sharing. Using social media in emergency situations, such as locating a person, largely depends on the amount and substance of the information they are comfortable sharing. To examine this aspect of social media usage in a current context, our survey includes specific questions on the willingness of individuals to share various types of personal information in the event of an emergency.

Alessandro Acquisti and Ralph Gross of Carnegie Mellon University conducted a study comparing data collected from Facebook and a survey of 506 students that looked at their attitudes towards social media. The survey questioned individuals on their usage, knowledge and opinions of Facebook as a social networking site (Acquisti et al., 2006). They gained further insight by questioning surveyed individuals on general privacy concerns with regards to terrorism, same-sex marriage, and economic policy. They found privacy policy, specifically the regulation of private information, to be a very important issue to their responders. Privacy policy was found to be more important to the respondents than terrorism or climate change, though less so than the state of the economy. The largest concerns about privacy regarded strangers' ability to find information about them. Non-members of Facebook were found to have a greater concern for privacy than members of the social media platform. Users tend to provide a lot of accurate personal information about themselves and are much more likely to exclude a piece of

information rather than provide false information. The researchers note that they "detected little or no relation between participants' reported privacy attitudes and their likelihood of providing certain information" (Acquisti et al., 2006). According to the 2006 study, most participants were aware of privacy settings, a significant amount of people do not know what their privacy settings are or how many people can see their profile. The study also analyzed data from the Facebook profiles of those who took the survey and found that 78% responded accurately in the survey. This survey was done in 2006 when Facebook was fairly new and had only 9 million members. While results are likely to change with the widespread popularity and use of Facebook in 2012, these findings are nonetheless interesting, especially with regards to the 25% of respondents who lacked understanding of the privacy control settings (Acquisti et al., 2006). Our survey updates the privacy implications of this study through a series of questions that gage the privacy setting used and perceived security level by respondents who designate themselves as social media users. By comparing respondents characterization of their privacy settings on a given social media platform (designated as high, moderate, or low privacy settings) and the actual settings implemented by respondents (chosen from a variety of common social media privacy settings, some of which are described in studies below), our results outline more recent overall sentiments of Pittsburgh-area social media users, in regards to personal privacy settings for social media.

How much information people decide to share via social media depends on a number of factors. Frequency of social media usage is one of these, as people tend to be conservative about disclosures at first, but relax their privacy settings over time as they become more comfortable with the usage of the application or website (Sadeh et al., 2009). Furthermore, Young and Quan-Haase found that "personal network size was positively associated with information revelation" (Young and Quan-Haase, 2009). Information revelation refers to the 17 items of information such as "relationship status, e-mail address, and cellular phone number" (Young and Quan-Haase, 2009). The results of this analysis show that people revealed quite a lot of information on Facebook. In the study, people voice three major concerns. The primary concern was that information could be used by strangers to cause harm. Many also voiced concern about data mining and the use of information without their consent, and the third concern was related to information being accessed by others in their network that weren't supposed to have access. Indeed, data analysis revealed that, "concern for Internet privacy was negatively associated with users' information revelation practices. That is, students with a high level of concern for Internet privacy tended to disclose less personal information on Facebook" (Young and Quan-Haase, 2009). However, concern about unwanted audiences had no effect on the amount of information revealed. Common strategies used to protect privacy are the use of personal messages rather than posts, changing the default privacy settings, the exclusion of certain personal information, 'un-tagging' oneself from posts, deleting past messages or posts, the use of limited profile settings, and blocking certain contacts. People rarely provide false information in order to protect privacy claiming that it seems "nonsensical to falsify information because their friends would question the validity of the information disclosed" (Young and Quan-Haase, 2009).

A common strategy adopted to protect information on social networking sites is using 'friends-only' privacy settings. This option allows only friends to see information posted on social networking sites. Stutzman and Kramer-Duffield examined this strategy. They surveyed a group of current undergraduate students. They report that 58.3% of users of Facebook use this privacy strategy. In the study, they found that "expectancy violations by weak ties and increased levels of interpersonal privacy management are positively associated with having a friends-only profile" (Stutzman and Kramer-Duffield, 2010). The results of the study also showed that women were more likely to have a friends-only profile than men and also that users with a larger number of friends are more likely to have a friends-only profile. Their results suggest that most users are only willing to share full information with strong ties (family, best friends) and weak ties (casual friends and acquaintances) (Stutzman and Kramer-Duffield, 2010). Users are typically not willing to share profile information with outsiders such as faculty, potential employers, marketers and law enforcement (Stutzman and Kramer-Duffield, 2010). The two studies on Facebook do a fairly good job drawing a boundary around what people want from privacy functions as well as describing ways in which people control their privacy. However, they do have various limitations. For example, it would be useful to find how these preferences translate to other social media sites such as Twitter, and most of this research involves surveys of teens and students ages 18-24. It would be useful to analyze the privacy preferences of adults as well. For instance, in the research done by Humphreys et al., it is shown that because Twitter users are generally older than Facebook users, there is an implication that they are less likely to engage in privacy protecting behaviors (Humphreys et al., 2010). Furthermore, it was found that Twitter users rarely share personally identifiable information, making it seem they are more cognizant of what they post on social media sites. To better gage privacy preferences among users of various social media platforms, across a range of ages, our survey includes several privacy-related questions, as mentioned above. Our survey puts this information in the context of emergency situations as well, in order to gage any changes in these preferences in the event of emergency conditions.

The work of Sadeh et al. (2009) on the definition of privacy policy related to the mobile social networking application, PeopleFinder, further supports the point that there are multiple factors that go into shaping an individual's privacy preferences. By allowing users to define their own privacy preferences, it is found that people are generally apprehensive about releasing personal information, but these privacy concerns gradually dissipate over time (Sadeh et al., 2009). Individual privacy preferences are the result of a complex interplay of factors ranging from time of day, geographical proximity and relationship with the information requestor. These decision factors corroborate with those identified by Consolvo et al., (2005) who argue that it is possible to deconstruct privacy management and to develop appropriate location-enhanced applications through machine learning. Part of our study focuses on user privacy preferences, in particular their willingness to share personal information in times of emergency. By focusing on

information production and consumption during an emergency, our survey considers many of the aforementioned factors that can affect a user's classification of their privacy preferences.

In addition, the study by Tsai et al. (2010) shows that Internet users have yet to appreciate and to adopt the use of location-sharing applications within social media, although their potential value in times of emergency are understood by users. Tsai et al. found that most users believe that the greatest benefit of such location-sharing applications is to locate people during emergencies, over other scenarios such as keeping track of family members and coordinating social activities. Users also believe this to be the most probable usage of such location-sharing applications. This suggests that users are open to the utilization of social media with location-sharing ability, as emergency messaging tools, especially with wider adoption of such services that is expected in the future. However, the study by Tsai et al. (2010) only surveyed Internet users, thus there may be a bias in the sample selection. Existing Internet users may be more open to new technology and use of location-sharing applications, while non-Internet users may be less inclined toward sharing personal information online. A possible reason for this may be that the non-Internet users are less familiar with how the application or online site works and how the information they shared may be utilized by others, and are thus more hesitant to use them (Sadeh et al., 2009; Consolvo et al., 2005). Our survey addresses this bias by gathering data on the survey respondents' profiles, including as their Internet usage frequency (making sure to designate Internet users from non-users) as well as their preferred privacy control settings.

It should be noted that other studies present a different perspective regarding the understanding of privacy preferences. For example, Palen and Dourish (2003) conclude that users' privacy preferences are the result of a dynamic interaction of circumstances, and are unpredictable. This suggests that it may be irrelevant to try and structure how users may react to situations and thus shape their privacy settings. The study by Sadeh et al. implies a similar concern, for they find that people tend to be inarticulate with their privacy preferences (Sadeh et al., 2009).

While the aforementioned research articles have explored the areas of public preferences in social media and usage of social media as a tool for emergency responders separately, there are additional issues that we hope to address through our study. By focusing on the social media usage and privacy preferences of the Pittsburgh community, we hope to make additional conclusions surrounding the most effective and probable uses of social media in an emergency situation. User's tendencies towards a particular type of social media, their level of frequency, and their perception of potential usage in a variety of emergency scenarios can tells us a lot about how social media can be effectively used in an emergency situation. Privacy preferences of users, as examined in our study, are a relevant indicator of the possible effectiveness or limitations of using social networking sites during emergencies. Although previous work has explored privacy preferences with social media, we are not aware of other studies investigating privacy preferences during emergency situations.

3.3 Methodology

3.3.1 Survey Design

The survey was designed to gauge whether or not Pittsburgh residents were open to using social media for emergency messaging. These public preferences reveal whether social media could best serve as a complement, or alternative, to traditional media. In order to develop a deeper understanding of people's opinions on social media and emergency situations, we constructed a survey that outlined key factors that questioned individual preferences. We designed our survey building on the 2011 Red Cross Survey (American Red Cross, 2011), primarily investigating usage preferences and privacy preferences.

First, we established a set of questions that explored individual's current use of the Internet. This included inquiries on the devices used (e.g. smartphone, desktop computer, etc.), preferred social media platforms, as well as on the frequency of typical usage and how it changes in an emergency. Moreover, we questioned how the public expected first responders to access emergency requests sent via social media and conventional methods as well as expected response times. We attempted to contextualize scenarios for the survey recipients by providing hypothetical and past emergency scenarios such as a nearby shooting and the 2010 Pittsburgh blizzard. For instance, we asked what forms of media were used to both obtain and report information during the snowstorm. By questioning the frequency and manner in which people use the Internet and social media, we were able to understand Pittsburgh residents' general comfort level with using technology on a daily basis as well as during emergencies.

The second part of our survey design consisted of questions regarding privacy preferences and expectations. Our survey used questions such as "what information are you willing to share on a social media site during an emergency" to better understand the effectiveness of using social media for emergency messaging. This section essentially highlighted whether or not people would share their information, how much information should be divulged, who this information is shared with, and through what medium this information would be shared. Our public preferences survey concluded with a series of demographic questions. Used for additional analyses, this section provided the opportunity for us to examine comparisons across different demographic groups.

3.3.2 Recruitment

In administering our surveys, we had to make a number of distinctions in terms of target population, how we would go about distributing both paper and online forms of our surveys, and the specific delivery of surveys. The four areas of methods we want to touch on are our participants, administering paper surveys, administering online surveys, and the limitations we encountered.

The participants in our survey were at least 18 years of age. We were most interested in Pittsburgh residents in order to possibly craft a set of recommendations for emergency responders to use for emergency situations in Pittsburgh. Participants were informed that if they were to participate, they would have the chance to win a $100 Amazon gift card as compensation for their time.

In order to obtain a somewhat representative sample of Pittsburgh we administered paper surveys to 179 people in different areas and neighborhoods of Pittsburgh including the Southside, Waterfront, Oakland, downtown Oakland, East Liberty, Squirrel Hill, Shadyside, North Shore, Schenley Park, Station Square, Strip District. This was not only an attempt to obtain representative demographics of education level, age, gender, and socioeconomic status but also to include people who regularly use the Internet and those who do not. This was to avoid biases towards Internet users. The Institutional Review Board at Carnegie Mellon University approved this study. While giving these paper surveys (attached to the Appendix) we utilized a script to help eliminate any possible bias while asking subjects to take the survey (Script attached in Appendix).

In order to obtain as many participants as possible, we advertised the survey online using non-social media messaging methods such as Craigslist, boringpittsburgh.com, reddit.com, email distribution lists, and bulletin boards in public places around Pittsburgh. In total, we collected 405 online responses and 179 paper responses. We screened out some participants who did not provide relevant answers to open-ended questions or who provided inconsistent responses to some of our multiple-choice questions. After screening, we were left with 390 of the online surveys and 170 of the paper surveys, for a total of 560 responses.

3.3.3 Statistical Analysis

To perform our analysis, we focused on participants' responses to multiple-choice and Likert-scale types of questions. Likert-scale questions were mainly used to gauge participants' preferences towards using social media under different situations. We binned participants' responses to these questions into two groups: agreement (i.e. participant responded very likely or likely) and disagreement (i.e. participant responded very unlikely, unlikely or neutral).

We performed a frequency analysis to determine overall trends in participants' preferences. We further used the Pearson's chi-squared test to compare responses between different demographic groups. These demographics groups were chosen based on factors that may affect social media usage such as gender, income, education, occupation, technical background, Internet usage, and privacy settings on social media sites.

A statistically significant result is defined as having a p-value below 0.05.

3.4 Limitations

While administering paper surveys, we encountered a few issues. Many people we approached declined to complete the survey, with a majority citing its extensive length as the reason for not taking it. On average, the survey took approximately 10 minutes to complete. It is possible those people who may be more invested in the subject of social media message in emergency situations in Pittsburgh may have been the ones who decided to complete it because the extensive time was worth the effort. This would cause us to miss out on the people who are less invested in the subject of social media. Moreover, we were limited because the surveys were based upon self-reported data. This made it difficult to regulate whether or not online and in-person respondents were taking the survey seriously. In order to get around this limitation, we screened all of the completed surveys by cross checking responses and ensuring short-answer responses were legitimate statements.

3.5 Results

The main goal of our analysis is to determine the role of social media in emergency messaging from the perspective of a typical Pittsburgh user. Is social media a viable back-up source of communication in an emergency when traditional media fails? Is social media a complement to traditional media in the current emergency messaging system? In order to answer these questions, we divide our analysis into the following sub-groups:

1) Demographics
2) Internet and social media usage
3) Social media usage during emergencies
4) Communication with emergency responders
5) Privacy concerns

The survey, as well as the results of select questions, can be found in our Appendix.

3.5.1 Demographics

3.5.1.1 General Demographics of Respondents

The demographics explored are shown as follows.

Gender: 50% of respondents were male, 49% female, and 1% chose not to answer.

Age: The mean age was 26.8 years with a standard deviation of 11.2. The age of the respondents ranged from 18 years to 81 years.

Occupation: 12% of respondents were in Science/Engineering/IT fields, 5% in Business/Management, 4% in Education, 4% in Medical, and 25% other. 50% of the respondents were students, of which 61% were Carnegie Mellon students.

Household Income: When asked what their annual household income was, 33% of respondents answered less than $50,000, 24% answered between $50,000 and $100,000, 20% answered more than $100,000, and 23% chose not to answer.

Internet Usage: When asked how many hours spent on average browsing the internet per day, 21% of respondents answered less than 3 hours, 59% answered 3-9 hours, and 20% answered more than 9 hours.

3.5.2 Differences Between Demographic Groups

We compared data across demographic groups to identify any possible trends in social media usage or privacy concerns. The groups of interest to us are defined by demographics such as age and gender, as well as traits such as typical Internet usage. Table 3.5.1 summarizes the different groups that the survey data is sorted by, as well as our initial hypotheses for each group.

TABLE 3.5.1 DEMOGRAPHIC GROUPS TO BE COMAPRED AND INITIAL HYPOTHESES

No.	Group	Initial hypothesis	Valid?
1	Gender: Male, female	Males are more willing to share information (such as contact and location) on social media than females, and may be more likely to use social media as emergency messaging	Valid
2	Income: <$50,000, $50-$100,000, >$100,000 annual household income	People from families with higher income levels have more access to the Internet and social media, and are more open to using social media as emergency messaging	Not Valid
3	Education background: High school graduate or below, current college student, college graduate or higher	Social media usage is unlikely to differ significantly across education levels	Not Valid
4	Current Student Status: student and non-student	College students are more likely to use social media	Valid
5	Internet usage: Low usage (0-3h/day), moderate usage (3-9h/day), high usage (>9h/day)	Heavy Internet users are more willing to mention emergencies on social media channels	Valid
6	Privacy settings: Public, private	Social media users with more public profile settings are more willing to use social media as emergency messaging and mention emergencies via their social media channels	Valid

We explored the validity of each a priori hypothesis in the following sections. A hypothesis was deemed valid if a statistically significant relationship was found between the two variables.

3.5.3 Internet and Social Media Usage

We aim to identify the preferred medium through which Pittsburgh residents obtain and provide information, be it through social media platforms such as Facebook, or traditional media such as government websites or phone.

3.5.3.1 Registration on Social Media Platform

The preferred social media platform for emergency messaging is the one with the greatest outreach, that is, with the largest number of registered Pittsburgh users. All 560 responses to the question “Are you a registered user of any of the following platforms?” are shown in Figure 3.5.1 below.

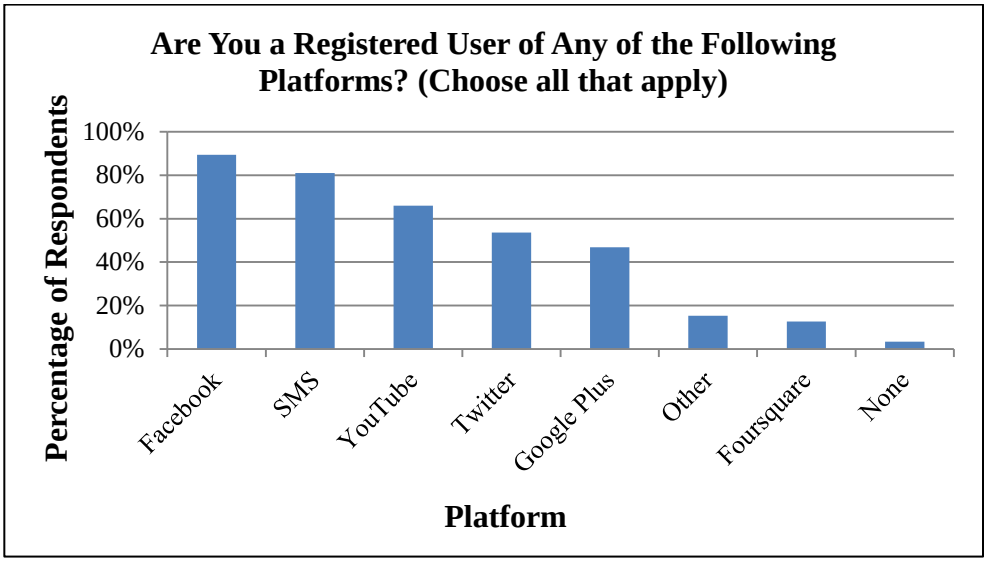

FIGURE 3.5.1 – FACEBOOK AND SMS ARE THE MOST POPULAR SOCIAL MEDIA PLATFORMS

As seen in Figure 3.5.1, Facebook is the most widely used social media platform, with 89% of respondents registered on Facebook. SMS/Text messaging is the next most commonly used platform, followed by YouTube and Twitter. This result suggests that Facebook and SMS/text messaging are likely to be more effective in reaching the largest number of Pittsburgh residents.

Usage of different social media platforms is also considered and analyzed through different demographic groups. As expected, frequent Internet users are more likely to be registered users of various social media platforms than infrequent Internet users (p-values of Internet usage and registration with each platform are below 0.05). A similar result is obtained for people who use mobile devices to access the Internet; mobile device users are more likely to be registered users across all the social media platforms than non-mobile device users (p-values of mobile device usage and registration with each platform are below 0.05). Thus, if social media is to be used as emergency messaging, it will most likely reach those who are already comfortable with using the Internet and those who are mobile device users. Social media will be effective for communication with these two groups, as they are expected to have access to any notifications and updates more quickly and easily.

In addition, a comparison of social media registration between current college students and non-college students is made. Figure 3.5.2 shows the percentage of each group (college students and non-college students) that are registered with each platform.

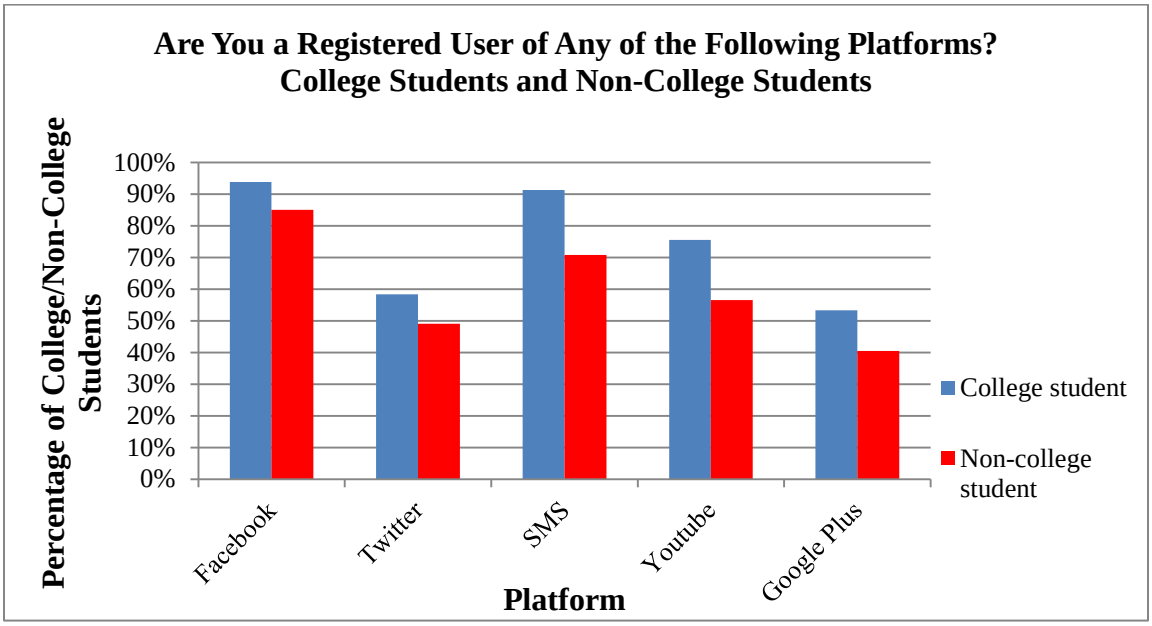

FIGURE 3.5.2 – COLLEGE STUDENTS ARE MORE LIKELY TO BE REGISTERED FOR SOCIAL MEDIA PLATFORMS THAN NON-COLLEGE STUDENTS

In general, college students are more likely to be users of Facebook, Twitter, SMS/Text messaging, YouTube and Google Plus than non-college students (p-values of college student and registration with each platform are below 0.05). This result is expected, since college students are more likely to be tech-savvy and comfortable with using social media. However, the result is still useful to campus security personnel, who may be interested to know which social media platform they should use to most effectively reach the student population. By the results shown in Figure 2, Facebook (with 94% of college students registered) and SMS/Text messaging (with 91% of college students registered) are the most widely used platforms. Although the level of Twitter registration (58%) is lower than the registration in other platforms, it is still a considerable fraction of students and cannot be disregarded as an alternative for emergency messaging among college students.

We also found that education levels affect social media usage, in particular Twitter and Facebook, as well as SMS/Text messaging. Education levels were grouped into three categories: up to high school graduates, college/undergraduate degree holders, and graduate degree holders. This result is summarized in Figure 3.5.3.

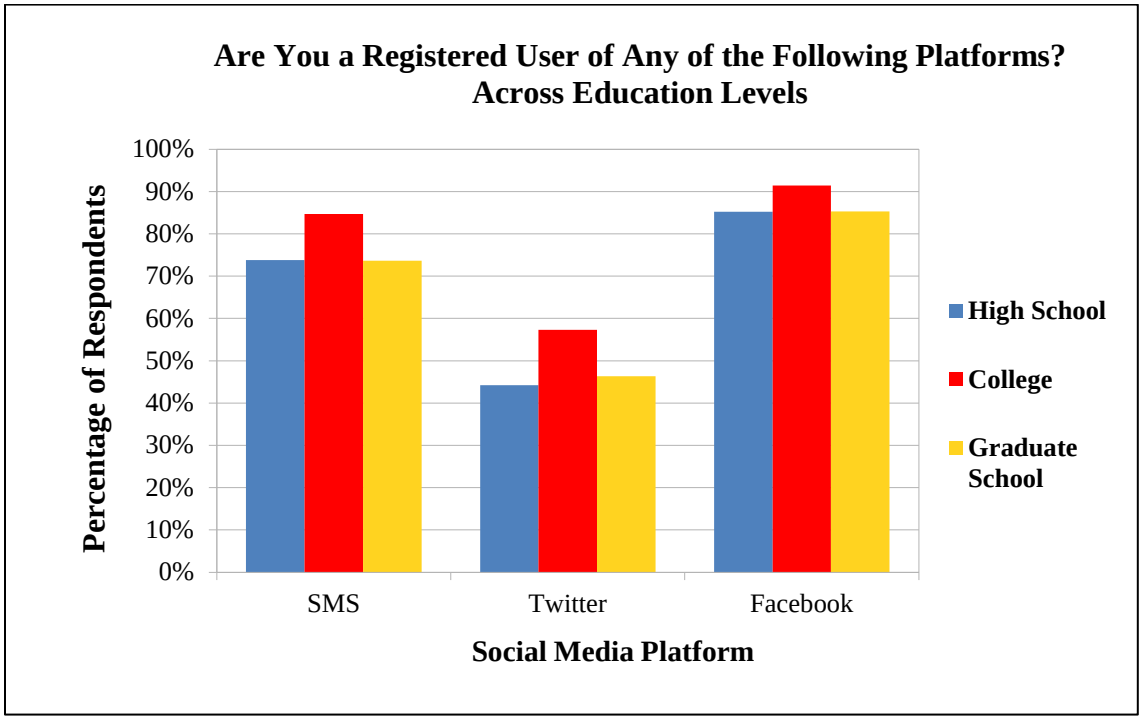

FIGURE 3.5.3 – COLLEGE DEGREE HOLDERS MORE LIKELY TO USE SOCIAL MEDIA

Across these three social media platforms, individuals with only an undergraduate college education are more likely to use social media (p-values < 0.05).

3.5.3.2 Viewing and Creating Content on Facebook and Twitter

In question 4 of our survey, a distinction is drawn between content viewing and content creation. Individuals were asked, "How often do you do the following?" with subsections for viewing and creating content on Facebook, Twitter and SMS/Text messaging. Considering that an active user is expected to both view and create content on social media, this information highlights the likelihood they are to obtain and provide information on social media in times of emergency. Results of this question for Twitter, Facebook and SMS/Text messaging are shown in the Figures 3.5.4 through 3.5.6.

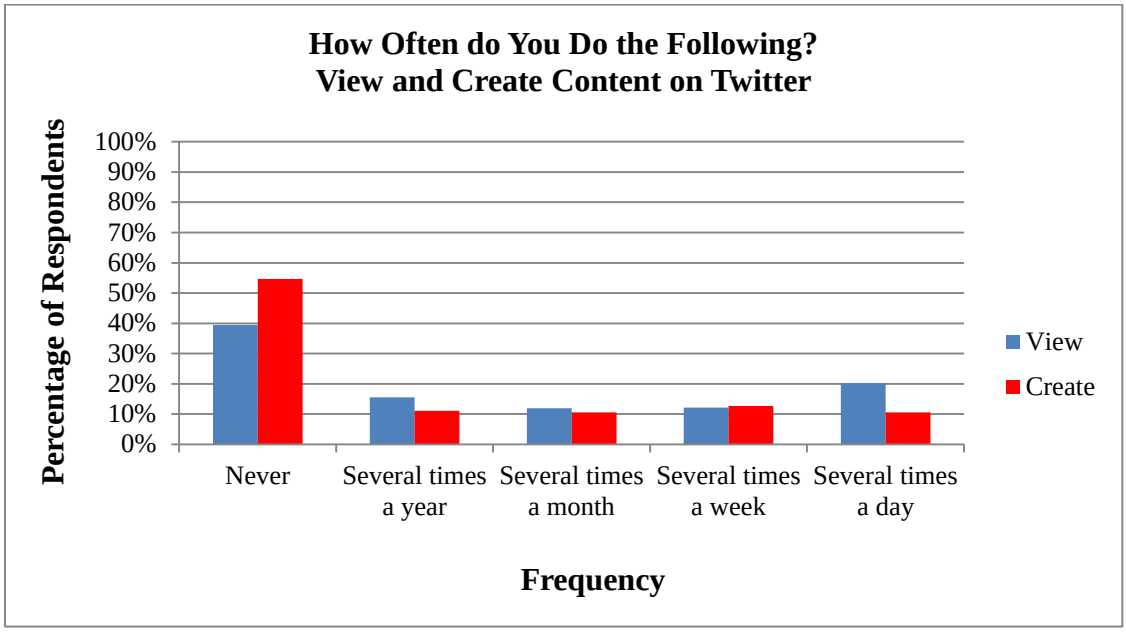

FIGURE 3.5.4 – MORE THAN HALF OF TWITTER USERS NEVER CREATE CONTENT

Figure 3.5.4 shows a total of 51% of respondents reported they never created content on Twitter, leaving the impression it would not be very effective for emergency responders to reliably consider looking at Twitter for emergency requests. In contrast, more users view content on Twitter than create content. Although it was not a high percentage, 23% of responders view content on Twitter several times a day, suggesting that it could be reasonable to use Twitter as a platform for sending out emergency alerts.

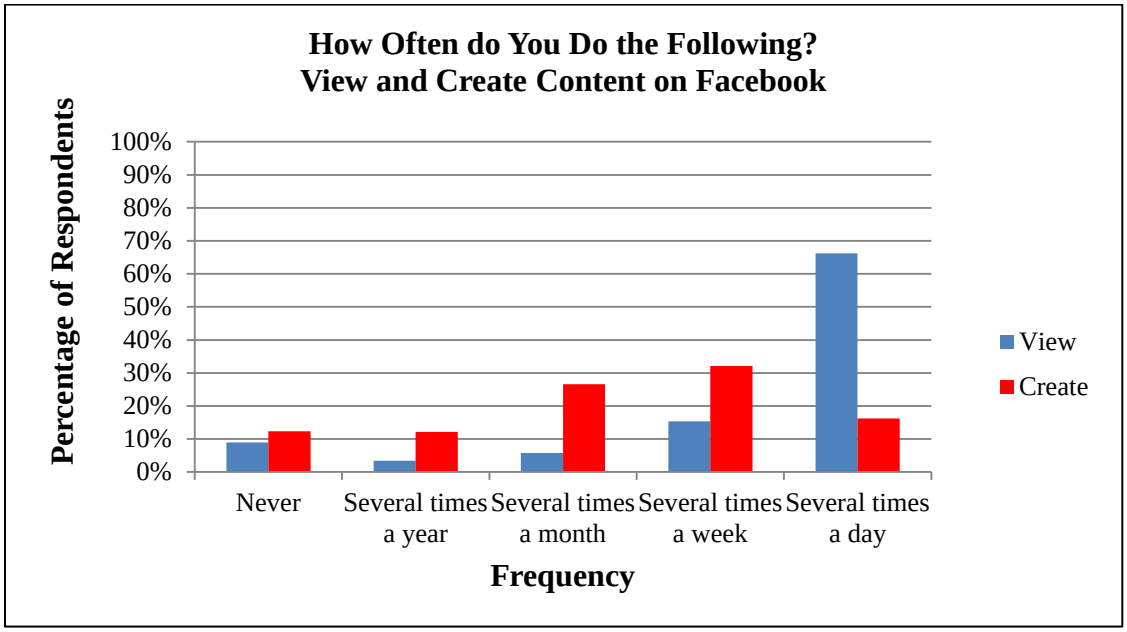

FIGURE 3.5.5 – 73% OF FACEBOOK USERS VIEW CONTENT ON FACEBOOK DAILY

Using Facebook as a platform, a large percentage of responders, 73%, claim to view content on the social media site several times a day. This indicates that Facebook could be a good platform for broadcasting information on emergency situations.

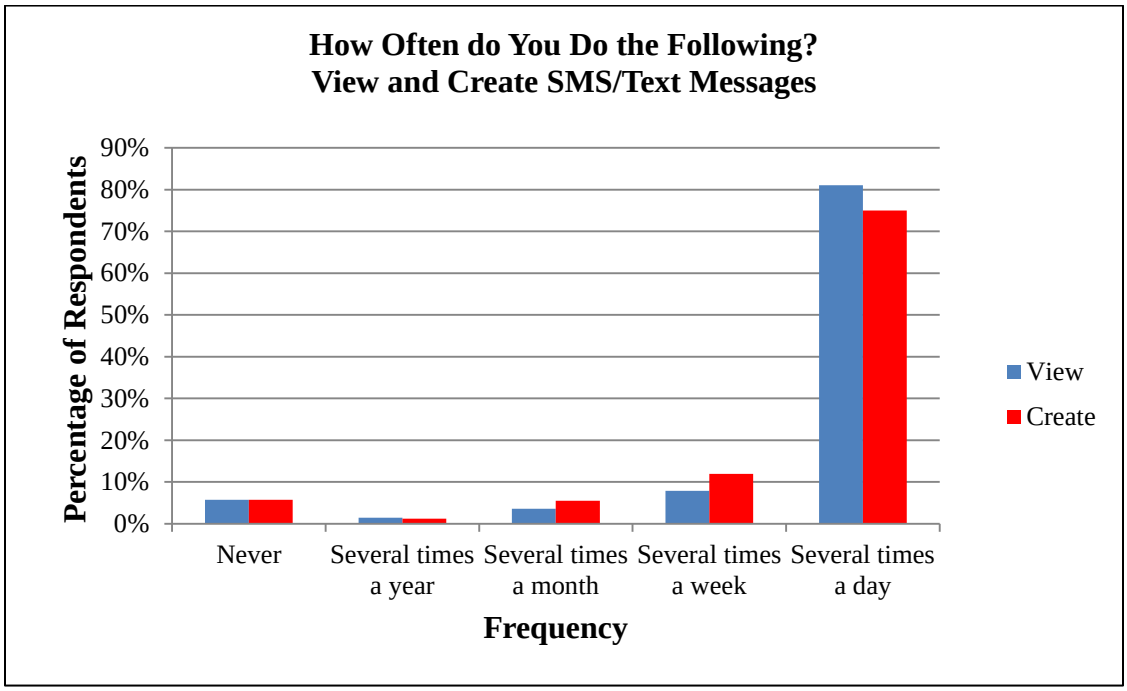

FIGURE 3.5.6 – 84% OF SMS USERS READ TEXT MESSAGES SEVERAL TIMES A DAY

From Figure 3.5.6, it is evident that both sending and reading SMS/Text messages is a very frequent daily activity for surveyed Pittsburgh residents (84% and 76% respectively). This information is useful in that it shows respondents may be willing to resort to traditional forms of communication, particularly using their phones, to obtain and report information in emergency situations because it is more accessible.

3.5.3.3 *Mentioning Emergencies on Social Media*

Question 7 on our survey, "If you came across the following emergencies or newsworthy events, how likely would you be to mention them on your social media channels?" explores the likelihood that respondents will use social media to report information in a variety of emergency situations. Figure 3.5.7 shows that any of the situations indicate a minimal likelihood to report using social media, including crime, people in need of assistance, traffic jams, downed power lines and car crashes. On the other hand, most respondents are likely to mention a riot or an area shooting on their social media channels. Both of these scenarios elicited a likelihood greater than 50%. A riot emergency would be reported by 60% of respondents via social media, while 53% of respondents indicated they would report an area shooting.

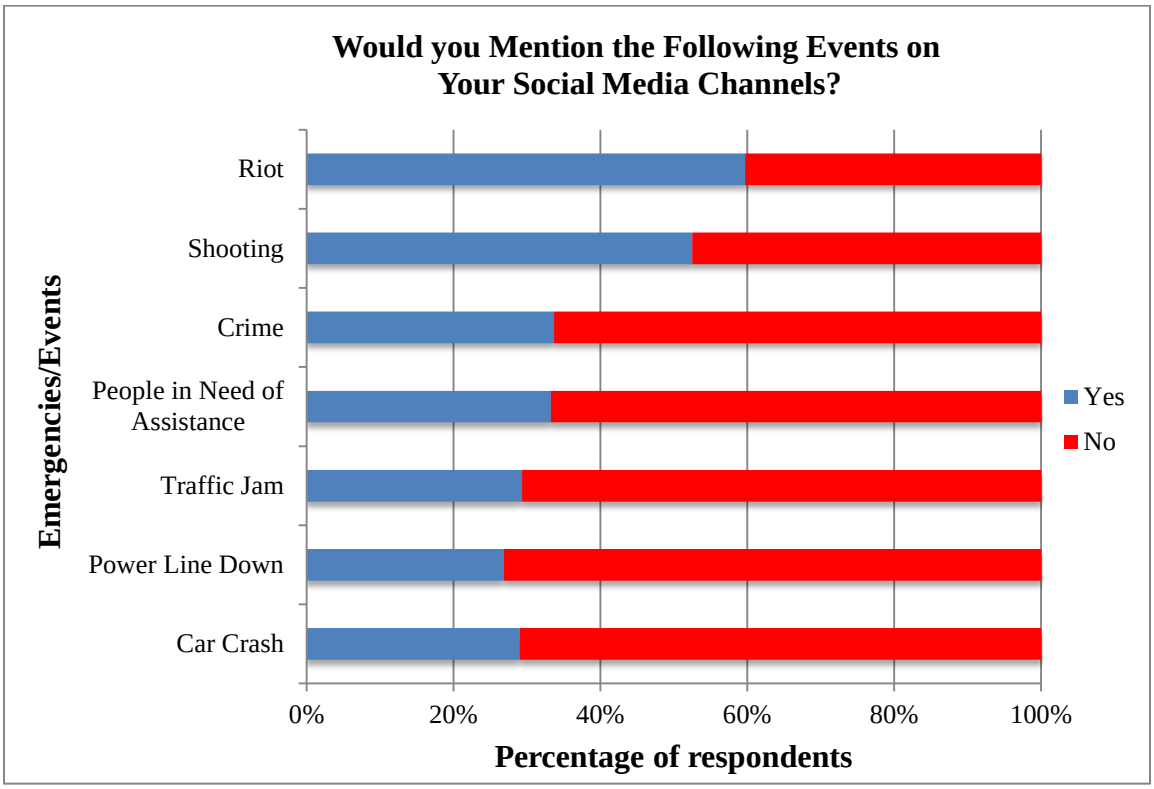

FIGURE 3.5.7 – MORE LIKELY TO REPORT SHOOTINGS AND RIOTS ON SOCIAL MEDIA

When broken down by demographic variables, there are few significant relationships that indicate anything specific about a given demographic. The majority of demographics show a general consensus among respondents as to what events are appropriately and effectively communicated via social media. The survey question that assessed respondents' likelihood to report various emergency situations was broken down by the following demographic indicators:

Education: A statistically significant relationship is found between education and mentioning a riot (p-value = 0.006). Those with higher levels of education are more likely to report the emergency; however, no relationship is found between education level and mentioning a car crash, a downed power line, a flood, traffic, need for medical assistance, a potential crime, or a nearby shooting.

Gender: A statistically significant relationship is found between gender and mentioning traffic (p-value < 0.005) and a potential crime (p-value = 0.033), where women are found to be more likely to report. A moderate relationship is found between gender and mentioning a need for medical assistance (p-value = 0.071), again in favor of female reporting. No relationship is found between gender and mentioning a riot, a car crash, a downed power line, a flood, or a nearby shooting, as all respondents indicated that they would report the emergencies at a fairly similar rate.

Income: There is a statistically significant relationship between income and mentioning traffic (p-value = 0.004). Those indicating lower household incomes are more likely to report the situation via social media, but there is no relationship found between income and mentioning a riot, a car crash, a downed power line, a flood, need for medical assistance, a potential crime, or a nearby shooting.

Technical Experience: There is a statistically significant relationship between those who indicated previous technical experience and mentioning a downed power line (p-value = 0.05), but no relationship between tech experience level and mentioning a car crash, a flood, traffic, a need for medical assistance, a potential crime, a nearby shooting, or a riot.

Internet usage: Internet usage is categorized into three groups, high frequency (more than 9 hours spent on the Internet a day), medium frequency (between 3 and 9 hours a day) and low frequency (less than 3 hours a day). There is a statistically significant relationship between Internet usage and mentioning a shooting (p-value = 0.004) and a riot (p-value < 0.005), where high and medium frequency Internet users are more likely to report the situation.

3.5.4 Social Media Usage during Emergencies

In question 10, we asked "Imagine you hear multiple gunshots fired nearby, but you are not in immediate danger. How likely would you use the following to stay informed about this event and hence be prepared to react safely if needed?" The question provided a Likert scale of very

unlikely, unlikely, neutral, likely and very likely for the following mediums of communication: Word of Mouth, SMS/Text Messaging, News Website, Facebook, TV, Email, Radio, Twitter, and Government Website.

The following is a graph showing the percentage of respondents for each likelihood level of each method of communication.

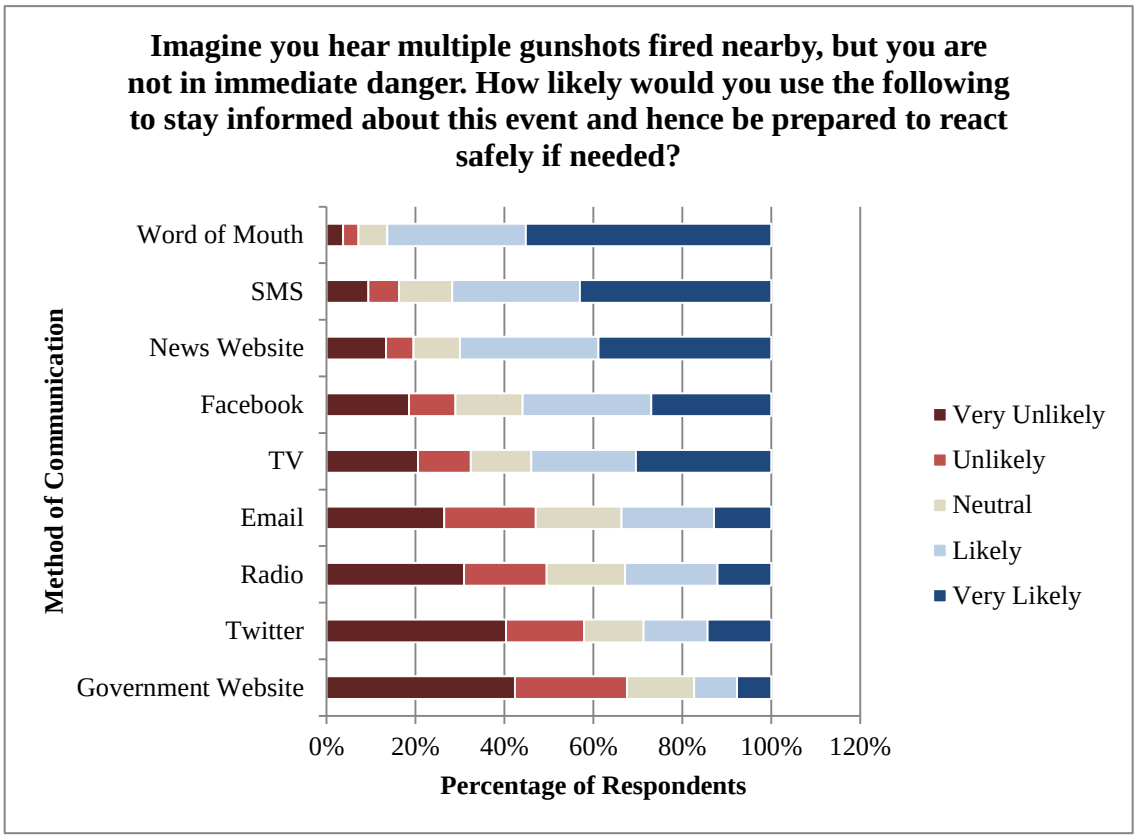

FIGURE 3.5.8 – MORE LIKELY TO USE WORD OF MOUTH, SMS, AND NEWS SITES TO STAY INFORMED DURING SHOOTING

The most popular method of communication was "Word of Mouth," followed closely by "SMS" and "News Website." The least popular were "Government Website," "Twitter," "Radio," and "Email."

In question 11, we asked "Imagine that you are in the same situation as in the previous question. However, in this case you have a medical emergency or know someone who has a medical emergency. How likely would you use the following to seek help?" The question provided a Likert scale of very unlikely, unlikely, neutral, likely, and very likely for the following mediums

of communication: Word of Mouth, SMS/Text Messaging, News Website, Facebook, Email, Government Website, and Twitter.

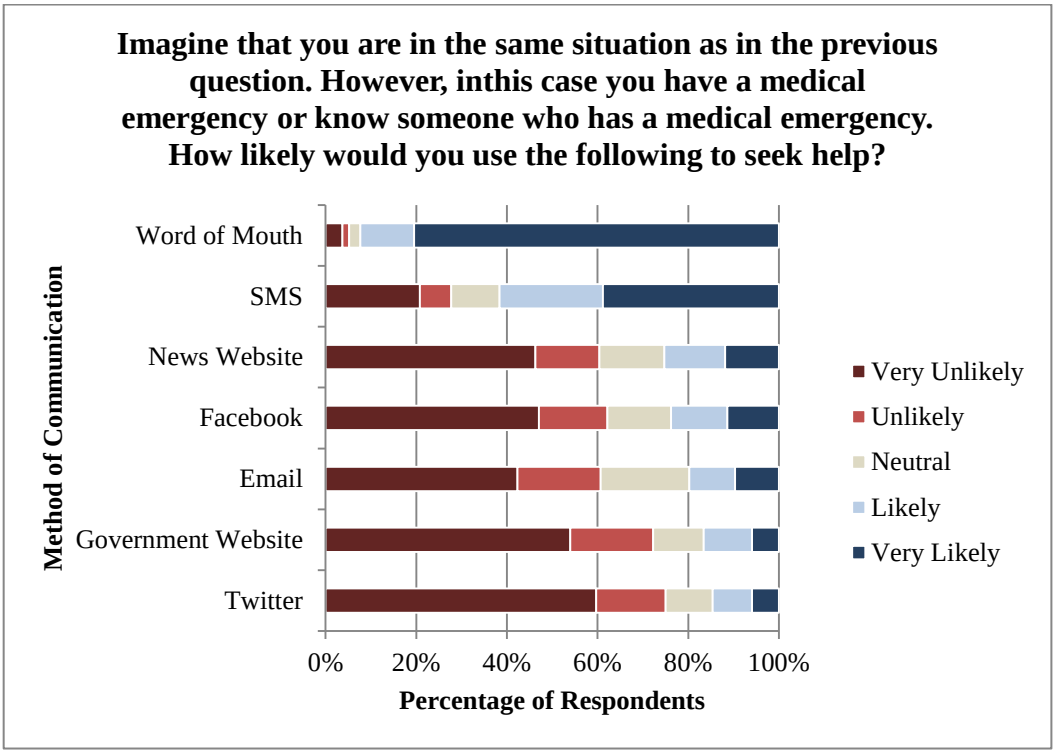

FIGURE 3.5.9 – UNLIKELY TO USE THE INTERNET TO SEEK HELP DURING MEDICAL EMERGENCY

The most popular method of communication to seek help was "Word of Mouth," followed by "SMS." There is a steep drop-off among the remaining methods of communication, with more than half of respondents answering either very unlikely or unlikely.

For both questions 10 and 11, the most popular methods of communication are "Word of Mouth" and "SMS.' In this hypothetical shooting scenario, respondents turned to more traditional methods of communication to both stay informed and to seek help. Almost half of the time, social media such as Twitter and Facebook were very unlikely to be used in order to seek help (Facebook: 47% very unlikely, Twitter: 60% very unlikely). However, Facebook is very likely or likely to be used over half the time to stay informed about the hypothetical shooting scenario.

Reference to the snowstorm of 2010 in Pittsburgh allows us to identify how Pittsburgh residents communicated during an actual emergency. Through question 14, "During the snowstorm, which of the following did you use to OBTAIN information related to the emergency?" we can identify the common media used to obtain information.

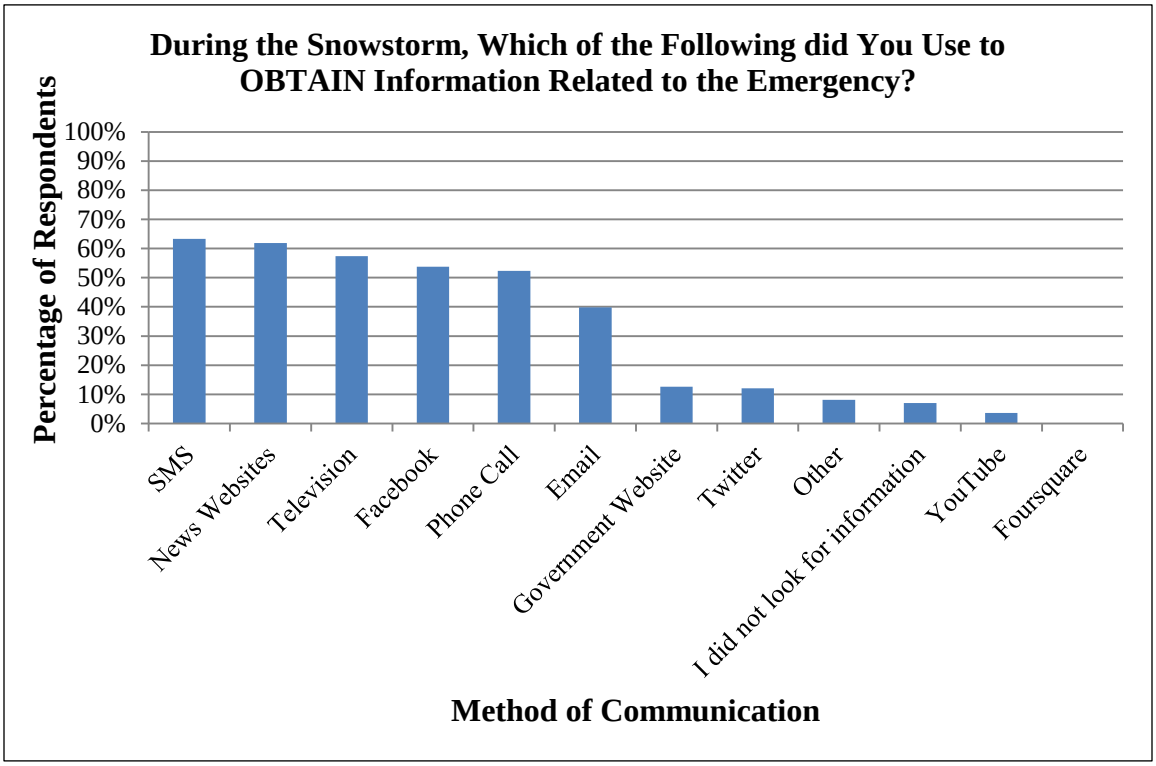

FIGURE 3.5.10 – PITTSBURG RESIDENTS USED FACEBOOK, SMS, PHONE, EMAIL, TV, AND NEWS SITESTO OBTAIN INFORMATION DURING 2010 SNOWSTORM

As shown in Figure 3.5.10, traditional methods of communication such as television and phone calls are still strongly utilized. Furthermore, text messaging and email are also extremely effective methods of communication. As far as social media is concerned, Facebook is the most popular method, aside from text messaging, to obtain information.

Reporting information during the 2010 snowstorm in Pittsburgh is further separated into reporting information to authorities and to friends and/or family. This distinction allows the use of different platforms for personal versus official communication with authorities to be identified. If we can isolate the most popular social media platforms to report information about an emergency to authorities, we can make a recommendation on which social media platform might be best for authorities or relief groups to use to obtain information during an emergency.

In question 15, we asked, “During the snowstorm, which of the following did you use to report information to authorities relating to the emergency? Choose all that apply.” Figure 3.5.11 shows the percentage of respondents who used each method of communication.

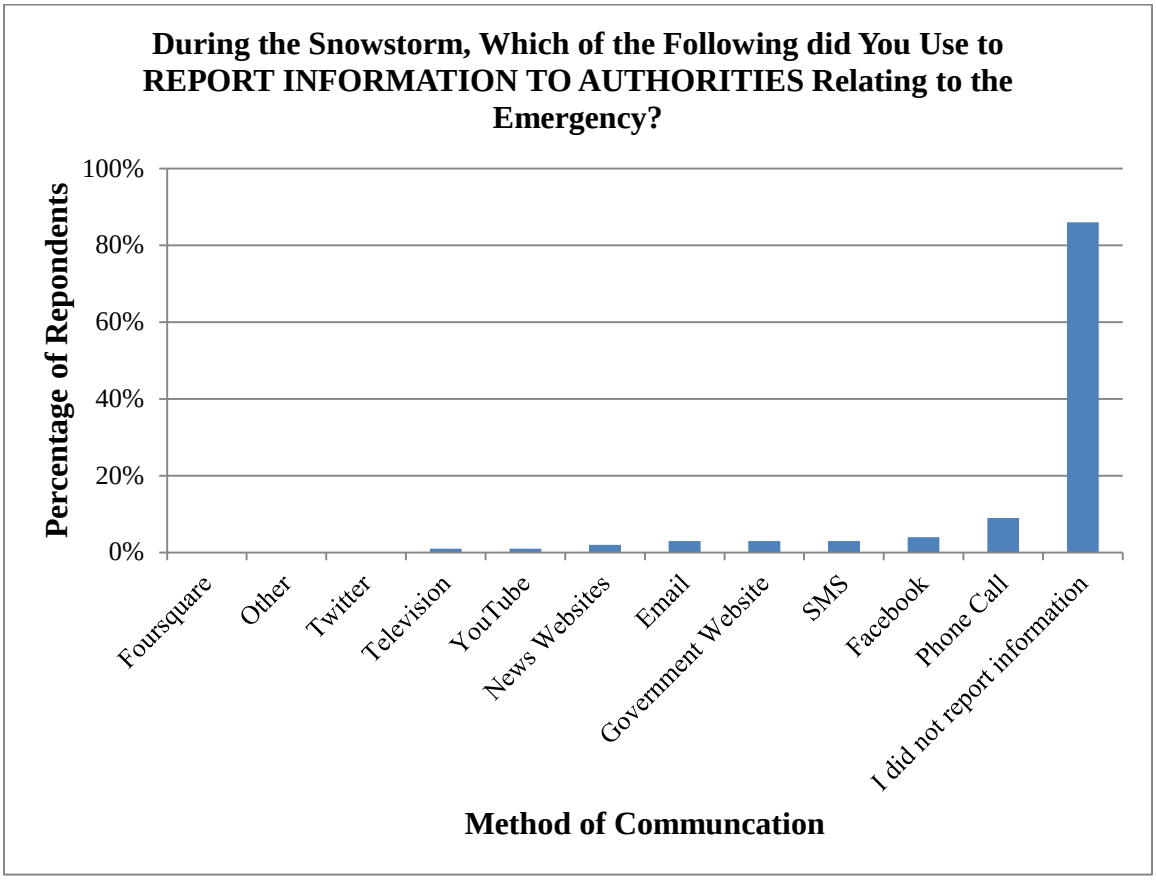

FIGURE 3.5.11 – MOST PEOPLED DID NOT REPORT INFORMATION TO AUTHORITIES DURING 2010 SNOWSTORM

A total of 86% of respondents answered "I did not report information." No respondents used Foursquare or Twitter to report information to authorities. Every other communication method records use by less than 10% of respondents. Most people did not report information to authorities, but the most popular method of communication among those who did report information to authorities was "phone call."

In question 16, we asked, "During the snowstorm, which of the following did you use to report information to friends and/or family relating to the emergency? Choose all that apply." The following graph shows the percentage of respondents who used each method of communication.

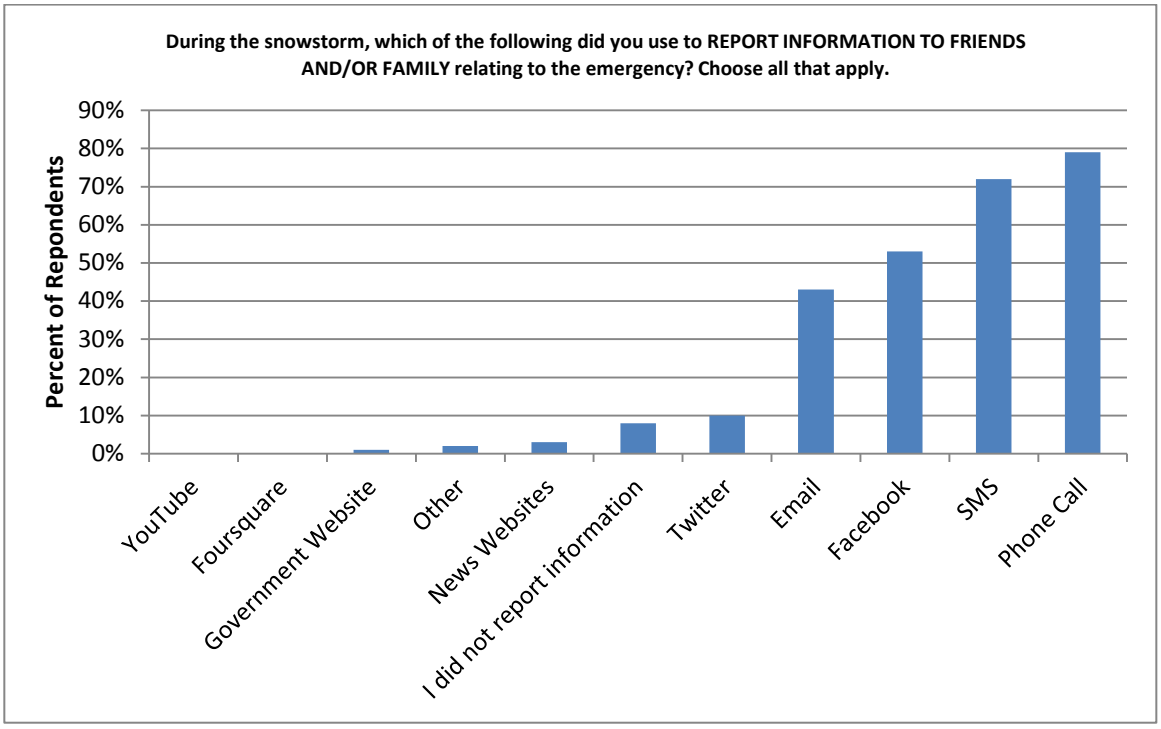

FIGURE 3.5.12 – PIITSBURGH RESIDENTS USED EMAIL, FACEBOOK, SMS, AND PHONE TO REPORT INFORMATION TO FRIENDS & FAMILY DURING 2012 SNOWSTORM

The most popular method of communication among respondents who reported information to friends and/or family was Phone call (79%), followed closely by "SMS" (72%). Facebook was the third most popular (53%). YouTube and Foursquare were not used at all. Unlike question 15, a majority of respondents did report information to friends and/or family.

The following graph compares the results from questions 15 and 16.

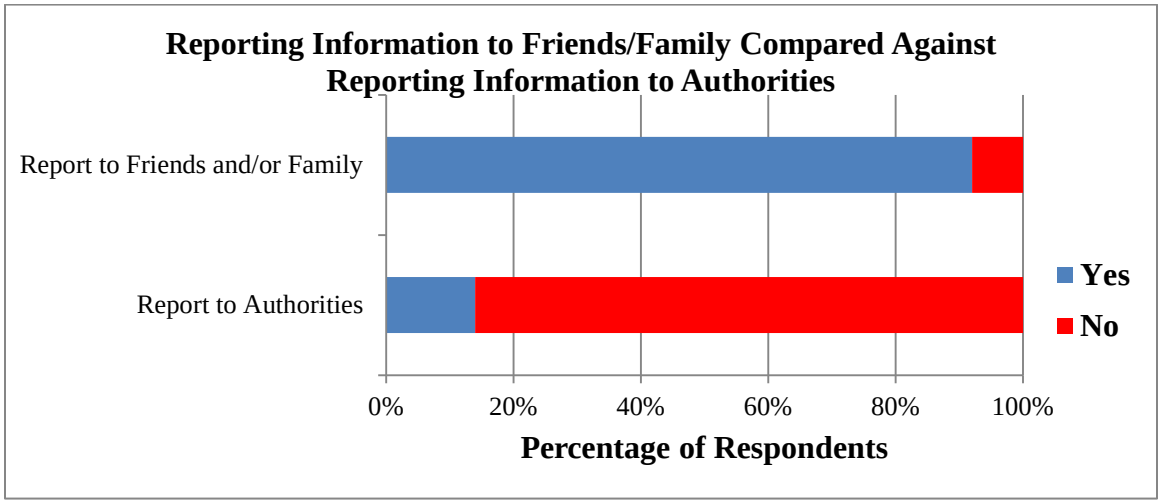

FIGURE 3.5.13 - REPORTED TO FRIENDS/FAMILY MORE THAN TO AUTHORITIES DURING 2010 SNOWSTORM

During the snowstorm in 2010, more people reported information to friends and/or family than to authorities. Only 14% of respondents reported information to authorities as compared to 92% of respondents who reported information to friends and/or family.

3.5.5 Communication with Emergency Responders

Question 17 asks "Which of the following communication methods do you expect emergency responders to respond to? Choose all that apply." Responses to this question help determine the most effective methods of communication with emergency responders. These results are shown in Figure 3.5.14.

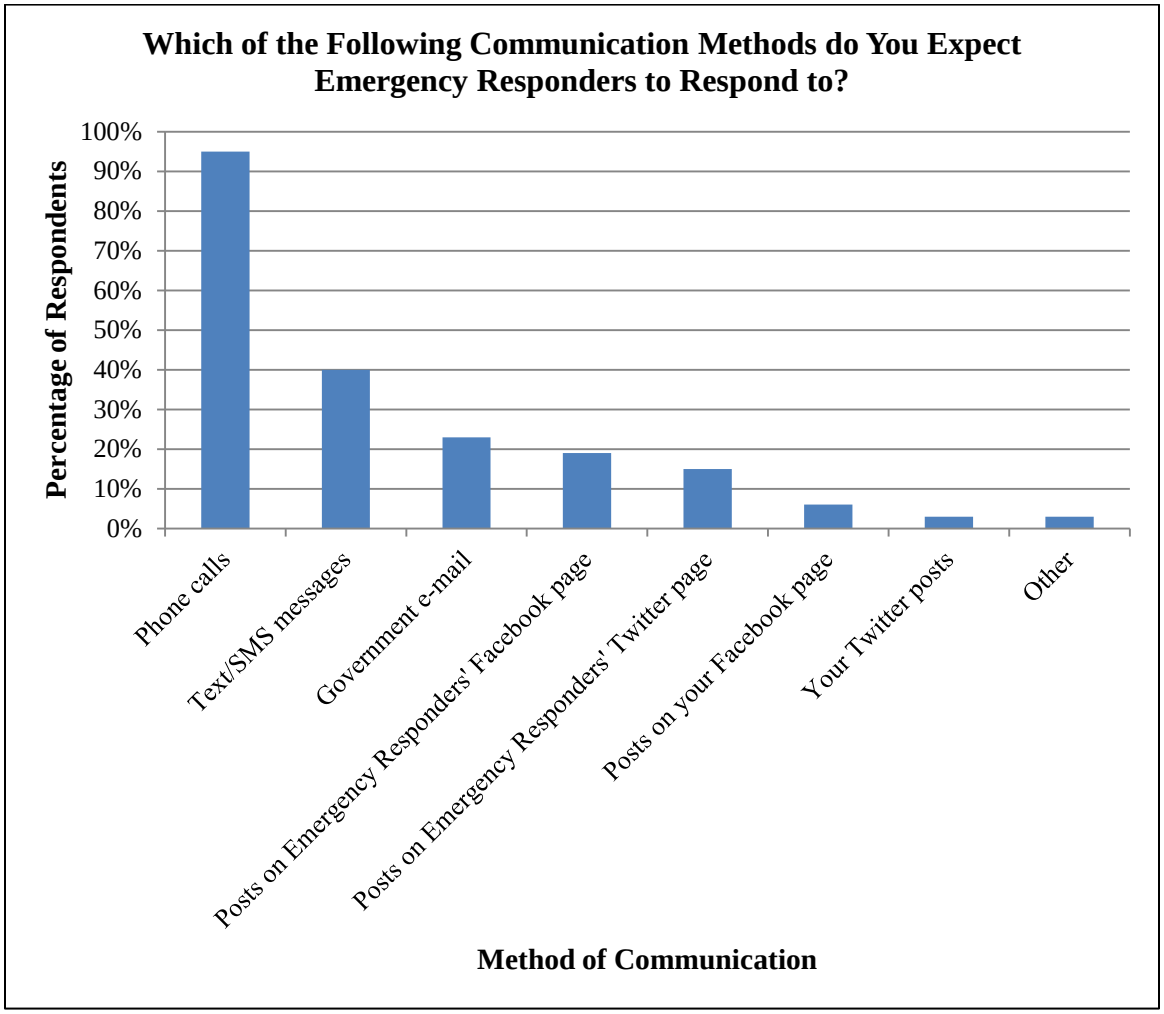

FIGURE 3.5.14 – MOST EXPECT THAT EMERGENCY RESPONDERS REACT TO PHONE CALLS AND TEXTS

Figure 3.5.14 shows respondents to the survey generally did not believe that social media is an effective method of communication. The vast majority of survey respondents expect emergency responders to respond to phone calls, and a significant minority expects responses to text messages. However, few respondents expect their Facebook or Twitter posts to be monitored by emergency responders.

Furthermore, respondents were asked "If you posted a request for help to a social media website, how long do you think it should reasonably take for help to arrive?" To this question, 14% responded "less than 15 minutes," 23% responded "15 minutes to 30 minutes," 18% responded "30 minutes to 1 hour," 22% responded "1 hour to 3 hours," and 22% responded "more than 3 hours." Few respondents expect a response time of less than 15 minutes and only 37% expect a response of less than half an hour. However, given the wide variety of responses, it is possible that respondents were confused by this question and did not understand what was meant by a "social media website." If expectations do not match actual response times, emergency

responders could aim to meet these expectations, or it could suggest that the public should be educated on realistic expectations and times.

Next, question 20 asked "On which platforms are you willing to receive emergency alerts from authorities? Choose all that apply." The results for question 20 are shown in Figure 3.5.15.

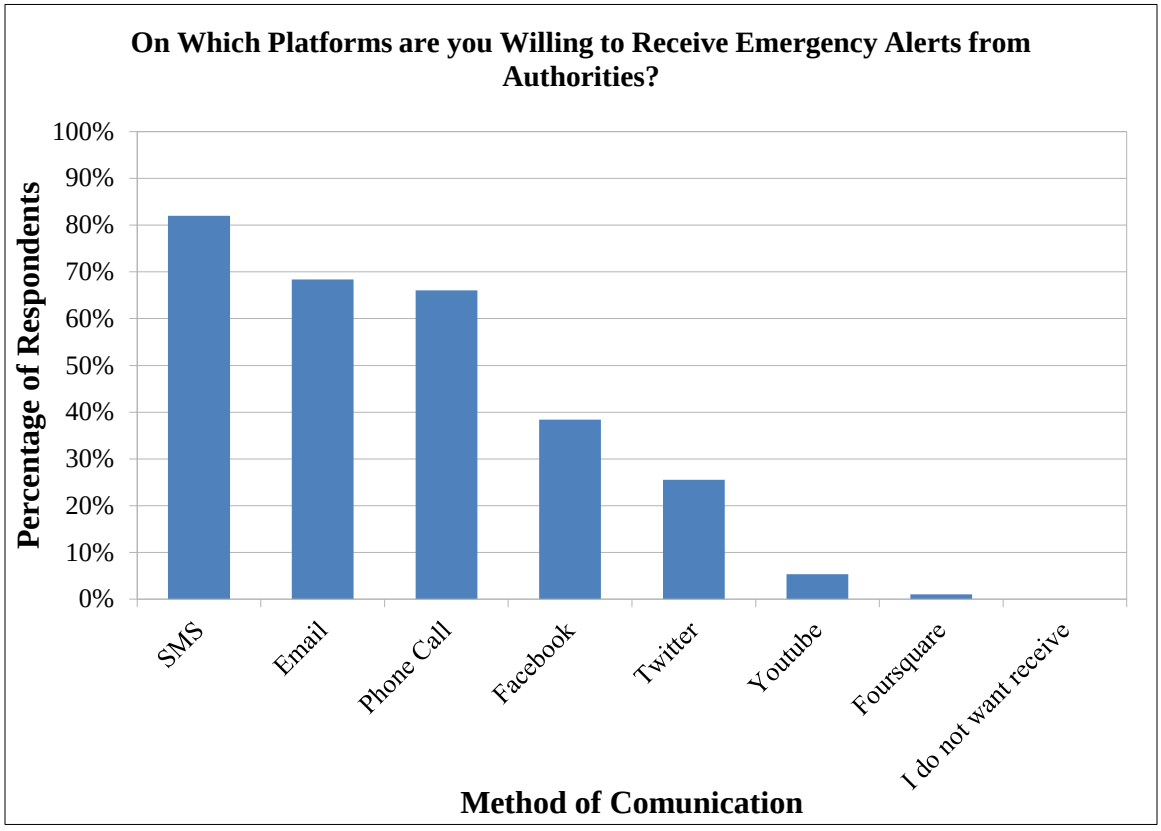

FIGURE 3.5.15 - WILLING TO RECEIVE AUTHORITY EMERGENCY ALERTS MAINLY BY SMS, PHONE, AND EMAIL

Most people are willing to receive alerts via text/SMS messaging, email, and phone calls with text/SMS messaging being the most popular method. A significant minority (38%) also said that they would be willing to receive alerts through Facebook. This may suggest that social media can be used as an opt-in system for receiving emergency alerts. It is possible that these are the platforms that government agencies and emergency responders may be interested in using to disseminate information effectively during emergencies.

3.5.6 Privacy Concerns

Privacy concerns are a possible reason why people may be unwilling to use social media in emergency situations. We compared the results of question 24, which asked "What information are you willing to share on a social media site during an emergency?" and question 25, which

asked “What information do you expect emergency responders to be able to access in an emergency situations even when you did not explicitly disclose that information to the emergency responder?” These results identify any discrepancies between the type and amount of information that social media users are willing to share and what information users expect emergency responders or services to have access to.

Specifically, we looked at privacy preferences through the lens of gender in order to explore the suggestions made by Stutzman’s research included in our literature review. The research indicates females are less likely to share information on social media than males, typically applying higher privacy settings to content posted on their personal social media sites. Our analysis of the survey responses is in agreement with these findings. While both men and women were more willing to share information on social media than not (54% of females and 67% of males fall into the “share” category, as defined by our survey parameters), females had a higher percentage of responses indicating a “don’t share” mentality when compared to their male counterparts. Of the 274 women surveyed, 45% favored the “don’t share” option, while only 33% of the 282 males surveyed chose the same option.

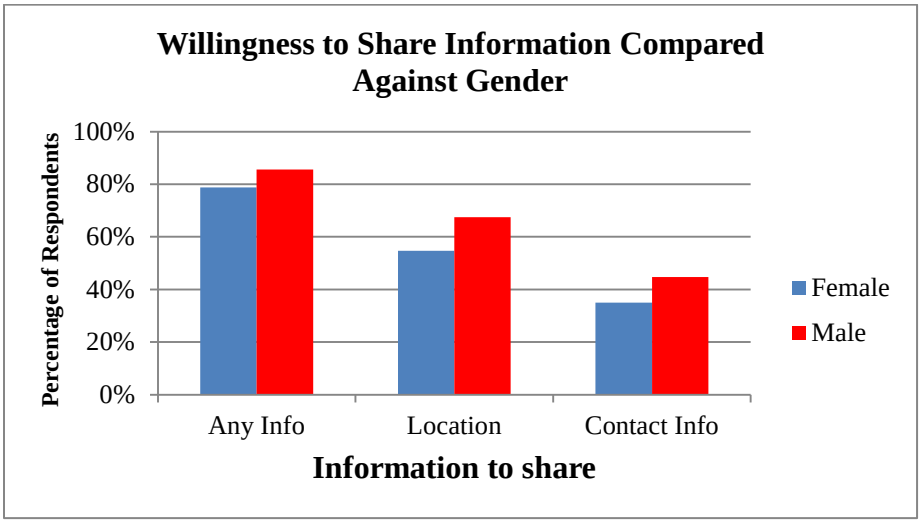

FIGURE 3.5.16 - MALES ARE MORE WILLING TO SHARE INFORMATION THAN FEMALES

As indicated in Figure 3.5.16, women are still suggested to be in favor of higher privacy settings with social media and generally less willing to share information. In the context of sharing contact information, 65% of women opted not to share, while only 56% of men chose not to share on social media. Figure 16 also explores the willingness of respondents to share any information at all (a response other than “none”) versus those who indicated that they were willing to share no information at all. In this case, 21% of women indicated the “none” option, while only 15% of men chose to share no information at all. Overall, females are slightly more likely than males to not want to share any information at all (p-value = 0.07).

Our analysis shows that males are more willing to share information—including contact information and location—on social media than females, which suggests males may be more open to using social media as emergency messaging. Thus our initial hypothesis that males are more willing to share information such as contact information and location on social media than females is valid.

While not all inclusive of privacy scenarios, Figure 3.5.16 is indicative of an overall higher social media privacy preference held by women than those privacy preferences held by men.

Another aspect of our survey analysis that is linked to social media users' privacy preferences is the relationship between users' willingness to share certain information such as location, contact information, personal safety status, safety status of those around, and contact information, compared to the expectation that users have on what information emergency responders are able to access through questions 24 and 25. In question 24 of our survey, we asked what information social media users are willing to share and in question 25 we asked about what information users expect emergency responders to have access to in the event of an emergency. The results are shown in Figure 3.5.17 and Figure 3.5.18.

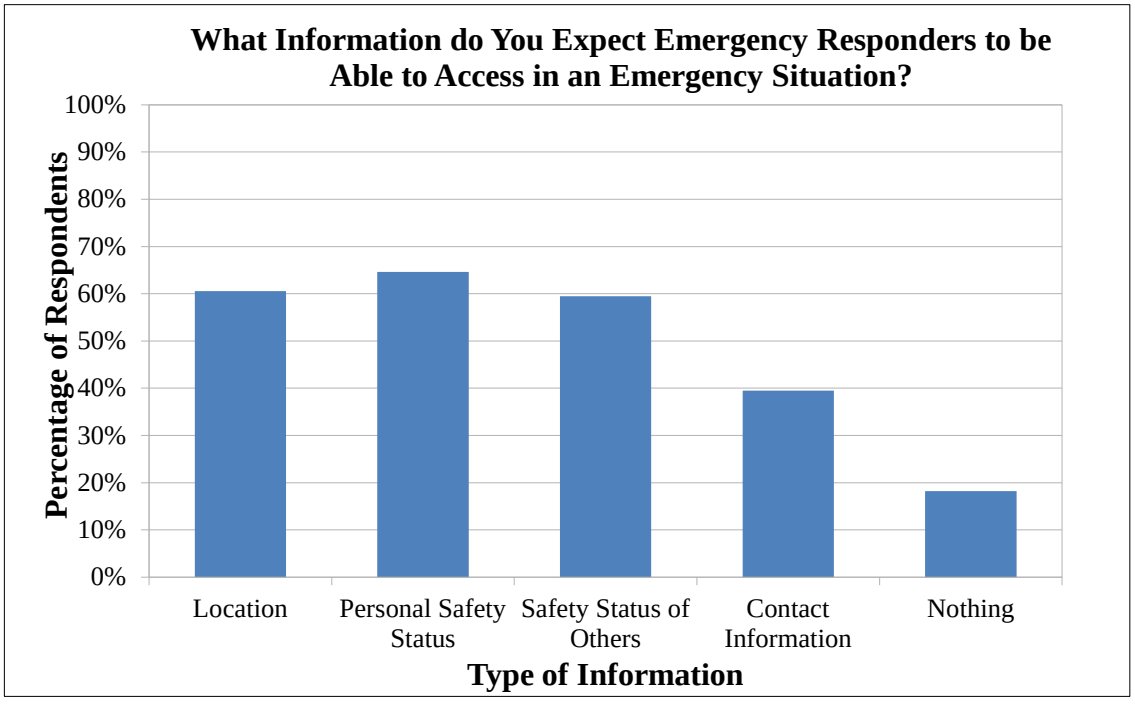

FIGURE 3.5.17 – MORE WILLING TO SHARE LOCATION AND SAFETY STATUS ON SOCIAL MEDIA

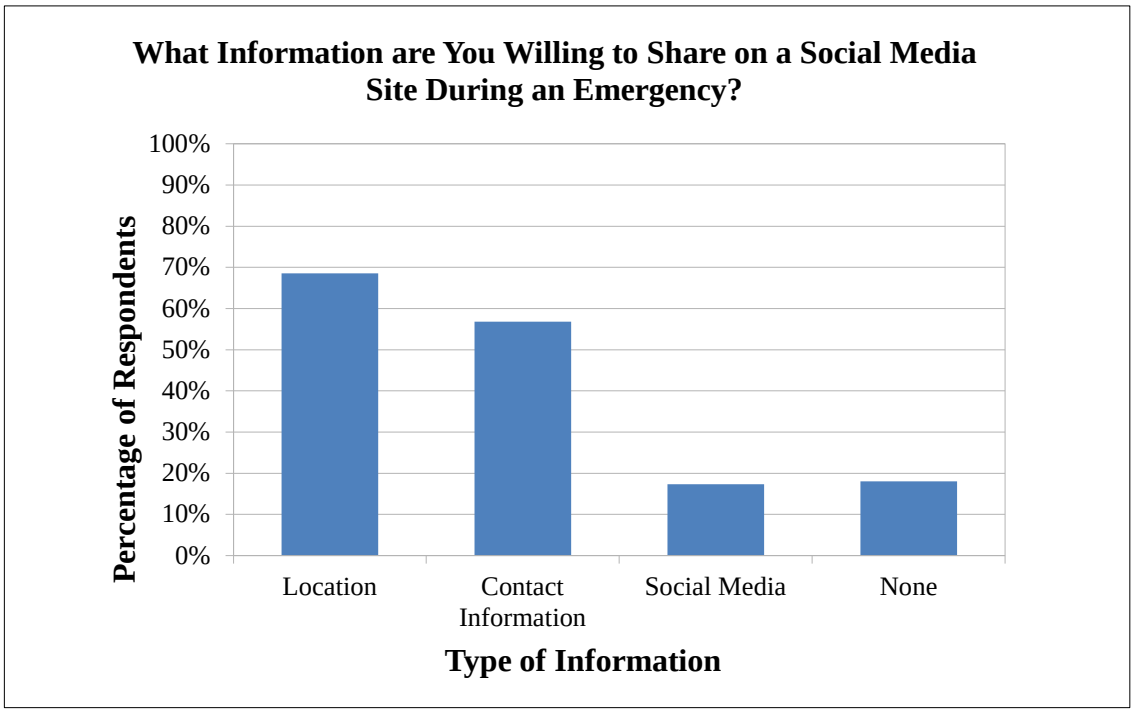

FIGURE 3.5.18 – EXPECT LOCATION AND CONTACT INFORMATION TO BE ACCESSIBLE BY EMERGENCY RESPONDERS

The results indicate social media users are willing to share less information on social media than they expect emergency responders to have access to. For example, less than 40% of responders were willing to share their contact information on social media; however 55% of responders expected emergency responders to have access to it. This is also the case with location, as 60% of all responders indicated they would not share location information on social media. However, the percentage of responders who expected emergency responders to have access to location information reached almost 70%. The causes of these discrepancies are unknown; however, there appears to be a common bias among social media users to simultaneously keep personal information private while expecting responding emergency teams to be able to obtain this data in the event of an emergency. It is also interesting to note that similar percentages of users reported they would not report personal information during an emergency via social media (just under 20%) compared to those who do not expect emergency responders to have access to any personal information in the event of an emergency (again, just under 20%). There is no indication that the same responders who answered “none” for question 24 also answered “none” for 25; however it does not seem unreasonable.

Privacy settings on social media were used as a proxy for privacy concern. Those privacy settings were compared to the responses of question 14 which asked “During the snowstorm, which of the following did you use to OBTAIN information related to the emergency? Choose all that apply.” We asked about methods of communication such as Facebook, Twitter, YouTube, SMS/Text Messaging, phone calls, email, government websites, Foursquare,

television, and news websites. Here, those concerned with privacy were less likely to obtain information from Twitter than those who were not concerned with privacy (p-value=0.004). However, there was no significant difference between those concerned and those not concerned with privacy and the use of any other method of obtaining information that we asked about.

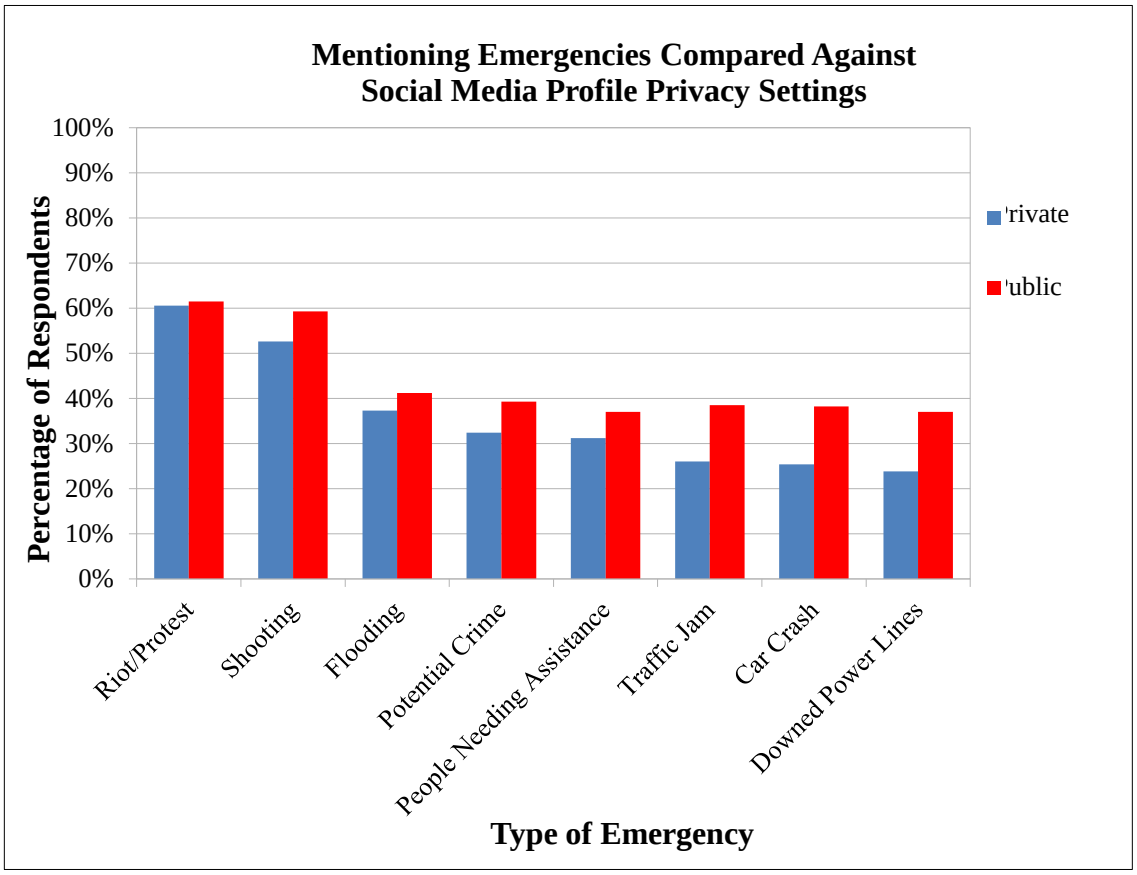

FIGURE 3.5.19 – THOSE WITH PRIVATE PROFILE SETTINGS ARE LESS LIKELY TO MENTION EMERGENCIES ON SOCIAL MEDIA

Some people are more concerned with their privacy while using social media than others. We think individuals who are less concerned with their privacy (i.e. more public profiles) are more willing to mention emergencies on their social media channels as indicated in Figure 3.5.19.

We found that for all potential emergencies we inquired about, individuals concerned with their privacy were less likely to mention it on their social media channels, confirming our hypothesis. There is a statistically significant relationship between privacy concerns and mentioning a car crash (p-value = 0.04), downed power line crash (p-value = 0.02), and major traffic jam (p-value = 0.02).

3.6 Conclusions

We investigated usage and preferences of Pittsburgh residents regarding social media. Overall and unsurprisingly, there is wide adoption of social media platforms. In particular, 89% of participants indicated that they were active users of Facebook, followed by SMS (81%), You Tube (66%), Twitter (54%) and Google+ (47%). Furthermore, we found that mobile devices are widely spread among social media users with 59% of participants accessing social media through a smartphone or similar device several times a day and an additional 8% several times a week. Nevertheless, 26% reported not using mobile devices to access social media.

Additionally, there is a considerably higher adoption of social media platforms among college students. Consequently, social media could be an extremely valuable resource for emergency messaging and alerts on college campuses. Our analysis shows that 94% of college students use Facebook and 91% use SMS. Therefore, these two platforms have the potential of reaching the most students in an emergency alert system on college campuses.

On the potential of social media being used as emergency messaging in Pittsburgh, responses indicate that social media is most commonly viewed by Pittsburghers as a platform to communicate large-scale events that do not present imminent harm or danger. 60% of the respondents were likely to report information on a riot through social media, and 53% would use social media to report a shooting. This is in contrast to all other emergencies, where the majority of respondents would not report any information. We believe that these results might have been influenced by recent events in Pittsburgh. In particular, shooting reports over the few weeks prior to the survey and, although less recent, the riots during the G20 meeting in 2010. On the other hand, traffic jams or crime does not seem to be a major problem in Pittsburgh. This result suggests that participants could have adjusted their opinions to their living environments. Nevertheless, the results still show willingness to use social media under certain scenarios.

In the context of the 2010 Pittsburg snowstorm, more traditional communication platforms such as phone calls (79%) were preferred to broadcast information about the event. However, SMS (72%) and Facebook (53%) were also used considerably. In contrast, to obtain information, SMS (63%) and News website (61%) were more preferred media than television (58%), Facebook (54%) or phone calls (52%). In addition, we found that most of the communication during the snowstorm happened between individuals themselves but not between individuals and emergency authorities. In particular, 94% reported information to friends or family but only 14% reported information to authorities. This suggests that social media is a better tool for peer-to-peer communication, as opposed to communication between individuals and authorities.

When presented with hypothetical emergency situations and asked about their preferred means of communication, participants preferred traditional means such as phone calls. However, SMS, webpages and Facebook were also highly regarded for both communicating with friends and/or

family as well as with the authorities. Since 1 in 5 survey respondents expect emergency responders to respond to posts on official FB pages and webpages, emergency responders could consider monitoring their pages during emergencies for such requests for help.

One interesting result of our survey is the role of texting in emergency response. During the 2010 Pittsburgh snowstorm, 72% of respondents said they reported information to friends and family via text, but what is most fascinating is that 82% of people are willing to receive alerts from authorities via text, and 39% expected emergency responders to respond to texts. There is a demand from the public for texting to be a utilized platform for communication during emergencies, both in terms of communicating with emergency responders and receiving alerts from emergency responders. One potential issue from our survey is that we failed to clearly define "emergency responders." Survey takers could have interpreted this to mean authorities such as police and fire departments or they could have been thinking more in terms of Non-Governmental Organization responders such as the American Red Cross. Typical 9-1-1 systems are unable to receive text messages, and would require a technological and organization upgrade to be able to do so. Emergency response organizations like the Red Cross should be able to offer texting as a means of communication with much more ease. Regardless of the difficulty of implementation, text communication in emergency situations is a potential area to be developed.

The privacy analysis indicates there is a significant relationship between privacy settings and social media usage and there is more of a concern for privacy while creating content than there is for viewing content. In particular, those with more private settings in their social media were less likely to report emergency events on their social media channels. Nevertheless, although not exclusively through social media channels, a large number of participants were willing to disclose their location (61%), safety status (65%) or even contact information (39%) during emergencies. Furthermore, a higher fraction believes that emergency responders can access their location (69%) or their contact information (57%). This highlights an interesting paradox where users expect emergency responders to have access to more information than they are willing to share.

Our results align with previous research in which social media was found to have played an important role during emergency situations; mainly through backchannel or peer-to-peer communication, but not necessarily through communication with emergency responders. Although we do not have a specific cause that explains the lack of involvement with authorities thorough social media, some possible reasons are that, historically, people have been trained to use the phone, that most emergency authorities have not yet embraced the use of social media, and that people fear excessive government monitoring on their social media activity.

Our results are based on public preferences, and indicate what Pittsburgh residents are willing to do and use. Currently, Pittsburgh residents do not seem to be open to the use of social media for emergency messaging. They are far more likely to use traditional methods for communication.

This suggests that social media is seen as a social tool and unlikely to be adopted for purposes of emergency messaging in the near future, unless authorities actively formalize this mode of communication.

Through our results and analysis, authorities and emergency responders may choose to either change their current communication methods to suit the current expectations and usage, such as have greater SMS capabilities for public communication or to shift public preferences toward greater online social media usage. Although, from a users' perspective, traditional media such as phone and television still have a predominant role during emergency situations, Pittsburgh residents seem to be open to alternative ways of communication during emergency situations. Pittsburgh residents are already social media users and many of them access it through mobile devices, suggesting that there may be opportunities to better reach people using social media channels.

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3.8 Appendix. Public Preferences: Scripts and Survey

Would You Use Social Media For Emergency Communications?

We are conducting a study to evaluate the use of Social Media as Emergency Messaging. Help us out with our research by participating in a 10-minute survey and you could win a $100 Amazon gift card!

If you are interested, visit the following link to take the survey:

http://bit.ly/cmuemergency

Thank you!
Policy Analysis Project Course Students

Figure A.1 Recruitment Material

Good afternoon. I'm a student from Carnegie Mellon University. We're doing a survey about people's preferences in regards to social media in Pittsburgh. The survey shouldn't take more than 10 minutes to complete and all information will be kept confidential. Once you finish you can enter an email address for a chance to win a $100 Amazon gift card. Would you like to take the survey?

If you have any questions while taking it please don't hesitate to ask me. Let me know when you've finished and I'll come collect the survey from you.

Figure A.2 Introduction script used with paper survey takers

A copy of the survey follows.

SOCIAL MEDIA SURVEY

This survey is being conducted by Carnegie Mellon students and faculty. Your participation is voluntary and all data collected through this questionnaire will only be used for research purposes. Collected data will not be linked to your identity; it will further be kept confidential by only allowing authorized researchers to access it. The survey collects information on your demographics, Internet usage, and opinions about social media.

We are also offering the opportunity to participate in a raffle to win a $20 Amazon gift card. Your participation in the raffle is also voluntary. Should you decide to participate, you will need to provide an email address that we will use to contact the winners; nevertheless, your email address will not be linked to your responses.

For more information, please contact the Principal Investigator: Lorrie Cranor. Email: lorrie@cmu.edu.

The Carnegie Mellon University Institutional Review Board (IRB) has approved the use of human participants for this study. If you have questions pertaining to your rights as a research participant, or to report objections to this study, you should contact the Research Regulatory Compliance Office at Carnegie Mellon University. Email: irb-review@andrew.cmu.edu Phone: 412-268-1901 or 412-268-5460.

To participate in this study you have to be at least 18 years old and understand the information above.

- ☐ *I have read and understand the information above. I want to participate.*
- ☐ *I prefer not to participate in this survey.*

Do you live in Pittsburgh?

- ☐ Yes
- ☐ No

1. Approximately how many hours do you spend using the Internet per day?

- ☐ Less than 1 hour per day
- ☐ Between 1 and 3 hours per day
- ☐ Between 3 and 6 hours per day
- ☐ Between 6 and 9 hours per day
- ☐ Between 9 and 12 hours per day
- ☐ More than 12 hours per day
- ☐ I do not use the Internet

2. How many hours of the reported above do you use a mobile device (smartphone, iPhone or similar) to use the Internet?

- ☐ Less than 1 hour per day
- ☐ Between 1 and 3 hours per day
- ☐ Between 3 and 6 hours per day
- ☐ Between 6 and 9 hours per day
- ☐ Between 9 and 12 hours per day
- ☐ More than 12 hours per day
- ☐ I do not use the Internet

Social Medial enables people to interact and share information through the Internet. Examples of social media include blogs, chat rooms, discussion forums, wikis, YouTube Channels, LinkedIn, Facebook, and Twitter.

3. **Are you a registered user of any of the following platforms? (Choose all that apply)**

- ☐ Facebook
- ☐ Twitter
- ☐ SMS/Text Messaging
- ☐ YouTube
- ☐ Google Plus
- ☐ Foursquare
- ☐ None
- ☐ Other:

4. **How often do you do the following?**

	Never	Several times a year	Several times a month	Several times a week	Several times a day
View content on Twitter	☐	☐	☐	☐	☐
View content on Facebook	☐	☐	☐	☐	☐
Receive SMS/Text Messages	☐	☐	☐	☐	☐
Create content on Twitter (e.g. Updating your status, posting pictures, etc.)	☐	☐	☐	☐	☐
Create content on Facebook (e.g. Updating your status, posting pictures, etc.)	☐	☐	☐	☐	☐
Send SMS/Text Messages	☐	☐	☐	☐	☐

SOCIAL MEDIA SURVEY

5. How often do you use the following devices to access social media?

	Never	Several times a year	Several times a month	Several times a week	Several times a day
Laptop Computer	☐	☐	☐	☐	☐
Desktop Computer	☐	☐	☐	☐	☐
Smartphone/ iPhone	☐	☐	☐	☐	☐
Tablet/iPad	☐	☐	☐	☐	☐

6. Have you ever experienced an emergency or witnessed a newsworthy event and posted information or photos about that event to a social media site? On which sites did you post this event?

- ☐ Facebook
- ☐ Twitter
- ☐ SMS/Text Messaging
- ☐ YouTube
- ☐ Google Plus
- ☐ Foursquare
- ☐ Never posted information or photos
- ☐ Other:

7. If you came across the following emergencies or newsworthy events, how likely would you be to mention them on your social media channels?

	Very Unlikely	Unlikely	Neutral	Likely	Very Likely
Car crash	☐	☐	☐	☐	☐
Downed power lines	☐	☐	☐	☐	☐
Flooded road	☐	☐	☐	☐	☐
Major traffic jam	☐	☐	☐	☐	☐
People needing emergency assistance	☐	☐	☐	☐	☐
Potential crime	☐	☐	☐	☐	☐
Nearby shooting	☐	☐	☐	☐	☐
Protest or riot in the area	☐	☐	☐	☐	☐

8. **Imagine that a snowstorm is happening in the area where you live. There are already several inches of snow on the roads and is preventing you from going anywhere. How likely would you use the following to stay informed about this event and hence be prepared to react safely if needed?**

	Very Unlikely	Unlikely	Neutral	Likely	Very Likely
Television	☐	☐	☐	☐	☐
Government Website	☐	☐	☐	☐	☐
Facebook	☐	☐	☐	☐	☐
Twitter	☐	☐	☐	☐	☐
SMS/Text Messaging	☐	☐	☐	☐	☐
Word of mouth (e.g. face to face, phone call)	☐	☐	☐	☐	☐
E-mail	☐	☐	☐	☐	☐
Radio	☐	☐	☐	☐	☐
News Website	☐	☐	☐	☐	☐

9. **Imagine that you are in the same situation as in the previous question. However, in this case you have a medical emergency or know someone who has a medical emergency. How likely would you use the following to seek help?**

	Very Unlikely	Unlikely	Neutral	Likely	Very Likely
Government Website	☐	☐	☐	☐	☐
Facebook	☐	☐	☐	☐	☐
Twitter	☐	☐	☐	☐	☐
SMS/Text Messaging	☐	☐	☐	☐	☐
Word of mouth (e.g. face to face, phone call)	☐	☐	☐	☐	☐
E-mail	☐	☐	☐	☐	☐
Radio	☐	☐	☐	☐	☐
News Website	☐	☐	☐	☐	☐

10. **Imagine you hear multiple gunshots fired nearby, but you are not in immediate danger. How likely would you use the following to stay informed about this event and hence be prepared to react safely if needed?**

	Very Unlikely	Unlikely	Neutral	Likely	Very Likely
Television	☐	☐	☐	☐	☐
Government Website	☐	☐	☐	☐	☐
Facebook	☐	☐	☐	☐	☐
Twitter	☐	☐	☐	☐	☐
SMS/Text Messaging	☐	☐	☐	☐	☐
Word of mouth (e.g. face to face, phone call)	☐	☐	☐	☐	☐
E-mail	☐	☐	☐	☐	☐
Radio	☐	☐	☐	☐	☐
News Website	☐	☐	☐	☐	☐

11. Imagine that you are in the same situation as in the previous question. However, in this case you have a medical emergency or know someone who has a medical emergency. How likely would you use the following to seek help?

	Very Unlikely	Unlikely	Neutral	Likely	Very Likely
Government Website	☐	☐	☐	☐	☐
Facebook	☐	☐	☐	☐	☐
Twitter	☐	☐	☐	☐	☐
SMS/Text Messaging	☐	☐	☐	☐	☐
Word of mouth (e.g. face to face, phone call)	☐	☐	☐	☐	☐
E-mail	☐	☐	☐	☐	☐
Radio	☐	☐	☐	☐	☐
News Website	☐	☐	☐	☐	☐

12. In 2010 there was a 25-inch snowstorm in Pittsburgh. Were you in Pittsburgh during that snowstorm?

☐ Yes *(Proceed to answer 14, 15, and 16)*

☐ No *(Skip 14, 15, 16. Proceed to answer 17)*

13. During the snowstorm, which of the following did you use to OBTAIN information related to the emergency? Choose all that apply.

☐ Facebook
☐ Twitter
☐ YouTube
☐ SMS/Text Messaging
☐ Phone Call
☐ Email
☐ Government Website
☐ Foursquare
☐ Television
☐ News Websites
☐ I did not look for information
☐ Other:

14. **During the snowstorm, which of the following did you use to report information to authorities relating to the emergency? Choose all that apply.**

- ☐ Facebook
- ☐ Twitter
- ☐ YouTube
- ☐ SMS/Text Messaging
- ☐ Phone Call
- ☐ Email
- ☐ Government Website
- ☐ Foursquare
- ☐ News Websites
- ☐ I did not report information to authorities
- ☐ Other:

15. **During the snowstorm, which of the following did you use to report information to friends and/or family relating to the emergency? Choose all that apply.**

- ☐ Facebook
- ☐ Twitter
- ☐ YouTube
- ☐ SMS/Text Messaging
- ☐ Phone Call
- ☐ Email
- ☐ Foursquare
- ☐ I did not report information to family and/or friends
- ☐ Other:

16. **Which of the following communication methods do you expect emergency responders to respond to? (Choose all that apply)**

- ☐ Phone calls
- ☐ Text/SMS messages
- ☐ Posts on your Facebook page
- ☐ Posts on Emergency Responders' Facebook page
- ☐ Your Twitter posts
- ☐ Posts on Emergency Responders' Twitter page
- ☐ Government e-mail
- ☐ Other:

17. **If you posted a request for help to a social media website, how long do you think it should reasonably take for help to arrive?**

- ☐ Less than 15 minutes
- ☐ 15 minutes - 30 minutes
- ☐ 30 minutes - 1 hour
- ☐ 1 hour - 3 hours
- ☐ More than 3 hours

18. **Imagine that someone you knew needed urgent help in an area-wide emergency. You have repeatedly dialed 911 and gotten a busy signal. How else would you try to contact emergency responders? Whom would you try to contact and how?**

19. **On which platforms are you willing to receive emergency alerts from authorities?**

- ☐ Facebook
- ☐ Twitter
- ☐ YouTube
- ☐ Foursquare
- ☐ Google Plus
- ☐ Other:

20. **What social medium do you use the most?**

- ☐ Facebook
- ☐ Twitter
- ☐ YouTube
- ☐ Foursquare
- ☐ Google Plus
- ☐ Other:

21. **Based on the social media you use most, how would you characterize the privacy settings on your social media account profiles?**

- ☐ Extremely Public
- ☐ Somewhat Public
- ☐ Neutral
- ☐ Somewhat Private
- ☐ Extremely Private
- ☐ Not sure
- ☐ N/A

22. **Based on the social media you use most, which of the following strategies have you used to protect privacy on social media sites (Choose all that apply)**

- ☐ Private or "friends-only" setting (Your profile cannot be seen by non-friends)
- ☐ Provide false information (e.g. wrong birthday, different last name)
- ☐ Block former contacts from seeing posts
- ☐ Used limited profile settings (People can only see certain information on your profile)
- ☐ Delete old posts
- ☐ Remove a "tag" or "mention" of yourself in someone else's post
- ☐ Block location information attached to a post
- ☐ Restrict your posts to a subset of your friends or people you have placed in a specific group
- ☐ Other:

23. **What information are you willing to share on a social media site during an emergency? (Choose all that apply)**

- ☐ Location
- ☐ Personal safety status
- ☐ Safety status of those around you
- ☐ Contact information
- ☐ None, I do not want to share information
- ☐ Other:

24. **What information do you expect emergency responders to be able to access in an emergency situations even when you did not explicitly disclose that information to the emergency responder? (Check all that apply)**

- ☐ Location
- ☐ Contact information
- ☐ Recent social media activity (Tweets, Posts, etc.)
- ☐ None, I do not want to share information
- ☐ Other:

25. **What is your gender?**

- ☐ Male
- ☐ Female

26. **What is your age?**

27. **What is your highest level of education?**

- ☐ No high school
- ☐ Some high school
- ☐ High school graduate
- ☐ Some college - no degree
- ☐ Associates / 2 year degree
- ☐ Bachelors / 4 year degree
- ☐ Graduate degree (e.g. Masters, PhD, medicine, etc)

28. **Do you have a college degree or experience in the fields of computer science, information technologies, or similar?**

- ☐ Yes
- ☐ No

29. **What is your household/family income?**

- ☐ Under $25,000
- ☐ $25,000 to $50,000
- ☐ $50,000 to $75,000
- ☐ $75,000 to $100,000
- ☐ Over $100,000
- ☐ Prefer not to answer

30. Which of the following best describes your primary occupation:

- ☐ Administrative Support (e.g., secretary, assistant)
- ☐ Art, Writing, and Journalism (e.g., author, reporter, sculptor)
- ☐ Business, Management, and Financial (e.g., manager, accountant, banker)
- ☐ Education (e.g., teacher, professor)
- ☐ Legal (e.g.. lawyer, law clerk)
- ☐ Medical (e.g., doctor, nurse, dentist)
- ☐ Science, Engineering, IT professional (e.g., researcher, programmer, IT consultant)
- ☐ Service (e.g., retail clerks, server)
- ☐ Skilled Labor (e.g., electrician, plumber, carpenter)
- ☐ Unemployed
- ☐ Retired
- ☐ Student
- ☐ I prefer not to answer
- ☐ Other:

31. If you are a student, what school do you go to?

- ☐ I am not a student
- ☐ Carlow University
- ☐ Carnegie Mellon University
- ☐ Chatham University
- ☐ Duquesne University
- ☐ Point Park University
- ☐ Robert Morris University
- ☐ University of Pittsburgh
- ☐ Community College of Allegheny County
- ☐ Pittsburgh Technical Institute
- ☐ Other:

If you attend Carnegie Mellon University, please answer the following.

Are you aware of the Carnegie Mellon opt-in emergency messaging system?

- ☐ Yes
- ☐ No

Emergency Text Messaging System
Are you registered for the emergency text messaging system?

- ☐ Yes
- ☐ No

Emergency Text Messaging System
"Emergency Alerts" are issued in the event of a serious immediate threat to the health or safety of students or employees. Emergency Alerts may be issued in response to any events that constitute an immediate threat to the campus community, including but not limited to criminal activity, extreme weather or natural disasters. The university's emergency alert system is known as "CMU Alert." This system notifies subscribers if there is an incident/event on campus that threatens public safety. All students, faculty and staff are encouraged to register for the CMU Alert service at https://my.cmu.edu/site/main/page.alert. In addition to email messages, Emergency Alerts are sent to registered phones by voice and/or text message using the CMU Alert system. Emergency Alerts may also be issued in conjunction with Crime Alerts or Safety Alerts. Carnegie Mellon University. "2011 Annual Security and Fire Safety Report". October 2011.

Now that you are aware of the system, will you sign up?

- ☐ No, too much effort.
- ☐ No, I do not know how to sign up.
- ☐ Yes
- ☐ Already signed up.
- ☐ Other:

4 Information Flow with Traditional Emergency Messaging and Social Media

This section focuses on how information flows through traditional emergency messaging media versus online social networks. The first section is a literature review on the current conditions. It mainly focuses on the infrastructure set up for traditional emergency messaging, and how online social networks compare to traditional systems. The literature review discusses the capabilities of social networks versus existing technology, an analysis of different tools available in social media networks, access to emergency messaging in emergencies for both traditional technology and social networks, how to authenticate messages posted on social media networks, technology and infrastructure available for emergency messaging and empirical research studies. Finally it focuses on the current set up of emergency messaging on the Carnegie Mellon University Campus.

4.1 Literature Review and Background Information

4.1.1 Capabilities of Social Media versus Existing Technologies

Communication is a key component in addressing and efficiently responding to an emergency situation. Communication has improved as technology advances. Today, social media sites rank as the "fourth most popular site for accessing emergency information" by individuals and communities to warn others of unsafe areas or situations and to inform friends and family that someone is safe and to raise funds for disaster relief (Lindsay, 2011). We review the legacy emergency alert systems in the United States to fully understand the methodology behind each system and why they became outdated.

The first emergency alert system implemented in the United States was the Control of Electromagnetic Radiation (CONELRAD) enacted by former President Truman in 1951 (Latimer, 2009). During this time, the United States was in the middle of the Cold War so it was necessary for the government to communicate to citizens quickly in the event of an attack. Certain radio stations were selected to give public alerts "via 40 kHz or 1240 kHz, which were highlighted on all radios sold after 1953 with a CD (Civil Defense) mark, so people could quickly find the frequencies" (FEMA, 2011). This system required radio stations to cease broadcasting in order to prevent enemy bombers from using the signals transmitted on AM stations in the form of electromagnetic radiation to locate targets (Latimer, 2009). However, this system became ineffective once long-range intercontinental missiles were developed and thus CONELRAD became obsolete (Latimer, 2009).

A new system was created in the 1960s during the civil defense era to replace CONELRAD (FEMA, 2011). This system was developed and implemented in 1963. It required all broadcasting stations to remain on air to transmit the emergency info on their own frequencies

(Latimer, 2009). This was known as the Emergency Broadcasting System (EBS). The EBS allowed national alerts to be broadcast not only on the radio but also on television stations. Initially it allowed the President to address the nation in case of an emergency but eventually it expanded “for use in case of state, territorial, tribal and local emergencies”. This expansion was voluntary but national alerts remained mandatory for broadcasters (FEMA, 2011). The EBS operated for thirty-plus years before being replaced by the Emergency Alert System (EAS).

The EAS, established in 1994, continued to expand the range and speed of emergency communication by allowing the President to “transmit a national alert within 10 minutes from any location at any time to the public via broadcast radio and TV stations, cable systems, and participating satellite TV and radio programmers” (FEMA, 2011). This alert system also reduced the possibility of transmission of outdated or duplicate messages by automatic transmissions using radio and television (Latimer, 2009). The EAS eventually became outdated however because alert communication was limited to radio and television. Some additional issues included power outages or damage to infrastructure where most stations did not have sufficient backup power (Latimer, 2009).

The current system is the Integrated Public Alert and Warning System (IPAWS) established by former President Bush in 2006 along with the Commercial Mobile Alert System (CMAS) (Latimer, 2009). This system is intended to solve the issue of reaching all citizens by tying even more channels of communication together than EAS has, such as “cell phones, pagers, satellite, television, radio, landline phones, computers, personal digital assistants and electronic road signs”(Latimer, 2009). The CMAS planning committee includes members not only on the national level, such as the Department of Homeland Security and FEMA, but also state and local governments, communication and broadcast specialists and members of special needs organizations (Latimer, 2009). However, no education advisors were asked to participate. Latimer believes that in order for IPAWS and CMAS to be fully operational, higher education institutions must play a larger role. These institutions will help determine how IPAWS can fit into existing emergency notification. This will require changes in emergency protocols by determining how to integrate SMS messages and other modern alerts. In current testing of IPAWS the messages look like text messages and are sent to cellular devices. Typical alerts include Amber alerts, imminent threat alerts and presidential alerts from which you cannot opt out (Latimer, 2009). Although IPAWS is a great improvement from the EAS, issues with this system still remain. For example, it has not been determined how to repair or avoid damaged infrastructure (cell phone towers, television/radio stations, etc.) so that emergency messages can still be disseminated.

Both (Latimer, 2009) and (FEMA, 2011) summarize the past emergency alert systems and point out the shortcomings from each. They describe the infrastructure each used and when/how each system was implemented. Latimer states that IPAWS is not ready to be integrated into current

alert systems. He also states some key questions remaining such as “How will CMAS implementation affect existing alert notification process?” (Latimer, 2009). However, neither of these articles explores how social media can help improve the alert systems.

The United States’ hazard warning systems has no comprehensive emergency alert strategy that covers all hazards in all places (Sorensen, 2000). If the United States does not enact new policies that will fit with today’s growing technologies, disparity will grow larger and gains that have been made over the past decades may be reversed (Sorensen, 2000).

Carnegie Mellon University utilizes an emergency alert system which sends text message and email alerts to those who opt-in to the program. Some emergency scenarios include bomb threat, gunman on campus, flooding, power outages and violent weather (CMU, 2011). The university is always updating their existing system to fit current technologies. Today, social media sites are some of the top sites accessed by individuals and communities to communicate about disaster relief (Lindsay, 2011). In our analysis, we investigate how Carnegie Mellon University is working to improve their emergency alert systems and how social media can be integrated, not only at a university level, but nationwide.

4.1.2 Social Media Analysis Tools

To gain situational awareness during crisis and emergency disaster situations, tools have been developed to track and monitor trends on social media sites. Some of the existing programs are TweetTracker which filters common keywords and hash-tags in tweets to create a situational analysis in disaster situations; TransMap, Twitalyzer, and Geotwitterous which all visualize and analyze tweets; Ushahidi which uses crowdsourcing to create crisis maps using Twitter, SMS, and email; and EPIC which is attempting to standardize tweets for better machine processing.

TweetTracker can monitor and analyze keyword specific Tweets and track location. It does so with historical review, integrated data mining tools, data reduction and real-time trending (S. Kumar et al., 2011). The four major components of TweetTracker are the Twitter Stream Reader, DataStore, Visualization and Analysis Module, and Google Translation Service. The Twitter Stream Reader filters tweets based on “keywords, hash-tags, and geolocations” (S. Kumar et al., 2011). DataStore is used to store the incoming data from Stream Reader, in database engine format. The point of user interaction is the Visualization and Analysis Module which is a system that includes filters to focus the tweets of interest, an analyzer to generate frequent tweets from hash-tags, hyperlinks and screen names, a date-based tweet to filter older tweets and a keywords trending engine to generate trends of keywords specified by the user (S. Kumar et al., 2011). Tweets that are geo-tagged are then displayed on a map as green and normal tweets as blue. Additionally, Google Translate is utilized to translate different languages. Finally, emerging trends are identified using a tag cloud created from tweets (S. Kumar et al., 2011).

At Arizona State University researchers created a Crisis Response Game, testing TweetTracker and QuickNets processing systems analyzing SMS messages and Tweets. In this game, volunteers either played the role of victim or first-responder. The results suggested that the most reliable way to find tweets is by hash-tags (M. Abbasi et al., 2012). Additionally, they suggest that it would be best to use an automated system to filter "ranked tweets" according to according to importance for a specific crisis (M. Abbasi et al., 2012). It should also be noted that in the game very few people include geo-tagging, and in the past the team had observed less than 5% of users provided location with their tweets due to privacy concerns (M. Abbasi et al., 2012).

4.1.3 Potential role for social media in emergency messaging

Utilizing social media to supplement emergency messaging is an opportunity whose costs and benefits have yet to be fully analyzed. In order to be worth using to augment traditional media, social media must help solve some pre-existing issue in modern emergency messaging. In the following section we will analyze past examples of failures in emergency messaging, such as 9/11 and Hurricane Katrina. Then we will analyze the wireless infrastructure, because much of the access to social media comes through wireless connections (laptops, smart phones, etc.)

4.1.3.1 Past failures in Emergency Messaging – 9/11 and Hurricane Katrina

The world trade center attack on September 11th 2001 was one of the first significant emergency messaging stresses in America in the 21st century. Immediately after the planes crashed into the towers of the WTC, people were confused and concerned. People needed more information about what had happened and who had been affected (Liu and Leysia, 2007). The individuals most affected by the disaster were the ones that had the greatest need to communicate with others; however this was made difficult by a barrier to access information and people. "Mobile telephony antennas located on top of the towers were destroyed and other portions of telecommunication infrastructure were down" (Liu and Leysia, 2007).

With telephone access down, people had to find another way to communicate and gather desired information. After the event, "An additional form of citizen-originated communication emerged: persistent peer-to-peer communications in the forms of fliers and posters literally papered buildings, fences, cars and signposts around the region of impact" (Liu and Leysia, 2007). These fliers helped individuals try to find their missing loved ones and to find help where it was needed. Slowly these fliers transitioned from informative to sentimental. "The messaging areas evolved into makeshift memorial sites with candles, teddy bears, and additional messages of support" (Liu and Leysia, 2007). The aftermath of 9/11 shows that people need to be able to reach out to their community for support during emergencies.

On August 29, 2005 Hurricane Katrina destroyed cities and towns in Louisiana and Mississippi (Liu and Leysia, 2007) .In this disaster, the peer to peer communication occurred in different manners. This disaster was significantly different in scope from 9/11, because it occurred over a

long period of time over nearly 93,000 square miles of the U.S. Southeast – roughly an area the size of Great Britain (Townsend, 2006).

"Shelters and web sites emerged as the destinations – information hubs – for seeking and providing information" (Liu and Leysia, 2007). The use of websites as information hubs clearly showed the possibility of using Social Media sites for information sharing. However, access to the internet and cellphone coverage was limited for much of the population. For those with coverage, if they had a phone they had a hard time finding a place to charge it (Liu and Leysia, 2007). The Townsend report provides further insight into how badly communication infrastructure was damaged from the hurricane. "Nearly three million customers lost telephone service. Broadcast communications, including 50 percent of area radio stations and 44 percent of area television stations, similarly were affected. More than 50,000 utility poles were toppled in Mississippi alone" (Townsend, 2006). Additionally, the emergency messaging infrastructure failed due to the lack of device inter-operability rather than the normally expected lack of system operability. Access to information was limited by over-dependence in messaging infrastructure as well as weaknesses of the infrastructure components.

4.1.3.2 Wireless Infrastructure – Useful but Fragile

The biggest and fastest growing medium of communication in modern times involves public cellular and broadband personal communication service (PCS) network (Kapsales, 2004). However the biggest problem in using this common route of communication in emergencies is its instability. Public cellular service is limited both by volume limitations and by a lack of supporting, or back up infrastructure. The volume limitation of public cellular service is due to the limits in the wireless spectrum. The fixed nature of the wireless spectrum means that an increase in total users causes a decrease in resource availability for each user. Therefore, wireless service can experience blocking even in non-emergency situations, such as rush hour (Kapsales, 2004). "During an emergency, blocking is exacerbated. On 11 September 2001, in New York City, over 75% of the wireless calls were subject to blocking and not completed" (Kapsales, 2004). This volume limitation is not acceptable for a medium to be used for emergency messaging.

The second limitation is caused by a lack of redundancy in system infrastructure. Landlines have been around long enough to develop a resilient infrastructure that allows re-routing to avoid any singular failure. However, wireless infrastructure does not benefit from the same age and thus lacks resiliencies. "An inoperable tower, base stations, or antenna will mean that thousands of people may not have coverage in a geographic area" (Kapsales, 2004). During certain emergencies it is almost inevitable that some wireless antennas or stations will go down. For example, in the 9/11 emergency 5 cell sites were directly damaged to the point of being inoperable, and a further 160 sites were made inoperable due to lack of power (Kapsales, 2004). A disaster that occurs in such a focused area can have sprawling effect on wireless service.

Kapsales' paper is important in understanding the two main limitations of wireless networks: volume and lack of backup infrastructure. The paper also highlights how wireless can fail in emergencies, and why it is not particularly dependable.

4.1.4 Authentication Issues with Social Media

Social media could be a very useful tool in emergencies. It has the potential to be used to alert the public in a far reaching way about emergency situations, but also can be used to collect information about the state of an emergency from people involved. It can be used by emergency responders to find out more information about the disaster and to better determine who needs help and where they are located. One major issue with using social media during emergencies is authentication. Authentication is the ability to verify information to show that it is true (Sauer, 2011). It is hard to determine if the information being posted by people to the social media sites is true. The spread of false information could do more harm than good. Thus it is important to understand the likelihood of false information being posted, the likelihood of its being corrected by others, and if there is a way to authenticate the information to determine if it is true. There are a few different ways that have been explored for authenticating information. The ways that we will be focusing on are crowdsourcing, data mining, and cognitive fingerprinting.

4.1.4.1 Crowdsourcing

Crowdsourcing is one way to determine if the information being released is factual. Crowdsourcing is to obtain information by following what is posted by the general public. If many people are posting similar information, it can probably be assumed that this information has truth in it. An example of crowdsourcing being used in social media to monitor information about a disaster occurred in Queensland, Australia. Queensland experienced horrible flooding. Between January 11th and January 15th, 2011 there where over 56,000 tweets about the disaster posted by 20,000 authors. The tweets were known to be about the flood because they included the hashtag #qldfloods (Sauer, 2011). The hashtag is a symbol used in Twitter to categorize posts. During the emergency the hashtag #Mythbuster was also used. This hashtag was used to mark information that had spread as false. One rumor that was quickly marked with the #Mythbuster hashtag was that there was a crocodile on one of the streets. The false information, however, was originally corrected by government agencies before it spread as false (Sauer, 2011).

Although crowdsourcing is an inexpensive and relatively easy way to verify information, it is not always reliable. An example of this is a Wikipedia news article about John Seigenthaler. Wikipedia is a website that relies on its users to proofread the articles and correct misinformation. For the large part it works very well, and inaccurate information on Wikipedia is fixed relatively quickly. However, for more obscure articles, the false information is not always identified and fixed. Seigenthaler was a close friend to both John and Robert Kennedy. He was even the pallbearer at Robert's funeral. Seigenthaler's biography on Wikipedia claimed that

Seigenthaler had been investigated for the deaths of the two Kennedy brothers. This news spread to other sites and was never corrected. It was finally removed when Seigenthaler saw the biography and asked Wikipedia to remove it (Cox, 2011).

4.1.4.2 Data mining to detect false information

Data mining is the process of collecting and analyzing large sets of data by looking for patterns in the data. A research group at Indiana University is working to develop a data mining technology known as Truthy. Truthy is being used to scan information that is spreading throughout Twitter. It was originally developed to follow how different memes spread throughout Twitter; however, they are hoping to eventually use it to follow the spread of misinformation online (Truthy, 2010). Truthy uses data mining, text mining, social network analysis and network models to detect false information. The team follows certain hashtags and key phrases to see when there is a significant increase in the spread of volume of one. When they see a large increase in volume they then focus their analysis on those specific hashtags and key words (Truthy, 2010).

Research is also being done at Columbia University on data mining. The research team is looking into monitoring the user's patterns and habits online so that anomalies can be detected. If the user begins having patterns online very different then the norm, it could be because the users account has been hacked. The researchers are using two different algorithms; association rules, and frequent episodes. The association rules algorithm is based on data that can normally be associated with each other. If a few aspects are being used, it can probably be assumed that another similar aspect might be used. The frequent episodes algorithm marks how often the user does something online to better predict what the norm for the user is. Both Truthy and the research being done at Columbia University are considered promising technologies that can help with authentication (Lee, 1998).

4.1.4.3 Cognitive Fingerprinting to Authenticate Individual Users

Cognitive fingerprinting focuses more on authenticating the person posting the message rather than the truthfulness of the post itself. Cognitive fingerprinting focuses on the fact that when people interact with a keyboard they leave their own unique pattern of typing based on how they think. The Defense Advanced Research Projects Agency (DARPA) is currently conducting research on cognitive fingerprinting. Developers at DARPA are hoping to not only map a person's cognitive fingerprint when they first log in to authenticate the user, but also want the system to continually map the patterns to see if there is a change of users on the system. Methods DARPA hopes to use for cognitive fingerprinting are monitoring keystrokes, eye scans, following how the user searches for information, how the user selects information, how the user reads the selected material, tracking the users eye pattern when reading the screen, the speed in

which the user reads the content on the page, and the main methods in which the user communicates (Cooney, 2012).

4.1.4.4 Empirical Research Studies of Information Flow through Social Media

Several different studies use modeling and statistical analysis to establish patterns by which users tend to post content onto OSNs (Guo et al., 2009; Gyarmati et al., 2010). These studies explored patterns in user generated content by observing three different types of online social networks: a blog system with millions of users in Asia, a bookmark sharing network, and a question answering social network, all of which have been widely used for several years. Guo et al. (2009) observed daily and weekly posting patterns and validated a stretched exponential distribution model for posting that was consistent for each OSN. Gyarmati et al. (2010) created a framework to measure user behavior in various popular OSNs including Bebo, MySpace, Netlog, and Tagged. The framework was applied for "more than 80,000 users … at 1-min intervals. The measurement was carried out from 15 March to 2 May, 2009" (Gyramati et al., 2010). From the data collected, they were able to observe detailed statistics on the amount of time spent online, the average amount of logins for all users, and the ratio between the amount of engaged users and the number of friends in their network over time (Gyramati et al., 2010). The research that they conducted is significant in that it could be scaled to any system in order to get a snapshot of how an OSN engages its users over varying periods of time.

Additionally, there were other studies that observed patterns in the diffusion of information through OSNs (Tang et al., 2010; Katona et al., 2011). Tang et al. (2010) investigated the use of "temporal distance metrics to quantify and compare the speed (delay) of information diffusion processes taking into account the evolution of a network from a global view." One of the datasets used in the study was acquired from interactions within a large group of people on Facebook. Through the study, they were able to characterize network reachability within the context of the connectivity of different users and were able to show the extensions of their work in the realm of OSNs (Tang et al., 2010). Katona et al., (2011), modeled "the adoption decision of individuals as a binary choice affected by three factors: (1) the local network structure formed by already adopted neighbors, (2) the average characteristics of adopted neighbors (influencers), and (3) the characteristics of the potential adopters". The data was acquired from a widely used OSN in Europe. From the model, they were able to both identify which types of individuals had the most influential power on their neighbors and predict how a group of users adopt an idea over time. The rate of information diffusion is definitely a critical part of our study.

4.1.5 Localization Technology

4.1.5.1 Motivation for a Localization Technology Analysis

The motivation for a localization technology analysis is to understand what localization technologies are available for helping emergency response dispatchers and the usability of each localization technology.

There are three accurate and precise absolute positioning technologies available today that are widely used in mobile devices.

GPS (Global Positioning System) localization offers excellent accuracy and precision for an attractive price. GPS localization works by using a network of satellites orbiting the planet to locate a device. Since the advent of smart phones, the number of people with GPS capability at all times has been on the rise (Canalys, 2008).

Another accurate, but less precise localization technology available today is cell phone tower triangulation. All cell phones are equipped with an RSSI (Received Signal Strength Indicator) (Iyer, 2007). A rough but accurate position of the cell phone can be determined by measuring the RSSI between the cell phone and the cell phone towers within range of the cell phone. The popularity of cell phones has brought this technology to most of the population in developed nations.

Additionally, Wi-Fi triangulation technology is available today for precise indoor localization. Wi-Fi triangulation works exactly the same way as cell phone tower triangulation. However, unlike cell phone tower triangulation, Wi-Fi triangulation relies on a mapped network of wireless access points to be deployed at a location. Carnegie Mellon University, for example, has mapped the location of all the wireless access points on their campus for Wi-Fi triangulation to work.

4.1.5.2 GPS Localization Technology

There are two fully operational global positioning systems today. The first is the United States of America's NAVSTAR (Navigational Signal Timing and Ranging Global Positioning System) GPS and the Russian GLONASS (Global Navigation Satellite System) GPS. (Andrews Space & Technology, 2001) The NAVSTAR GPS system is the world's most utilized navigational satellite system and has been fully operation since 1994. The GLONASS GPS system, in contrast, has only been fully operational since 2011. New GPS receivers today support both NAVSTAR and GLONASS resulting in an increase in accuracy.

GPS localization technology works by a having a network of 24 to 32 satellites orbit the earth in six different paths around the earth. The more satellites that are in view of a GPS receiver, the better the GPS receiver can calculate its position. The NAVSTAR GPS system currently has 31 satellites in orbit as of today. The 31 satellites are spread out in time along the six different orbital paths around the earth evenly such that at any one time at least four satellites are visible to a GPS receiver. Each GPS satellite broadcasts continuously, in a cone towards the earth its position, the position of other GPS satellites, and an extremely precise time stamp (produced by an onboard atomic clock synchronized with the other GPS satellites) (DePriest, 2002).

The GPS receiver calculates its position using the messages broadcast by multiple satellites over time and the time-of-flight delay between receiving the messages sent by multiple satellites over

time. With only three satellites in view the GPS receiver can calculate its position roughly. Each additional satellite in view of the GPS receiver increases the accuracy of the GPS receiver and reduces the time to get an accurate location fix. GPS receivers today can monitor dozens of satellites at a time, which allows the receiver to generate a very accurate location fix and lock in under a minute. Once locked on, the GPS receiver can generate localization data every second or faster. GPS receivers even use additional sensors to adjust for error and drift in the GPS signal to be more accurate (DePriest, 2002).

4.1.5.3 Cell Phone Tower Triangulation Technology

All cell phones communicate with the network they are roaming in periodically. During this communication, the cell phone towers within range of a cell phone can calculate a rough approximation of the radial distance between the cell phone and the tower using the RSSI (Received Signal Strength Indicator) from the cell phone (Iyer, 2007). The RSSI value is more accurate the closer the cell phone is to a cell phone tower and less accurate as the cell phone moves away from a cell phone tower (Nave, 2000). This is due to the inverse-square-law. As the distance between the cell phone tower and the cell phone increases not only does the power of the communication signal drop but also changes in the distance from the cell phone tower must be greater to be noticeable. As the cell phone moves closer to the cell phone tower changes in distance become more noticeable and the accuracy and precision increases.

With just one cell phone tower with an Omni-directional-antenna the location of the cell phone can be calculated to be within some radius of a cell phone tower. With two or more cell phone towers with Omni-directional-antennas, the accuracy of the calculation is increased. In rural areas, most cell phone towers have Omni-directional-antennas, which allow one antenna to cover a large area reducing the cost of the cell phone tower.

Many cell phone towers have directional antennas, which allow for greater positioning accuracy when the cell phone is in the range of fewer cell phone towers (Smith, 2008). In addition, in many densely populated areas, there are usually cell phone towers with overlapping coverage allowing for localization that is even more accurate. Nevertheless, the precision of cell phone tower triangulation is not nearly as good as GPS and will not provide emergency responders with the all the information they need for every emergency situation (Smith, 2008).

4.1.5.4 Wi-Fi Triangulation Technology

Wi-Fi triangulation works the same way as cell phone tower triangulation. However, both technologies differ in scale and power consumption. For example, enabling the Wi-Fi antenna on smart phones and laptops results in a substantial reduction in battery life for the mobile device. This is because in order to achieve a higher data rate, Wi-Fi antennas use more power to transmit and receive data. This reduces the number of data packets that are corrupted during communicating and that have to be retransmitted. When a packet is corrupted, it is retransmitted, lowering the effective data rate (Wild Packets, Inc., 2012).

The proximity between Wi-Fi access points and the mobile device communicating with them is usually much smaller than the distance between a Cell Phone and a Cell Phone Tower (Barcoding Incorporated, 2011). This means that the RSSI triangulation method for Wi-Fi positioning is usually more precise than Cell Phone Tower Triangulation. Both Wi-Fi and Cell Phone Tower Triangulation systems suffer from the same accuracy problem due to the inverse-square-law (Nave, 2000). However, the problem is not as acute as it is with Cell Phone Tower Triangulation because the distances in Wi-Fi networks are smaller. The power output from Wi-Fi access points, though, is smaller too so it is not always true that Wi-Fi Triangulation is more accurate.

While Wi-Fi Triangulation has the potential to be more accurate and precise than Cell Phone Tower Triangulation and works indoors compared to GPS, Wi-Fi networks must be mapped first to provide useful localization data (Gardham, 2010). Each Wi-Fi access point must have its location entered into a data base along with the Wi-Fi access point's unique identification number. For enterprise Wi-Fi networks, this is not a problem because the network is professionally maintained. Many Wi-Fi networks, however, are strung together in an *Ad-Hoc* fashion and the Wi-Fi access points in them are not in a localization database. Additionally, the Wi-Fi access points in many Wi-Fi networks move around requiring frequent database updates to the Wi-Fi access point positions. Finally, most Wi-Fi networks are private and privately maintained. Without a compelling incentive, *ad-hoc* Wi-Fi networks will remain unmapped preventing their use in triangulation techniques. Table 4.1.1 below summarizes the different localization technologies and the situations in which they operate

TABLE 4.1.1 - LOCALIZTION TECHNOLOGY CAPABILITIES

	Accuracy (meters)	**Location**		**Prolonged Power Outages**	**On The Ground Infrastructure Destruction**
		Inside	Outside		
GPS	1 – 30	X	✓	✓	✓
Cell Phone Triangulation	50 – 300	✓	✓	X	X
Wi-Fi Triangulation	10 – 20	✓	✓	X	X

4.1.5.5 Localization Technology Emergency Situation Analysis

Motivation for a Localization Tech Emergency Situation Analysis

The motivation for this localization technology emergency situation analysis is to understand what localization technologies will be available for helping emergency response dispatchers locate victims of natural and man-made disasters. GPS Localization, Cell Phone Tower Triangulation, and Wi-Fi Triangulation technologies allow victims of natural and man-made disasters to share their location through social networks or through dedicated emergency response systems (e.g. 911) with emergency response dispatchers as long as the specific localization technology the victim is using is working. The goal of this analysis is to compare and contrast the strengths and weaknesses of the three (GPS, Cell Phone Tower Triangulation, and Wi-Fi Triangulation) localization technologies described in this report and the possible media of communication for the localization technologies to emergency response dispatchers (e.g. Internet (Online Social Networks and Email), Telephone, and Text Messaging).

Localization Technology Attributes

GPS receivers can accurately calculate their position to within one meter on average and will be accurate to at least eight meters 95% of the time. (GPS.GOV, 2011) However, lack of a clear line of sight to GPS satellites, sources of noise, and interference can cause the GPS receiver to be off by up 30 meters. (Maps-GPS-Info, 2011) For outdoor localization (with a clear line of site to the satellite), GPS receivers are the most accurate and reliable source of localization information given standard GPS receiver accuracy. Only natural or manmade disasters that cause heavy electromagnetic interference in the GHz range will compromise GPS receivers. For example, the ash fall caused by a volcanic eruption can degrade the GPS signal (Geology.com 2012). Additionally, GPS receivers do not need to connect to a network in their area (that could be compromised) to work. For indoor localization, GPS performs poorly. Lack of a clear line of sight to GPS satellites prevents the GPS receiver from calculating its position. In urban areas, where a clear line of sight to GPS satellites might not be possible, many GPS receivers use cell phone tower triangulation information to compensate for the lack of a clear line of sight to GPS satellites.

Cell phone tower triangulation is used to increase GPS receiver accuracy when the GPS receiver cannot get a good lock on its position due to its location. Tall buildings, electromagnetic noise, and lack of a clear line of sight to GPS satellites can all cause GPS receivers to be unable to calculate their position. Cell phone tower triangulation does not require a line of sight to a cell phone tower to work and functions indoors and outdoors. However, cell phone tower triangulation is only accurate to within 50 to 300 meters on average in dense urban areas (FCC). In rural areas with less cell phone tower coverage the accuracy may be nonexistent or have an area of uncertainty for miles. (Smith, 2008) Cell phone tower triangulation relies of a network of

operational cell phone towers (in the near area) to work. Extended power outages, network congestion, and electromagnetic interference can all disable cell phone tower triangulation.

Wi-Fi network triangulation is used to provide more accurate localization information than cell phone tower triangulation. The accuracy of Wi-Fi triangulation is between 10 to 20 meters on average (Skyhook Wireless, 2012). Additionally, Wi-Fi triangulation does not require a line of sight to wireless access points to work. However, Wi-Fi triangulation relies on a network of operational wireless access points to work that must be located in the immediate area. Local power outages, network congestions, and electromagnetic interference can all disable Wi-Fi triangulation. Additionally, Wi-Fi triangulation relies on a mapped infrastructure of multi-party equipment to work. Wireless access points can be moved around or disappear easily causing triangulation calculations to produce inaccurate information.

Communication Technology

Online social networks (OSNs) and email offer a new way for communication between victims of a disaster and emergency response dispatchers beyond traditional phone based systems. OSNs and all other internet communication rely on a working backbone of communication infrastructure. The backbone consists of telephone lines, fiber optic networks, cell phone towers, etc. In a disaster situation where there is extended power outage and/or large scale infrastructure destruction the internet connection in the disaster area may be disabled. OSNs have the potential to offer emergency response dispatchers a great way to handle the flood of communication produced by large scale natural disasters that often saturate telephone lines. When natural disasters do happen the telephone system often becomes saturated with traffic (if it is still functioning) and will be unable to connect all calls. (911 Broadcast, 2012) However, email and other internet communication will still function as they use a separate communication system that is able to handle heavy traffic more easily. FCC regulations mandate that essential communication systems be battery and generator backed to be able to function for up to eight hours or more without power (Miller R., 2007). Telephone and Internet communications, that are routed though the telephone network, fall under this umbrella.

Telephone systems like E911 currently provide emergency response dispatchers and disaster victims with a way to communicate. They work through the wireless and landline telephone systems. FCC regulations instituted after Hurricane Katrina mandate that cell phone towers and telephone system be battery backed and must be able to operate for up to eight hours without power. Additionally, central switching stations must be battery backed for up to 24 hours. (Miller R., 2007) Telephone communication allows an emergency response dispatcher and a disaster victim to communicate quickly and verbosely in real time. However, during large scale emergencies the telephone system may become saturated with phone calls and will cease to connect new calls. (911 Broadcast, 2012) In these cases, if the telephone system is still functioning, text messaging will continue to operate due to the low bandwidth nature of the

medium. However, text messaging and telephone communication are still direct and non-broadcast ways of communication. Emergency response dispatchers will only be able to handle so many requests. OSNs provide a possible way for emergency response dispatchers to deal with the flood of traffic more easily than traditional systems do.

Emergency Situations

Different emergency situations can cause localization technologies and communication systems to stop working. Listed below are common large-scale natural disasters that continue to plague mankind. While not all of the large-scale natural disasters listed in Table 4.1.2 below can compromise localization and communication systems, they are shown here for completeness.

TABLE 4.1.2 - LARGE SCALE NATURAL DISASTERS

Avalanche	Drought
Blizzard	Flood
Earthquake	Tsunami
Famine	Epidemic
Fire	Volcanic Eruption
Hail Storm	Heat Wave
Hurricane	Tornado

Hurricane Katrina is an example of a natural disaster that disrupted phone and Internet communication in New Orleans. It caused wide spread flooding and power outages that crippled the city and left storm victims without any way to communicate to emergency response dispatchers or responders except for painting signs on their roofs. All localization and communication technologies rely on a communication infrastructure located in the disaster area (except for GPS, which relies on an infrastructure of satellites in orbit). Large-scale natural disasters that can take out localization and communication infrastructure will cripple emergency response. Disasters that can easily do this include earthquakes, hurricanes, and tsunamis. Fire and flooding not caused by earthquakes, hurricanes, and tsunamis are common enough that they are contained easily before widespread damage to the communication infrastructure can occur. (Vasquez, 2012) For example, tornados are common natural disasters that carve a path of destruction through a community. However, they do not create a wide area of destruction that cripples communication infrastructure for days and prevents help from reaching the affected area. Blizzards and hailstorms are examples of natural disasters, which can cut off the affected area physically from help, but which do not necessary create conditions for wide spread power failure and infrastructure damage. (GPAgSystems, 2010) Avalanches and volcanic eruptions, however, can be completely devastating for the community within the path of destruction and can completely cut the community off from the rest of the world electronically and physically. (Geology.com, 2012) They can cause the destruction of roads, power lines, and communication lines preventing aid from easily reaching the affected areas. Famines, droughts, epidemics, and

heat waves are examples of natural disasters that can cause the destruction of communities, tremendous pain and suffering, and human life loss, while not compromising communication infrastructure. In conclusion, there are disaster situations, which can compromise communication and localization network infrastructure, and many disaster situations that can prevent aid from reaching the affected community and cause pain and suffering while not completely compromising communication and localization networks.

TABLE 4.1.3 - COMMUNICATION TECHNOLOGY CAPABILITIES

	Network Conges-tion	**Short Power Outages (< 1 day)**	**Prolonged Power Outages (> 2 days)**	**On The Ground Infrastructure Destruction**	**Easy Voice Two Way Communica-tion**	**Easily Push Information**
Landline Telephone (Traditional)	X	✓	X	X	✓	X
Cell phone (Traditional)	X	X	X	X	✓	X
Internet Communication (Social Media)	✓	X	X	X	X	✓

Common Emergency Messaging Examples

The Carnegie Mellon University emergency messaging and alert system is pre-programmed to alert Carnegie Mellon Faculty, Staff, and Students about the following man-made and natural disasters with pre-scripted alert messages.

TABLE 4.1.4 – CAMPUS EMERGENCIES

Biological/Chemical/Radiological Spill or Leak	Bomb Threat
Campus Evacuation	Elevator Emergency
Fire or Explosion	Flooding
Gas Leak	Gunman on Campus
Infectious Disease Response	Power Failure
Structural Damage	Terrorism – Suspicious Material
Violent Weather	Water Interruption

In each of the above campus emergency situations, mass communication technology can be used to alert members of the campus community about the situation. Mass email, text messaging, and telephone calls are used to do this. Localization and communication infrastructure is unlikely to be destroyed for the above campus emergencies. Victims of any of the above emergency situations will be able to alert emergency response dispatchers easily and receive help.

4.1.6 Existing Campus Emergency Alert System

Carnegie Mellon University currently has an opt-in emergency alert system. In cases of immediate threat to the health and safety of the Carnegie Mellon community, an emergency message will be sent out through text message, voice message, or both. An email will also be sent out to all students, faculty, and staff. In order to receive alerts through text or phone messaging, one must subscribe to the CMU alert system; Carnegie Mellon students, faculty, and staff are encouraged to register but participation is not mandatory. Students, faculty, and staff can sign up or remove themselves from the alert system at any point. During freshmen orientation week, there is a strong push from campus policy and Resident Assistants for freshmen to sign up for the alert system. As of April 2012, Carnegie Mellon's opt-in system has 65% participation of students and 60% participation of faculty and staff.

In March 2012, Carnegie Mellon received two emergency alerts: first, a suspicious package found on Beeler Street, and second, a gunman in the University of Pittsburgh area. Working with Ms. Madelyn Miller, Carnegie Mellon's Director of Environmental Health & Safety, we were able to obtain statistics on the emergency alert system for these two incidences. Figure 4.1.2 shows the percentage of received and not received voice messages, emails, and text messages for the suspicious package reported on Beeler Street. "Received messages" indicates that the message reached the intended recipient, but the time that the message was heard/read is unknown. "Not received" is defined as no answer, hung up before message, rejected, unreachable, and wrong number/username, meaning, the intended recipient has no way of receiving the message. Figure 4.1.2 shows text messaging alerts were nearly 100% efficient in delivering the alert to the intended user, the most successful delivery rate. The breakdown of voice alerts is shown in Figure 4.1.1. Forty-three percent of voice message alerts ended up in voicemail, therefore the actual time the message was heard by the user is unknown. "Shared"

means the phone is shared by multiple users, most likely an office phone. The emergency message sent for the Pitt gunman yielded similar results. The average message delivery time was 2 minutes for the suspicious package and 1 minute for the Pitt gunman, however the time the user read the message could not be determined.

Although the current Carnegie Mellon alert system does not incorporate Social Media, using Twitter tracking tools we have noticed students are spreading alert messages to one another through tweets. For example, on April 7, 2012 Pitt Bomb Threat was tweeted by 48 people and reached 43,000 Twitter users. The initial tweet was sent out by news source Triblive.com, and then spread by students and various Twitter users.

These findings show that the Carnegie Mellon alert system is rapid and accurate with message delivery, but we would like to see if Social Media could enhance the system by reaching a larger portion of the campus while being equally as fast.

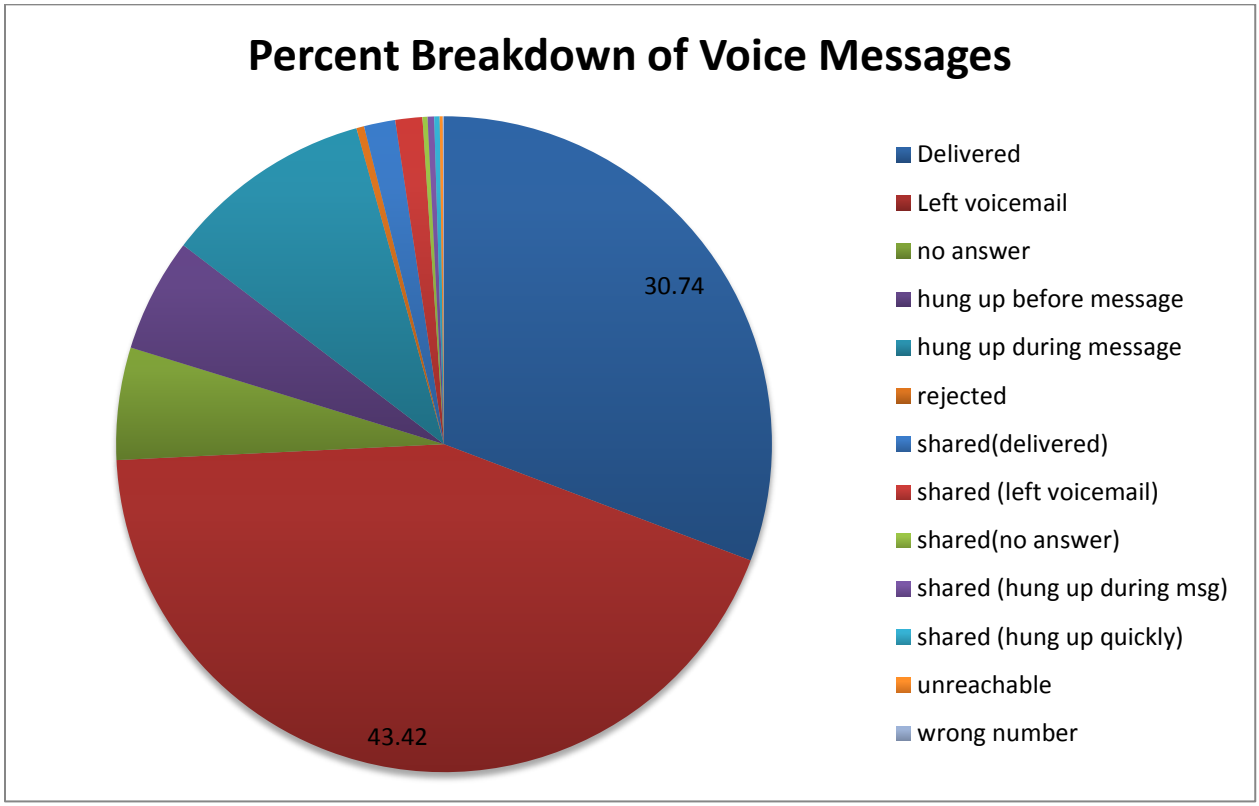


FIGURE 4.1.1 - BREAKDOWN OF VOICE MESSAGE ALERTS.

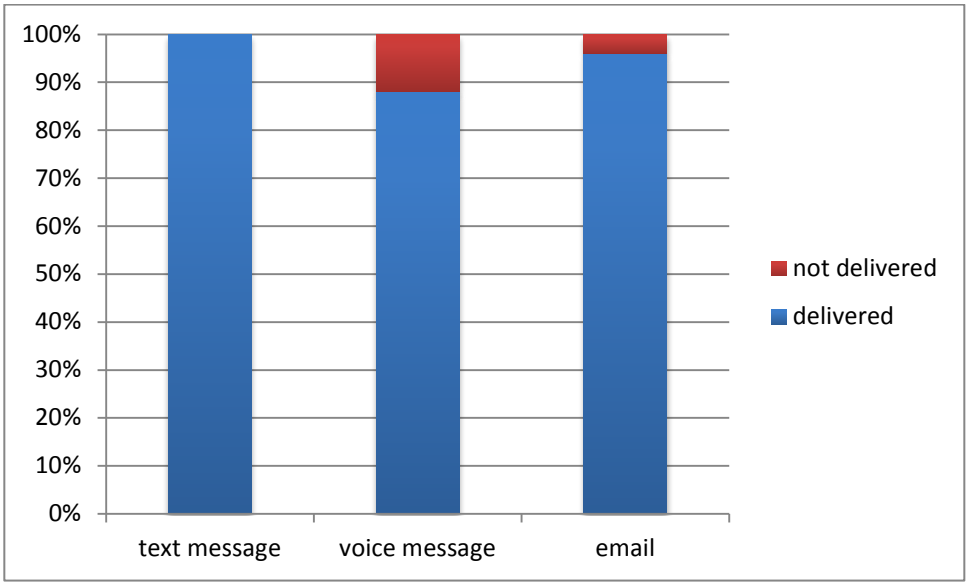


FIGURE 4.1.2. SUCCESSFUL DELIVERY OF TEXT MESSAGE, VOICE MESSAGE, AND EMAIL.

4.2 Information Flow in Social Media Experiments

The main way we studied how information flows was to conduct two experiments on Carnegie Mellon's campus. The first experiment tests the capabilities of the traditional Carnegie Mellon emergency messaging system versus social networks. The experiment looks at the number and the demographics of people reached by the different modes of communication. The second experiment looks into how false information spreads and how quickly it is corrected. This is tested by advertising free donuts; however, we release the wrong room for event. We then determine how long it takes for the word to spread that the free donuts are actually in a different room, and the information posted online is wrong.

4.2.1 Previous Experiments

4.2.1.1 Purdue University

Purdue University is designing an experiment where a message will be sent out through multiple medium, so the speed the message spreads and the effectiveness of each communications medium can be determined. The experiment in Purdue has not been performed yet; however, Alexander G. Barnett outlined his intentions of the experiment and reviewed statistics on Facebook, Twitter, Instant Message (IM), and email. Since we intend on running a similar experiment at Carnegie Mellon, the statistics and predicted outcome will be useful to understand.

In 2010, Facebook was the most browsed site online. Facebook users ages 18-34 make up 39.9% of all Facebook users. The usage of mobile devices accessing Facebook increased by

121% from 2009 to 2010. From these statistics, Facebook could be beneficial to the emergency alert system, because of increased access on mobile phones, and because it is the most popular website. This OSN is also able to spread information through uploaded pictures and videos, which could be beneficial in gauging the validity of messages.

In 2010, 87% of Purdue students surveyed by Barnett had heard of Twitter, while only 7% were current users. These numbers were higher than for 2009, showing that Twitter awareness is rising. However, only 33% of Twitter users visit the site once or more a day, and most Twitter users access it through their mobile device. Similar to Facebook, the most users are in the 18 to 34-age range. Since only 33% of Twitter users visit the site once or more per day, it is likely that this would not be the fastest way of initially reaching the public in an emergency. Twitter would expand its user base if it incorporated an emergency alert system.

IM can be sent via Skype, Live, Yahoo, and AIM, among others. Skype and Live are currently the leading IM networks. According to Barnett, putting together an automated alert system sent through multiple IM networks on a large scale would be difficult and costly.

Because email is almost universal, and can be accessed on mobile phones, email is an excellent candidate for incorporation in an emergency alert system. Ninety-four percent of adult Internet users have an active email account and this number is predicted to stay constant.

Based on the statistics above, Barnett suggests an alert system blog, which can be subscribed to through Facebook. This would be an opt-in messaging system and the user could receive updates through Facebook, email, text message, and potentially Twitter. Because social media usage is on the rise, emergency systems should consider incorporating them into their emergency messaging methods. The experiment we will be performing at Carnegie Mellon will test the conclusion that CMU Emergency Alerts would best reach the campus community by including Facebook and Twitter into their messaging system.

4.2.1.2 Mississippi State University

In January 2008, Mississippi State University (MSU) experienced a Tornado watch. The tornado never hit the campus, but it came close enough that the school initiated its emergency response alert system. The emergency alert system is called the Maroon Alert. The Maroon alert messages are sent to members of the campus community either via cell phone, instant messaging or email. Members of the campus only receive the alert if they register their cell phone number. This is similar to Carnegie Mellon's campus where people must also opt-in to receive emergency messages. After the event, a campus-wide survey was distributed to determine the users' preferred way of receiving alerts and how they responded to the warning. The emergency message alerted the community about the tornado and instructed people to take shelter immediately. (Sherman-Morris, 2009)

The survey was emailed to all MSU faculty, students, and staff. A link to the survey was also placed on the university's homepage, and sign-on page. A raffle for either a $50 or a $100 gift card was used as an incentive. The survey included 30 questions. The questions asked when and how the respondents first heard about the tornado warning, how the respondents first received the Maroon Alert , how they first heard about the National Weather Service (NWS) alert, and what they thought was the best way to provide warning information was (especially during teaching). The survey was completed by 970 out of 3,818 employees and 1,595 students out of 14,634. (Sherman-Morris, 2009)

The results showed that most of the faculty knew about the tornado before the alert was sent, while the students did not know until they received the warning. Less than 1% of those surveyed never knew that there was a tornado warning. Most students and faculty first received the Maroon Alert through the text messaging system on the cell phone. Social media use was not a main topic of question for this survey; however, respondents were asked if they heard about NWS-issued tornado warning via the internet. Internet ranked fourth with 26.1% of students and 26.4% of employees hearing about the NWS warning first via the internet. Ranked above it were local television, word of mouth, and a weather text message service on their cell phone. Students chose cell phone text messages as the preferred choice of receiving emergency warnings while employees chose the instant messaging system. (Sherman-Morris, 2009)

The survey conducted at MSU gives us some important baseline information about how other campuses conduct emergency alerts and how the students and employees respond to these alerts. Our group plans to expand on the research done at MSU and include social media.

4.2.1.3 Morakot Tsunami and Virginia Tech

One of the primary focuses of the proposed Experiment at CMU will be to understand the benefits of utilizing social networks in emergency response compared to traditional response mechanisms. One of the popular social networks that would be a viable candidate for this study is Twitter. Twitter offers several benefits that would (in theory) greatly enhance the capabilities of emergency management. In particular, Twitter is cost-effective and provides streaming of information in real-time (Mills et al., 2009). This could greatly reduce the time delay emergency responders will have in gathering vital information as events unfold. Additionally, Twitter is scalable (i.e. minimally affected by the size of the user community), compatible with current mobile technology, and user-friendly (Mills et al., 2009). This allows Twitter to mold to the particular needs of the user. In the case of CMU, they would simply need to create an account that students would follow for pertinent safety information. The already existing community of Twitter users on campus could provide the pathways that information could be spread throughout the University. As such, Twitter could potentially be implemented as a low-cost supplemental tool to the existing emergency response system.

However, Twitter is not without its faults. In particular, Twitter is prone to crashing when a large quantity of Tweets is sent simultaneously (Mills et al., 2009). This would be a very likely scenario in emergency situations as victims would immediately and frequently report information. As long as Twitter remains unreliable in its server capabilities, CMU and other similar (or larger) sized communities cannot solely rely on Twitter as a method of emergency response. A secondary concern for Twitter's servers is security. For example, rampant phishing (collecting user information by masquerading as a legitimate website) and spamming (the mass distribution of messages) are a continuous concern for Twitter and have resulted in hacks and the spread of misinformation on Twitter (Mills et al., 2009).

Huang et al. (2010) conducted an additional study analyzing the use of social networks during and after a disaster. They observed the limitations of Taiwan's local and national government emergency response systems during the 2009 Taiwan Morakot tsunami disaster. Through the use of popular OSNs in Taiwan, namely Plurk and Twitter, emergency responders were able to better manage the overwhelming volume of information and requests for help.

From this case study, Huang et al. found that OSNs expand the capacity and the capabilities of professional emergency rescuers beyond the standard systems used (i.e., the 911 emergency system) by allowing them to provide "direct information [to residents] during emergencies and [help them understand] the severity and breadth of major disasters" (Huang et al., 2010). Additionally, since OSNs allowed users to communicate bi-directionally with an unlimited number of users at once "victims and professional emergency responders [had the ability to] build relationships and share timely and important information directly with those in immediate need" (Huang et al., 2010).

This phenomenon of sharing information through social networks during an emergency is not unique to the Morakot disaster. Palen (2008) illustrates the use of information sharing through OSNs during the 2007 Virginia Tech shooting. Palen discovered that though the first official communication was sent via email, almost immediately students began texting each other to notify each other of their safety (Palen, 2008). From there, students began using instant messaging clients and Facebook to see who was actively online (and thus confirm that they were alive).

What the Virginia Tech shooting and the Morakot tsunami disaster show is that even in an unofficial capacity, social networks can play an integral part in improving emergency response mechanisms. Our experiment is designed to test whether or not social networks can be effective in an official capacity.

Despite the advantages OSNs would provide for emergency response, there is concern that affected individuals and responders may be misled by inaccurate information without the necessary confirmation mechanisms in place (Huang et al. 2010). Through our second

experiment, we hope to observe the potency of crowdsourcing and whether or not OSNs already have the resources, in the form of a community of users, to police themselves and determine the validity of shared information.

4.2.2 Experiment 1: Test of CMU Emergency Messaging Systems

4.2.2.1 Introduction

The existing emergency alert systems at Carnegie Mellon University consist of text, e-mail, and phone messaging. There are various Carnegie Mellon University affiliated Facebook and Twitter pages that many students, staff and faculty follow. In this experiment we will look into the effectiveness of reaching people on the Carnegie Mellon University campus via existing channels and through OSNs. Using a survey, we will test the travel speed of distribution systems and determine the number of people reached by different emergency messaging systems. Some questions we wish to answer from this experiment are where people see the emergency message first, how soon after it was sent do they receive it, how people spread a message, where people are located when they see the message, if there is a correlation between where and how they received the alert and are different segments of the population better reached through certain methods. This experiment has been approved by Carnegie Mellon's Institutional Review Board (IRB).

4.2.2.2 Methodology

Distribution of messages

This experiment utilizes the existing emergency response system employed by Carnegie Mellon to distribute a link to an online survey. There are three primary methods this system employs to notify campus population: email, SMS (text messages), and phone calls/voicemail. We distributed the survey link to existing opt-in members of CMU's emergency response system. In particular, we chose to contact individuals using the SMS and email systems. We did not include the voicemail system in our test because of the difficulty users would face remembering a spoken website address. The numbers of people signed up for each of these methods are shown in Table 4.2.1.

TABLE 5.2.1 – CMU EMERGENCY ALERT SYSTEM COMMUNICATIONS MEDIUM PREFERENCES

	User Preference		
	Text-Only	Voice-Only	Both
Faculty	210	346	183
Staff	741	879	726
Student	4090	1676	1819

Because certain individuals opt-in for only one or a combination of notifications, we designed a sampling system that allows us to gather data from every unique group. This sampling is shown in table 4.2.2.

TABLE 4.2.2 - SURVEY DISTRIBUTION TO CMU ALERT SYSTEM USERS

		Survey Distribution	
		Email	SMS
User Preference	Text-Only	50%	50%
	Voice-Only	100%	0%
	Both	50%	50%

When assigning individuals, to a particular notification alert (email vs. SMS), every other individual was assigned to each condition. For the voice-only group, we distributed the survey via email as we assumed these users were much more acquainted with email than SMS.

In addition to the emergency response system, we distributed the survey through social networks as well. Using specific Facebook and Twitter accounts active on campus, we recruited responders who utilized social networks to gather campus news and information. The Facebook and Twitter accounts we chose to distribute the survey were selected because of their large number of “followers” and their willingness to distribute our survey.

Survey Design

For the survey, we chose to utilize the Survey feature within Google Documents. The nine questions included on the survey are found in Table 4.2.3. First, we are interested in determining how long it takes the average user on campus to receive and read a particular message sent through varying channels. Secondly, we wanted to map out the physical location of the campus community members surveyed when they read the emergency response. Finally we wanted to see if users share the emergency message with others or read the emergency response message from additional sources, either official or unofficial.

TABLE 4.2.3– EXPERIMENT 1 SURVEY

1. How long ago did you first learn of the message about this test of the CMU emergency alert system?
   - Fewer than five minutes ago
   - Five minutes or longer ago

2. Where were you when you first learned about this test of the CMU emergency alert system?
   - In a CMU academic building
   - In a CMU dorm
   - In a CMU building (not an academic building or dorm)
   - Outdoors on CMU campus
   - Off campus in the Pittsburgh area
   - Off campus outside the Pittsburgh area

3. Were you in class when you first learned of the message about the test of the CMU emergency alert system?
   - Yes
   - No

4. Have you signed up for CMU emergency messages?
   - Yes, I signed up for emergency text messages
   - Yes, I signed up for emergency phone calls
   - Yes, I signed up for emergency text messages and phone calls
   - No

5. How did you FIRST learn of this message about the test of the CMU emergency alert system?
   - Received an e-mail
   - Received a text
   - Read on official CMU Facebook page
   - Read on non-CMU Facebook page
   - Read official CMU tweet
   - Read non-official CMU tweet
   - Read on official CMU alert website
   - Heard about it verbally

6. How else did you learn about this message about the test of the CMU emergency alert system?
   - Received an e-mail
   - Received a text
   - Read on official CMU Facebook Page
   - Read on non-CMU Facebook Page
   - Read official CMU tweet
   - Read non-CMU tweet
   - Read on official CMU alert website
   - Heard about it verbally
   - None

7. Did you share this message about the test of the CMU emergency alert system?
   - No
   - Yes - I Posted it on Facebook
   - Yes - I sent a tweet
   - Yes - I sent e-mails
   - Yes - I sent texts
   - Yes - I told people verbally

8. Are you?
   - Undergraduate student
   - Graduate student
   - Staff
   - Faculty

Other

9. Are you
Female
Male

10. Is English your first language?
No
Yes

Collection of responses and auxiliary data

To categorize our survey results into each of these preference and campus status groups, we sent a unique web address (linking them to the survey) to each of these groups. Additionally, we created a unique web address for the Twitter survey and for the Facebook one. Consequently, as we collected the results, the data sorted itself into the preexisting preference/status groups. This allowed us to later compare data from individual groups against others. In total, we distributed 15 unique web addresses (5 for staff/faculty, 5 for students, 1 for Facebook, and 1 for Twitter).

4.2.2.3 Results

On April 11, 2012 at 11:00am, we sent out 10,675 survey links using Carnegie Mellon's alert messaging system through email and text to students, faculty, and staff, as well as the official CMU Facebook and Twitter pages. Between 11:00am and 1:00pm, 19% of students and 42.32% of faculty/staff had completed the survey.

The results overwhelmingly showed that email alerts yielded the most survey responses from faculty, staff, and students, with text message being the second media with most responses. Figure 4.2.1 shows the breakdown of media, which participants responded through. From this graph, Social Media (Facebook and Twitter) makes up less than 10% of the responses from faculty/staff and grad/undergrad students. Figure 4.2.2 shows similar results, regardless of location, email was still the preferred media, with text message being second. Media responses were the same for male and female; and non-native speakers responded the same as native speakers.

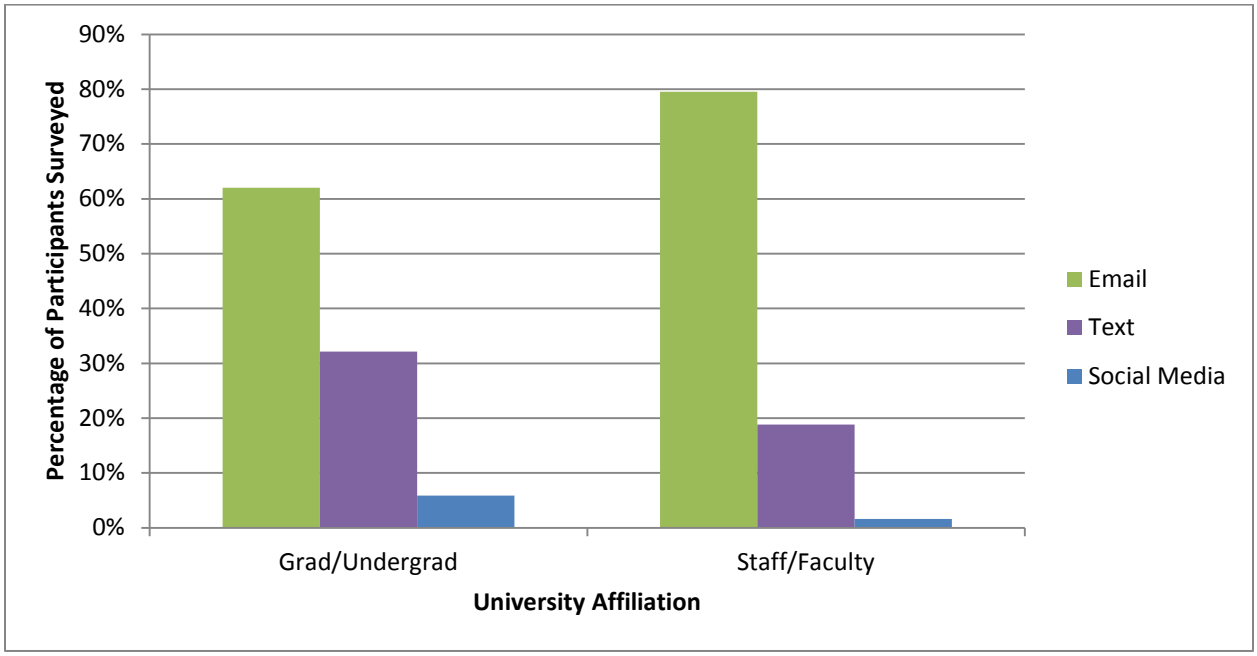


FIGURE 4.2.1 - MEDIA WITH MOST RESPONSE WITH RESPECT TO STAFF/FACULTY VERSUS GRADUATE AND UNDERGRADUATE STUDENTS

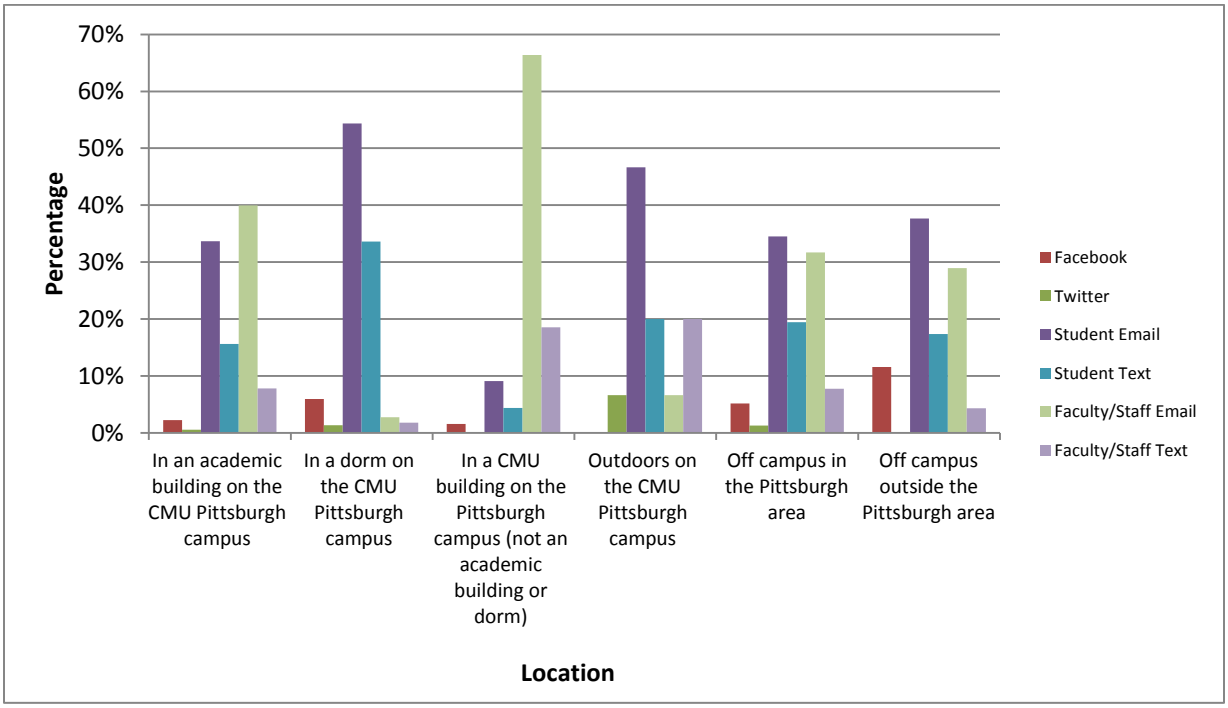


FIGURE 19.2.2 - MEDIA WITH MOST RESPONSES WITH RESPECT TO LOCATION

As mentioned before, Social Media had a significantly lower response rate compared to email and text message. Facebook and Twitter only generated 79 responses. Of those 79 responses, 71% were students and 18% were staff. In all cases Facebook was preferred over Twitter.

These data can be seen in Figure 4.2.3. Of those 79 responses, 15 people were not signed up for Carnegie Mellon's Emergency alert system, and therefore, would not have seen the alert message had we not used social media.

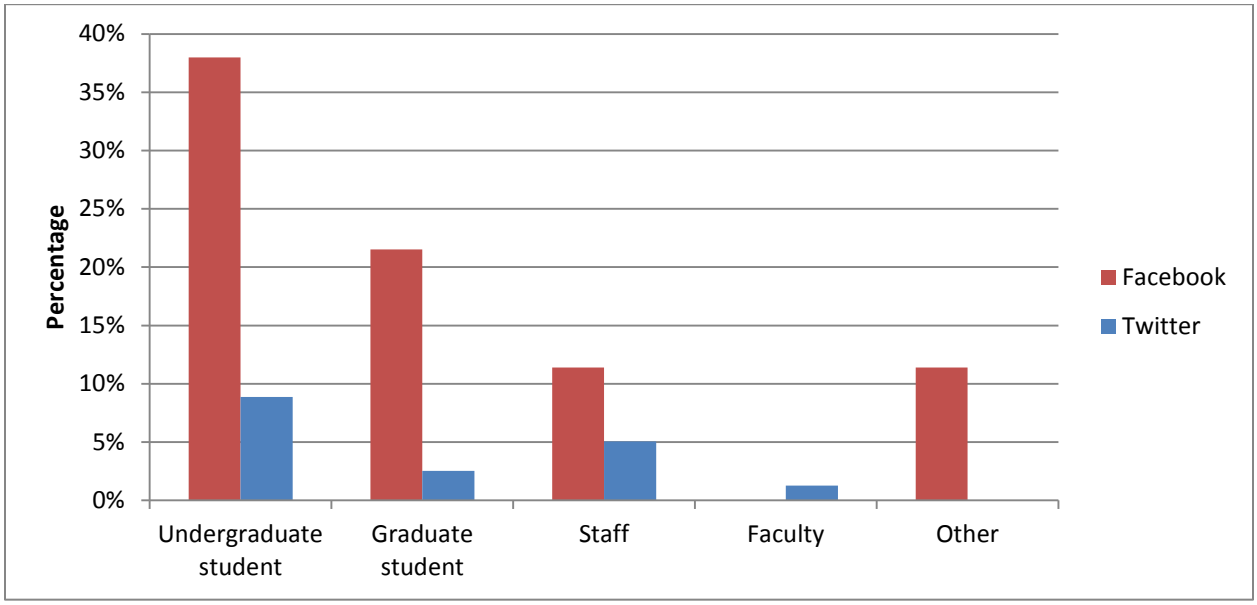


FIGURE 4.2.3 - SURVEY RESPONSES FROM PEOPLE RECEIVING ALERT VIA SOCIAL MEDIA BY UNIVERSITY STATUS

The alert message was sent out at 11:00 AM and within the first ten minutes we had received 400 survey responses. The time stamp for the first hour can be seen in Figure 4.2.4. The spike in text message responses at 11:20 AM is because the text message was resent, and further details on this issue can be found in our limitations section.

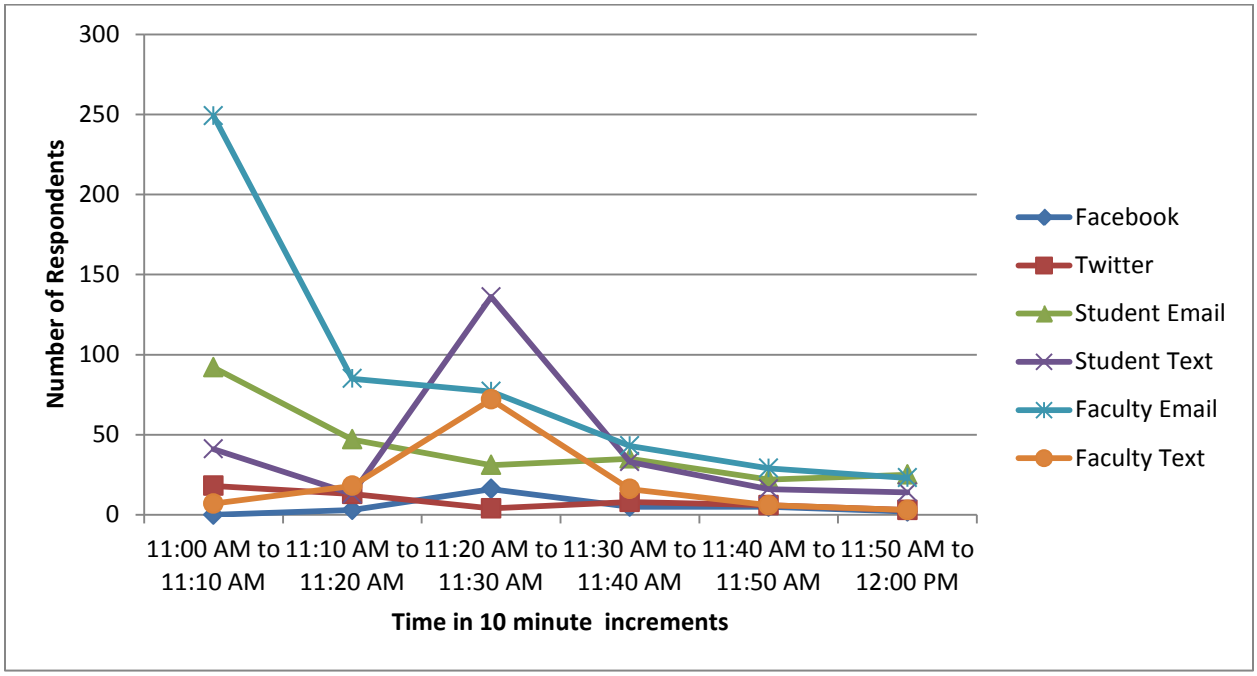


FIGURE 4.2.4 - TIME STAMP OF SURVEY RESPONSES WITHIN THE FIRST HOUR OF ALERT MESSAGE BEING SENT

Regression Analysis

Since the survey conducted for Experiment 1 contained mostly categorical variables, each possible response for each question was separated into dichotomous categorical variables in which a 1 symbolized that the option was selected and a 0 symbolized that the option was not selected. The full regression can be found in Appendix A and a full list of all the variables used can be found in Appendix B.

A multiple linear regression model was constructed on the dataset using the Minitab 16 software. The response variable selected for the regression represents whether individuals learned of the message about the test of the CMU emergency alert system in less than 5 minutes (lrndTestLT5M). The resulting equation was:

lrndTstLT5M = - 0.578 - 0.0435 inClass + 0.0620 isMale + 0.0585 engFirstLang

- 0.161 firstVerbal - 0.902 firstTwtNO + 0.308 firstTwtO

+ 0.720 firstFBNO + 0.126 firstFBO - 0.0329 firstCMA

+ 0.138 firstTxt - 0.161 usedVerbal - 0.317 usedTwtO

- 0.023 usedFBNO + 0.0147 usedFBO + 0.0443 usedCMA

+ 0.0098 usedTxt - 0.0808 usedEmail + 0.223 hiCMUB

+ 0.206 hiCMUDorm + 0.303 hiCMUAB + 0.248 hiOCIP + 0.185 hiOCOP

+ 0.190 hiCMUNPitt + 0.629 shNo + 0.250 shYesTxt + 0.681 shYVerbal

+ 0.967 shYFB + 0.831 shYTwt + 0.772 shYEmail + 0.082 lvlFaculty

+ 0.0708 lvlGrad + 0.233 lvlOther + 0.113 lvlStaff - 0.0019 suEMNo

- 0.0058 suEMPhone + 0.0051 suEMText - 0.136 srv2 - 0.041 srv3

+ 0.058 srv4 + 0.010 srv5 + 0.063 srv6 - 0.071 srv7 + 0.095 srv8

+ 0.0250 srv9 - 0.0472 srv10 + 0.0119 srv11 - 0.100 srv12

The variables firstEmail, hiCMUOutdoors, lvlUndergrad, and srv13 were found to be highly correlated with the other X variables and were thus removed from the equation. The variables usedTwtNO and srv1 both had all values equal to 0 and were thus also removed from the equation.

Upon observing the variables for where individuals first learned of the message about the test of the CMU emergency alert system, the variables indicating that individuals learned about the test from a non-official Facebook page (firstFBNO) and from receiving a text (firstTxt) both had p-values of less than 0.01 and were both positively correlated with the response variable. This suggests that the use of both non-official Facebook pages and text has a significant positive relationship with how fast an individual receives a message, implying that both media could potentially be effective in reaching a greater public in times of an emergency.

Similarly, when observing how else individuals learned of the message about the test of the CMU emergency alert system, the variables indicating that individuals learned about the test from verbal communication (usedVerbal) and e-mail (usedEmail) has p-values less than 0.01 while variables indicating that individuals learned about the test from official CMU tweets had a p-value less than 0.05. All three variables were negatively correlated with how fast individuals received the message, which suggests that individuals received the message after 5 minutes. However, all three of these mediums could potentially still be used to reach a significant amount of individuals if the information being sent out is not particularly time sensitive.

Regarding the location in which individuals first learned about this test of the CMU emergency alert system, the variables for being in an academic building on the CMU Pittsburgh campus (hiCMUAB) and being off-campus in the Pittsburgh area (hiOCIP) had p-values less than 0.05 while the variable for being in a non-academic building on the CMU Pittsburgh campus (hiCMUB) had a p-value less than 0.10. All three variables were positively correlated. Surprisingly, the variable for being in a dorm (hiCMUDorm) on the CMU Pittsburgh campus had a p-value of 0.107 and could not be considered statistically significant. However, given how

close its p-value is to the threshold in comparison to the other variables that were not found to be statistically significant (p-value for being off campus outside the Pittsburgh area: 0.184; p-value for being on a CMU campus other than the Pittsburgh campus: 0.376), it may inferred that there is a significant correlation between the proximity of an individual to the main campus and the rate at which they learned about the test of the CMU emergency alert system. It is likely, however, that individuals more readily access the devices necessary to receive the alerts when they are in non-housing buildings on the main campus or when they are in the vicinity of the main campus.

From the analysis, it is important to note that for those who shared the message about the CMU emergency alert system using word of mouth (shYVerbal), Facebook (shYFB), Twitter (shYTwt), and e-mail (shYEmail), there was a strong positive correlation with how fast they learned about the test as each variable had a p-value less than 0.01. Additionally, there was no statistical evidence to suggest that the survey number corresponding to the survey each individual filled out had any correlation with the speed by which individuals learned about the test of the CMU emergency alert system.

4.2.2.4 Discussion

In all cases Faculty and Staff preferred email, and students preferred text message. These results may be biased because we did not test voice messages. While in class, little of the participants responded to the survey, only 17% of students and 2% of faculty and staff.

We expected Social Media to play a large role in responses; however it led to less than 5% of survey responses. The data showed that when Social Media was used, Facebook was preferred over Twitter.

4.2.2.5 Limitations

While the survey and distribution system provided a large amount of data, the experiment was not without important limitations or faults. The most evident limitation of the experiment was the impracticality of distributing links to the online survey through voicemail, one of the primary channels of the existing CMU emergency response system. Because each medium tested was directed to the survey via a unique online web address, we chose to exclude voicemail recipients in the test because of the difficulty these users would face in having to remember and type in the website address after they received it through voicemail.

The consequences of this choice are several. First, by forgoing distribution through voicemail, we limited the overall pool of recipients who were potential candidates of survey respondents. Additionally, voicemail notifications are more popular among certain campus demographics most notably older members of the campus community. In particular, 47% of faculty chose to receive emergency notification through voicemail only. Additionally, more staff chose receive voicemail (37%) messaging than SMS (32%) or both (31%). This is in contrast to the student

population, where only 22% of those that opted-in chose voice only. By choosing not to distribute through voicemail, we may collect data that provide insight into the preferences of these demographic groups. For example, the groups may prefer receiving emergency messages via voicemail off campus and e-mail while on. This information is critical in reaching our objectives and may be missing.

Another web address accessibility issue that likely altered the results of our experiment was the use of non-smartphones throughout the campus community. Unlike smartphones, users with non-smartphones are not able to access the online survey immediately after receiving an SMS message with the web address. This accessibility issue not only could affect the results that we received (such as when they took the survey), but also may limit the amount of individuals who took the survey due to convenience issues or because they simply forgot about the SMS. This weakness in online links can also cause significant problems if utilized in a real emergency.

An issue that was not expected with the experiment design involved the warning message that was sent the day before of the experiment. In it, the CMU Emergency Response System notified recipients of the test that was to follow the next day. It is likely that this message confused recipients of the survey as they were unsure of how to respond to the question that asked when they first heard of the message of the warning system. Questions that are confusing or unclear pose serious consequences to the results of the survey. This was a limitation to the experiment that could have been avoided had the survey question clarified what was meant by “first heard.”

Additionally, there was a distribution error that occurred during the experiment. To categorize data depending on how recipients accessed the survey (e.g., email, SMS), we created a unique URL address for each distribution system to access the survey. Unfortunately, for one of the channels (CMU Public Relations Facebook/Twitter), the wrong URL was posted. As a result, data that was meant to be separate was collected with others. The primary consequence of this error is the number of respondents in the affected groups will be inaccurate and may affect our conclusions on which channel best distributes information to the campus community.

Finally, an additional issue we did not expect during the experiment occurred with the message distribution via SMS. In the original notification, the SMS was split (due to length) into two sequential messages. The break occurred in the middle of the URL and therefore made it impossible for the surveyed to reach the correct website. This issue was later fixed with a second SMS 20 minutes later. The consequences of this issue are several. First, respondents were not able to access the website after the first message and therefore may have reached an incorrect website or chosen not to go to the correct one after the second message was sent (due to frustration, etc.). Also, the distribution of two messages again may have confused those surveyed on how they answered when they originally heard of the emergency message.

4.2.2.6 Conclusions, Experiment 1

From experiment 1 we can conclude that Social Media does not play a primary role in emergency alert responses. This conclusion is just based on the need for a response and seeing the message through Social Media first. We are unable to collect data on participants who completed the survey but saw the message on Social Media later on in the day. This leads us to the conclusion that Social Media may not be helpful for immediate response but could enhance communication later in the day.

However, as Facebook and Twitter are free and user friendly, Social Media could be a supplementary conduit for the existing Carnegie Mellon alert system. The survey did reach 15 additional people through Social Media. Even though this is a small number, this tells us Social Media can reach a group of university affiliates that are currently not being reached through the CMU alert system. Further instigation would need to be done to see the amount of recipients that saw the message through social media, but did not respond.

4.2.3 Experiment 2 – Information Self-Correction in Social Media

4.2.3.1 Introduction

Social Media may have some self-correcting behavior. People may tend to spread a truth more than a lie, if they have the ability to distinguish which one is true. We want to experimentally explore information self-correction within social media. We also want to measure the rate of self-correction, because in an emergency situation, erroneous information needs to be corrected quickly.

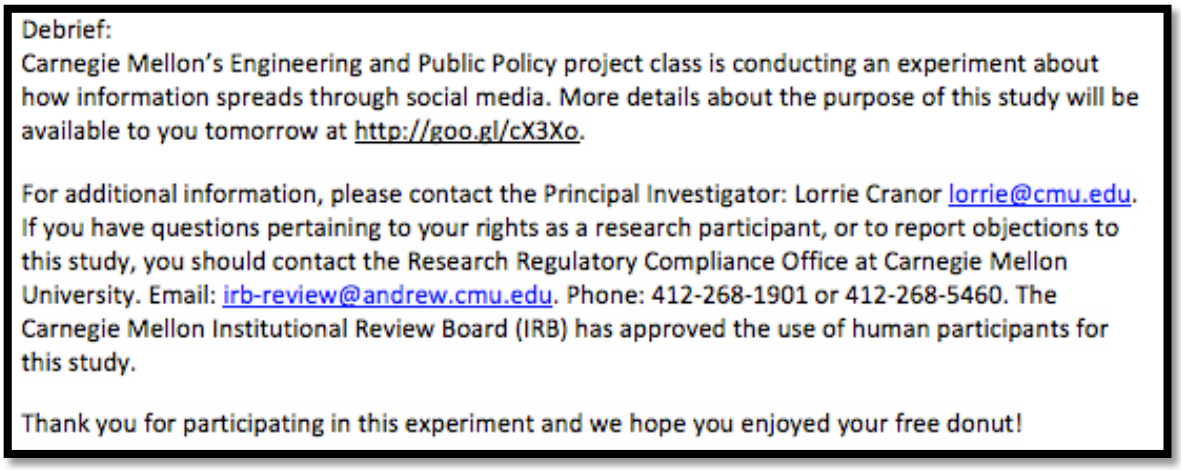
Our second experiment tested the existence and rate of self-correction in Social Media; specifically Facebook and Twitter. In the experiment we offered free food at some location, but indicated the wrong location in the original announcement message. The information that was hopefully to be corrected in re-tweets and re-posts was the location of the food. We expected to have a large number of people show up at the false room in the first hours of the experiment, and later in the day, we expected the number of people going to the wrong room to significantly decrease. This experiment has been approved by Carnegie Mellon's IRB.

4.2.3.2 Methodology

In this experiment, we created a campus-wide event to give out free donuts. The day before the event, we posted on several Facebook and Twitter accounts an advertisement for free donuts for participants. In our advertisements for the event, we purposefully included the wrong room number. The incorrect room was West Wing Common Room (subsequently called "Room A"), a well-known and convenient location on campus. At this location, we placed a sign that notified any students attempting to get free donuts to the correct location, which was in the 3rd floor of the University Center, a building adjacent to West Wing. Additionally, we placed a student at the

entrance of Room A, located in West Wing lounge, to count the amount of people that arrived at the room for the free food and at what time they arrived.

As people arrived in the correct room (UC 318G, subsequently referred to as "Room B") we asked participants to answer a short survey with questions to gather specific information from participants on where they heard the incorrect information, the correct information, and other important data. In addition to handing out the free food, we provided a debriefing statement that notified the participants of the general focus of the experiment and the role they played (but not too specific so as to alter their actions after getting the free food). Also, we requested each participant to visit a website the next day to read a more complete debriefing statement (as seen in Figure 4.2.5) to explain the project's attempt of measuring crowdsourcing in social networks.


Debrief:
Carnegie Mellon's Engineering and Public Policy project class is conducting an experiment about how information spreads through social media. More details about the purpose of this study will be available to you tomorrow at http://goo.gl/cX3Xo.

For additional information, please contact the Principal Investigator: Lorrie Cranor lorrie@cmu.edu. If you have questions pertaining to your rights as a research participant, or to report objections to this study, you should contact the Research Regulatory Compliance Office at Carnegie Mellon University. Email: irb-review@andrew.cmu.edu. Phone: 412-268-1901 or 412-268-5460. The Carnegie Mellon Institutional Review Board (IRB) has approved the use of human participants for this study.

Thank you for participating in this experiment and we hope you enjoyed your free donut!

FIGURE 4.2.5 - EXPERIMENT 2 DEBRIEF

Survey Questions

In addition to tallying the number of people that arrived at both Room A and B and their arrival times, we wanted to collect additional information from individuals involved to supplement our analysis. To do so, we surveyed every individual that arrived at Room B with a brief three-question survey (Table 4.2.4)

TABLE 4.2.4 - EXPERIMENT 2 SURVEY FORM

Experiment 2 Survey Fom 4/11/12

Q1: Where did you first hear about Donut Day?
Q2: Did you hear that Donut Day was in a different room before you found out it was here?
Q3: If yes, how did you find out it was here?

	Q1							Q2		Q3							
Person	Time	CMU Facebook	A friend's facebook	CMU Twitter	a friends twitter	text	word of mouth	Yes	No	At the other room	CMU facebook	a friends facebook	CMU Twitter	a friends twitter	text message	word of mouth	email from a friend
1																	

Advertising Messages

On the day before the experiment, the following message was posted on several CMU organizations' Facebook sites and Twitter feeds. Students in the project class were also asked to post the messages. The message for Twitter was:

CMU FREE DONUT DAY! Come to West Wing Lounge between 10:30 am – 2:30 pm tomorrow and get a free donut. #CMUfreedonutday!

On the day of the experiment, the following message was posted on several CMU organizations' Facebook and Twitters as well as students in the experiment group and class:

CMU FREE DONUT DAY! Come to West Wing Lounge between 10:30 am – 2:30 pm today and get a free donut. #CMUfreedonutday!

The following day we asked the organizations to post the link to the debrief statement in the following message.

Yesterday's free donuts were part of an experiment. Find out why we gave out free donuts and learn more:
cups.cs.cmu.edu/donutday.html

On the day of the experiment the time to give out free donuts was extended to 4:00 pm so that we could have a larger sample size. We decided to extend the experiment at around 1:30pm and the following message was posted:

CMU FREE DONUT DAY! Now extended until 4:00 pm! Come to West Wing Lounge next to the University Center! #CMUfreedonutday!

Some sample tweets by one CMU Twitter source are shown in Figure 4.2.6 below.

FIGURE 4.2.6 - SAMPLE POSTS FROM CMU TWITTER

Distribution of Advertisements

In this experiment, we solely used online social media to advertise this event. In particular, we chose to use Twitter and Facebook because of their popularity in the United States and Carnegie Mellon's campus. We contacted several student organizations that maintain highly followed accounts to distribute the information. The organizations involved and their numbers of "followers" were Activities Board with 474 followers on Twitter, and Graduate Student Assembly (GSA) with 520 followers, Asian Student Association (ASA) posted on their private Facebook page, and Dancer's Symposium also posted on their private Facebook page.

4.2.3.3 Results

On the day of the study, 121 participants attended the CMU Donut Day event and completed our survey in the correct room. From the survey, we found that 50 people found out about the event through various OSN communication channels. Figure 4.2.7 shows how each channel was effective in reaching the population observed. The primary response was "Word of mouth" with 59 responses, followed by "A friend's Facebook" with 41 responses, then "CMU Twitter" with 10 responses.

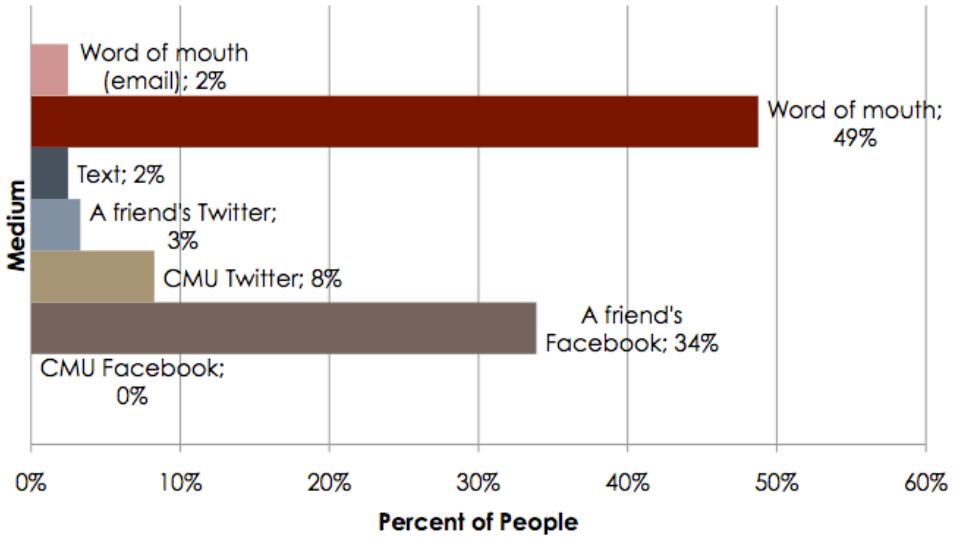


FIGURE 4.2.7 - SOURCE OF KNOWLEDGE OF DONUT DAY

From observing participants who entered the incorrect room throughout the duration of the study, it was found that there was a decrease in the number of participants who entered the incorrect room. Figure 4.2.8 plots of the number of individuals entering both rooms over the study period. It can be seen that there was a steady decline in the number of individual entering the wrong room, from 16 individuals in the first hour (10:30 am –11:29am) to no individuals in the last hour (3:29pm – 4:29pm). Conversely, the number of individuals who entered the right room first began with 9 participants within the first hour (10:30 am –11:29am) and increased to 23 participants in the last hour (3:29pm – 4:29pm).

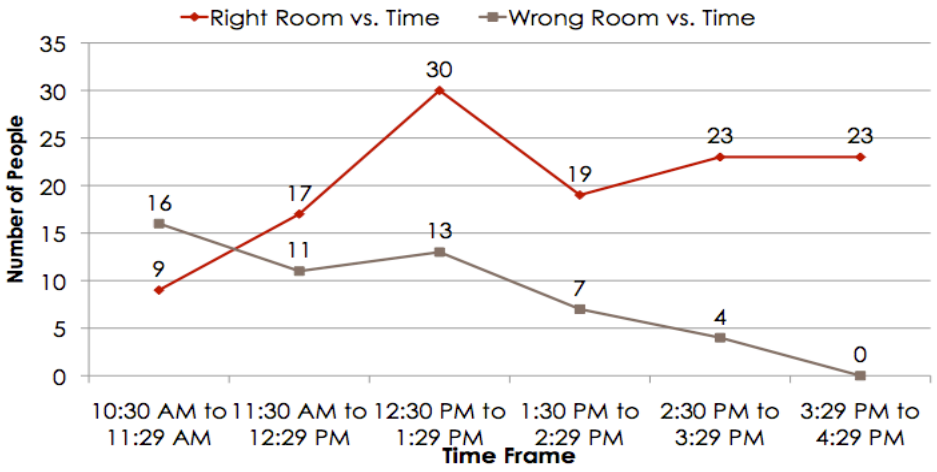


FIGURE 4.2.8 - ARRIVAL RATES AT THE WRONG ROOM VERSUS THE RIGHT ROOM

We noted when false information was corrected and when re-posts were made on Facebook. An example of the correction of false information is depicted in the image Figure 4.2.9 below that shows an example of a participant correcting the false information posted to the correct room number and location. It is important to note, however, that this particular correction did not occur 3 minutes after the experiment began. It is likely the post was made later on in the day after the experiment already began because we asked members of our class to post the message on their personal Facebook/Twitter accounts.

FIGURE 4.2.9 - EXAMPLE OF INFORMATION CORRECTION ON FACEBOOK

For each separate medium we saw different correlations with respect to time for which medium they first heard of the event. Some important correlations to note are there were a steady increase in “Word of mouth” and a general decrease in “A friend’s Facebook.” Additionally, “Text” had almost no responses at the beginning of the experiment but gradually increased toward the end as depicted in Figure 4.2.10 below.

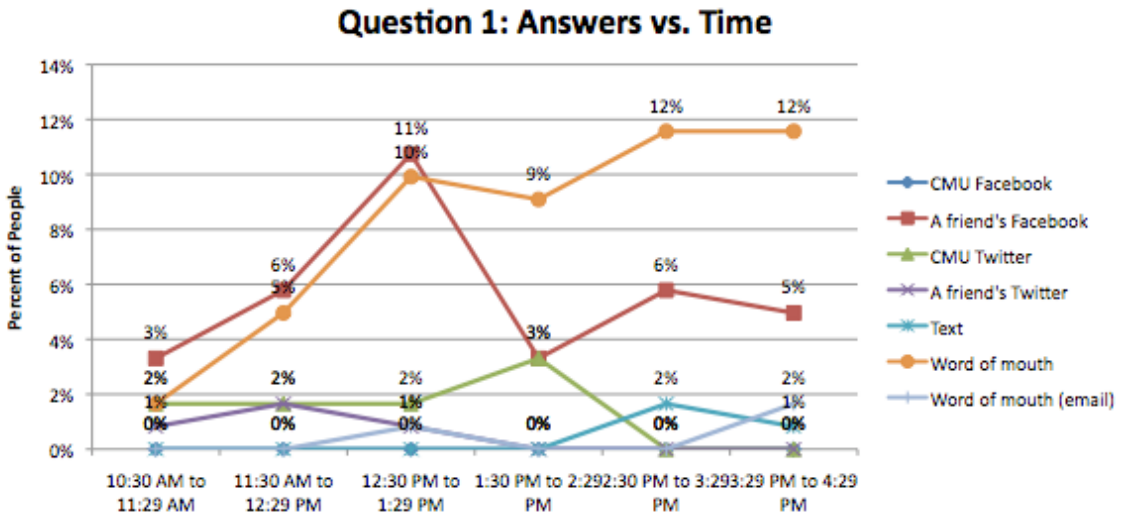


FIGURE 4.2.10 - SOURCES OF INFORMATION CONCERNING THE LOCATION OF DONUTS OVER TIME

Question two of the survey asked if the participants heard the event was in a different room first before they arrived at the correct location. Overall 69 participants answered, “Yes,” 51 participants answered “No,” and one person left the response blank.

Over the course of the experiment we observed a steady increase in “No” responses and a gradual decrease in “Yes” responses as depicted in Figure 4.2.11 below.

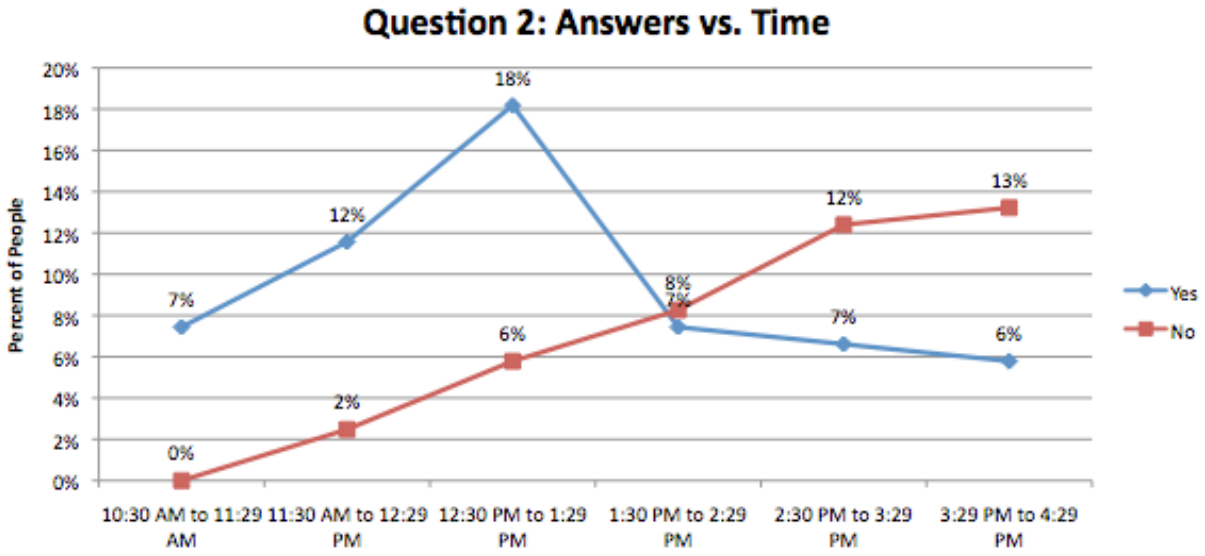


FIGURE 4.2.11 - NUMBER OF PEOPLE ENTERING THE TEST ROOM VERSUS TIME “YES” OR “NO” RESPONSE TO IF PARTICIPANTS HAD HEARD OF THE EVENT IN A DIFFERENT ROOM FIRST

We asked each participant, if they heard that the event was in a different room first, how they found the correct room and where they found the correct room number and location. Of the 121

participants, 38.84% answered “At the other room,” 22.31% answered “Word of Mouth,” 6.61% answered “A friend’s Facebook,” 3.31% answered “E-mail from a friend,” 0.83% answered “Text message,” and 28.10% left a blank response.

Over the course of the experiment, with respect to time, it is important to note a gradual decrease in responses that participants found the correct information at the other room as depicted below in Figure 4.2.12. There were also gradual increases in all other communication medium over time. There were no responses from a friend’s Twitter.

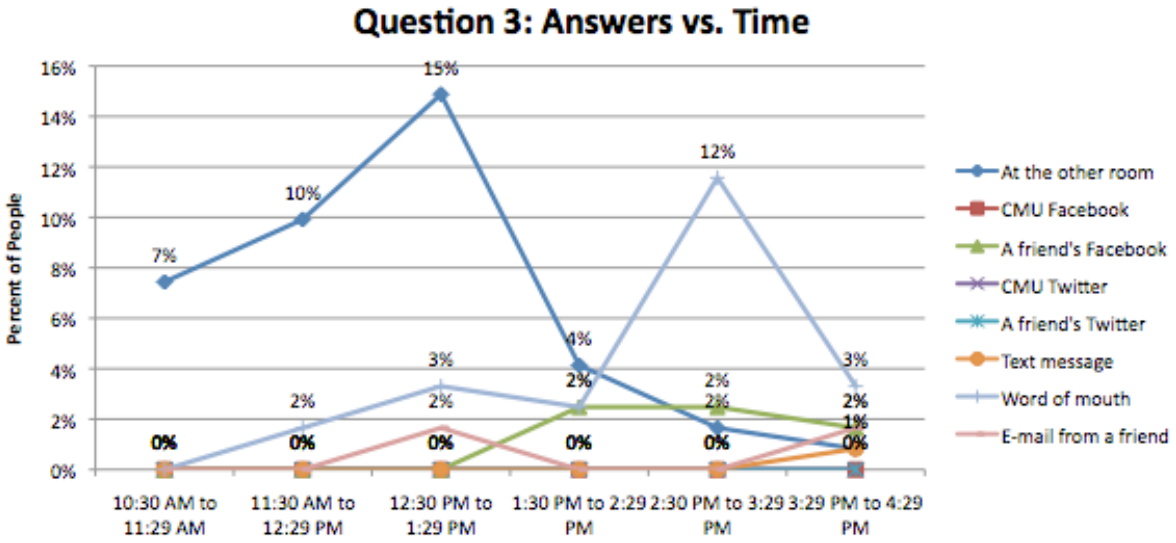


FIGURE 4.2.12 - SOURCE OF CORRECTED FALSE INFORMATION: NUMBER OF PEOPLE ENTERING THE TEST ROOM VERSUS TIME

Due to the great number of responses of hearing the correct information from word of mouth we plotted the number of people hearing corrected information by word of mouth and social media versus time in Figure 4.2.13 below. There were overall more responses of word of mouth than social media and both had increasing trends over the course of the experiment.

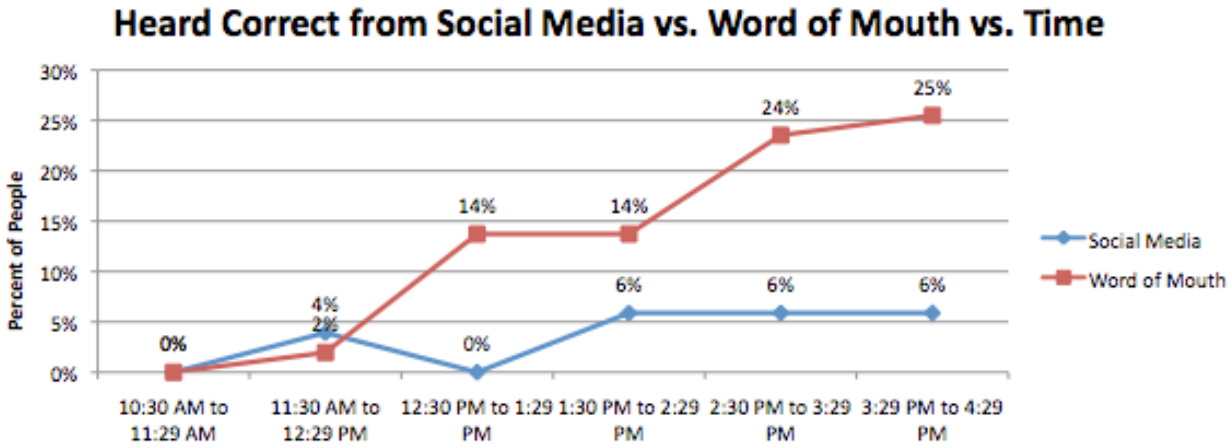


FIGURE 4.2.13 - HEARD CORRECT INFORMATION FROM HIGHEST TWO RESPONSES, SOCIAL MEDIA OR WORD OF MOUTH: NUMBER OF PEOPLE ENTERING TEST ROOM VERSUS TIME

Twitter Analysis

In experiment two the following sources listed in Table 4.2.5 were used to search the key terms in the message "CMU FREE DONUT DAY, 8 am – 2 pm today, #CMUfreedonutday, UC 318G,free donut, West Wing Lounge, WW Lounge." The second column depicts the number of times the message was found on the respective application.

TABLE 4.2.5 - TWEET SOURCES FOR EXPERIMENT 2

Source	Number of occurrences
*foursquare	1
HootSuite	1
*HTC Peep	1
TweetDeck	2
*Twitter for Android	4
*Twitter for BlackBerryÂ®	1
*Twitter for iPad	1
*Twitter for iPhone	2
Twuffer	1
Web	4
Grand Total	18

* - Mobile device application

There was a great deal of irrelevant data collected. After manually cleaning the raw data, 18 relevant entries were retrieved from Experiment 2. From experiment 2, 10 out of the 18 entries were collected from various mobile applications across different platforms, including Android, BlackBerry, and iOS. The table below, Table 4.2.6 depicts some of the twitter names of users who posted about donut day with the corresponding number of tweets in column two.

TABLE 4.2.6 -NUMBER OF TWEETS PER USER

Experiment 2	
Screen Name	Number of Tweets
activitiesboard	1
Bravo_Tango	1
clegassie	2
cmugsa	1
gabrielle__j	1
giantspatula	1
hyejookim	1
JessiDG	1
keeboch	2
lorrietweet	2
LostSheepProd	1
neksec	2
PrivacyCamp	1
Sean__Chin	1

In this experiment only a few re-tweets were witnessed on our interface as depicted in Table 4.2.7 below. Column one shows the text that was posted on twitter followed by the poster and in the third column the number of tweets is shown. Although only a few users re-tweeted, the poster “JessiDG” did in fact post the correct room number.

TABLE 4.2.7 EXPERIMENT 2 RE-TWEETS

Tweet Text	Poster	Number of Re-Tweets
CMU FREE DONUT DAY! Come to West Wing Lounge between 10:30 am – 2:30 pm today and get a free donut. #CMUfreedonutday!	clegassie	2
CMU FREE DONUT DAY! Come to West Wing Lounge between 10:30 am – 2:30 pm today and get a free donut. #CMUfreedonutday!	neksec	2
There are free donuts available in 318G of the UC as part of a CMU Engineering and Public Policy class experiment on social media.	JessiDG	3
CMU FREE DONUT DAY! Now extended until 4:00 pm! Come to West Wing Lounge (dorm next to UC and football field)! #CMUfreedonutday!	PrivacyCamp	2

Table 4.2.8 below shows frequency by which certain tweets were re-tweeted throughout the course of the study. From the tweets that were re-tweeted, none were re-tweets themselves; in other words, the re-tweets only propagated down a maximum of one degree from the original tweet. Although it can possibly be said that this was the result of how people normally engage with Twitter, several factors, such as the lack of urgency inherent in the nature of both experiments, in addition to the limited time scope of both experiments could also contribute to the limited propagation of information in both experiments. From Table 4.2.8, it can be seen again that the text from the original message tends to be tweeted the most out of all the words used. The presence, however, of words such as “class”, “engineering”, and “experiment” allude to the fact that people started to become more vocal about the nature of the event on Twitter, which contributes to the idea of crowd sourcing through the use of the platform.

TABLE 4.2.8-EXPERIMENT 2 FREQUENCY AND TOP WORDS

Word	Occurrences	Frequency	Rank
Free	23	9.8%	1
Donut	19	8.1%	2
CMU	14	6%	3
West	12	5.1%	4
Lounge	12	5.1%	4
Wing	12	5.1%	4
Come	10	4.3%	5
day	10	4.3%	5
cmufreedonutday	8	3.4%	6
get	7	3%	7
between	7	3%	7
today	7	3%	7
policy	4	1.7%	8
class	4	1.7%	8
engineering	4	1.7%	8
now	4	1.7%	8
experiment	4	1.7%	8
public	4	1.7%	8
available	4	1.7%	8
donuts	4	1.7%	8
part	4	1.7%	8
dorm	3	1.3%	9
activitiesboard	3	1.3%	9
extended	3	1.3%	9
until	3	1.3%	9
next	3	1.3%	9
giantspatula	3	1.3%	9
football	3	1.3%	9
field	3	1.3%	9
cmugsa	2	0.9%	10

Table 4.2.9 depicts the accuracy of the tweets over time. In this table, we can see how after 3:00 pm, only the correct information was being re-tweeted (with the exception of the 3 messages sent after 5:00 pm by individuals in our group who were conducting the study).

TABLE 4.2.9-ACCURACY OF TWEETS OVER TIME

	Did the tweet reflect the right room?		
Hour of Day	No	Yes	Total
1:00 PM	1		1
2:00 PM	5		5
3:00 PM	1	4	5
4:00 PM		2	2
5:00 PM	3		3
Total	10	6	16

Facebook Analysis

As a result of Facebook's privacy settings in addition to the wide range of media on which users can contribute information on the platform, only a limited amount of data was collected. More specifically, only 3 relevant posts were collected for Experiment 2 (Table 4.2.10).

TABLE 4.2.10 - FACEBOOK DATA COLLECTED FOR EXPERIMENT 2

ID	Post ID	Message	Time Created	Post Type
1	889520292_10151476041810293	Seeking like-minded Pitt students to wear fake mustaches and plaid sweatshirts to CMU free donut day. When confronted mumble something about robots and immediately try to leave the conversation	2012-04-10 T14:37:15+0000	status
2	1472970123_3011574176370	CMU FREE DONUT DAY! Now extended until 4:00 pm! Come to West Wing Lounge next to the University Center! #CMUfreedonutday!	2012-04-11 T18:03:49+0000	status

3	1472970123_3010395986916	CMU FREE DONUT DAY! Come to West Wing Lounge between 10:30 am – 2:30 pm today and get a free donut. #CMUfreedonutday!	2012-04-11 T13:59:22+0000	status

From this data however, however, we can get a sense of the breadth of Facebook, as posts pertaining to Carnegie Mellon affairs are easily reaching individuals from the University of Pittsburgh campus, as reflected by the first post.

4.2.3.4 Discussion

It is difficult and unethical to simulate an actual emergency or disaster situation so we devised the "free Donut Day" experiment to study how information travels and self corrects. We found an overall increasing trend of word of mouth communication that dominated all other media and a decreasing trend of social media communication. This shows that participants relied mostly on face-to-face interaction. We can infer that people are more likely to pass correct information to friends or other individuals by word of mouth. Over time, fewer people heard the incorrect information first. When people did hear of false information first other forms of communication most often corrected it.

Like the first experiment, this one showed that social media were not particularly helpful for getting a message out to a large audience (push) quickly. The value of social media in emergency situations may be their ability to reach a younger sector of the population or their contribution to situational awareness (pull) as a situation unfolds.

4.2.3.5 Limitations

There are several concerns we have with the results of this experiment. First, our experiment did not garner as many participants as we were expecting. We tried to counteract this by extending the length of the experiment by two hours and reposting the advertisement for the event on social networks. Nevertheless, the small number of people that attended should be considered when evaluating the significance of the results.

Secondly, of the people who did attend the event, one reoccurring concern that we faced was after we asked people to share the information of the event with their friends. We originally assumed that attendees would simply share information about the correct room number. However, many individuals asked whether they were to share the correct or incorrect room number. Trying to avoid any undue influence on the results, we told attendees to do what they

wanted. Consequently, it is likely that our results were affected by this oversight and the change in rate over time does not reflect the subjects' normal behavior.

Third, we faced difficulty in collecting information shared on Facebook. Because of privacy settings on individuals, we were only able to collect a fraction of the total information (e.g. number of posts, rates of activity) shared on Facebook regarding the event. Any information we did collect was from individuals with lower privacy settings and likely does not reflect the total amount shared regarding the event.

We are also concerned about the effects of the locations we chose for the experiment may have on the results. While we spent considerable amount time of trying to locate and reserve rooms that were conveniently located on campus (but not too convenient so as an individual could accidentally find the rooms), the locations were separated from the most trafficked routes on campus. While this limited the amount of "accidental" participants, it also created an inconvenience factor that may have limited the number of attendees of our event. In particular, we noted that graduate students on campus were unfamiliar with the incorrect room location (West Wing, an undergraduate dormitory). While we were aware of this particular issue, we chose to continue with the experiment at the same location.

4.2.3.6 Conclusions, Experiment 2

The results suggest that over time false information does self-correct through different communication and social media channels. We found that a majority of correction of false information was through word of mouth and secondarily through Facebook. These results support our hypothesis that the number of people going to the wrong room significantly decreased over time. We also found that participants at Carnegie Mellon University generally used Facebook more than Twitter to communicate on social media.

4.2.4 Conclusions, Information Flow

Using social media in emergency messaging situations has both advantages and disadvantages. However, when paired with traditional emergency messaging systems it can be used to compensate for some of the short fallings of traditional emergency messaging. During emergencies, phone lines often become overloaded with people making calls. Social networks provide another way for people to communicate. The infrastructure used to help people communicate can also fail during emergencies. Cell phone towers and phone lines can be taken down. Internet and access to social media sites sometimes run on different systems and may provide a back-up if infrastructure failures cause some of the more traditional media to fail.

The goals of the first experiment were to study the different ways in which people on Carnegie Mellon's campus received emergency alerts, the type of media that reached people fastest, and if people were reached through social media who otherwise may not have been reached. Currently 65% of students and 60% of staff are signed-up for emergency alerts. We expected that by

posting the message on Facebook and Twitter we may be able to reach a portion of the other 35% of students and 40% of staff. The results showed that less than 5% of the survey responses were through Facebook and Twitter. Of this 5%, 71% of the responses were from students. This may be because people saw this link after they answered the survey through e-mail or text messages. Even though social media did not reach a large percentage of people, it did reach some people who might otherwise not have received the alert. We also found that faculty and staff prefer to receive emergency alerts through email while students prefer text messages.

For experiment 2 our goal was to study how false information is corrected in online social media. One of the concerns with using social media in emergency situations is that it does not pose restrictions on people posting incorrect information, and that there is no easily monitor the spread of information on social media sites. We wanted to see if over time people naturally corrected the false information that was posted. Though our sample size was small, our hypothesis was valid and more people became aware of the correct location, without going to the wrong one, during the experiment. More people heard the correct room initially and went directly there. The wrong information was mostly corrected through the word of mouth, though there were also Facebook and Twitter posts that corrected the false information.

Based on our research and the experiments we conducted we feel that social media could be a possible supplement to traditional emergency messaging systems; however, at this time it is not widespread enough that it should replace these methods. As social media grows and becomes more widespread it may eventually be the most efficient way to spread information.

4.3 Appendices, Information Flow

4.3.1 Appendix A – Regression Analysis

4/23/2012 7:59:46 PM

```
Welcome to Minitab, press F1 for help.
* NOTE * All values in column are identical.
* NOTE * All values in column are identical.
```

Results for: Worksheet 2

Regression Analysis: lrndTstLT5M versus inClass, isMale, ...

```
* firstEmail is highly correlated with other X variables
* firstEmail has been removed from the equation.

* NOTE * All values in column are identical.
* NOTE * All values in column are identical.


* usedTwtNO has all values = 0
* usedTwtNO has been removed from the equation.

* NOTE * All values in column are identical.


* hiCMUOutdoors is highly correlated with other X variables
* hiCMUOutdoors has been removed from the equation.

* NOTE * All values in column are identical.


* lvlUndergrad is highly correlated with other X variables
* lvlUndergrad has been removed from the equation.

* NOTE * All values in column are identical.


* srv1 has all values = 0
* srv1 has been removed from the equation.


* srv13 is highly correlated with other X variables
* srv13 has been removed from the equation.


The regression equation is
```

```
lrndTstLT5M = - 0.578 - 0.0435 inClass + 0.0620 isMale + 0.0585 engFirstLang
              - 0.161 firstVerbal - 0.902 firstTwtNO + 0.308 firstTwtO
              + 0.720 firstFBNO + 0.126 firstFBO - 0.0329 firstCMA
              + 0.138 firstTxt - 0.161 usedVerbal - 0.317 usedTwtO
              - 0.023 usedFBNO + 0.0147 usedFBO + 0.0443 usedCMA
              + 0.0098 usedTxt - 0.0808 usedEmail + 0.223 hiCMUB
              + 0.206 hiCMUDorm + 0.303 hiCMUAB + 0.248 hiOCIP + 0.185 hiOCOP
              + 0.190 hiCMUNPitt + 0.629 shNo + 0.250 shYesTxt + 0.681 shYVerbal
              + 0.967 shYFB + 0.831 shYTwt + 0.772 shYEmail + 0.082 lvlFaculty
              + 0.0708 lvlGrad + 0.233 lvlOther + 0.113 lvlStaff - 0.0019 suEMNo
              - 0.0058 suEMPhone + 0.0051 suEMText - 0.136 srv2 - 0.041 srv3
              + 0.058 srv4 + 0.010 srv5 + 0.063 srv6 - 0.071 srv7 + 0.095 srv8
              + 0.0250 srv9 - 0.0472 srv10 + 0.0119 srv11 - 0.100 srv12
```

Predictor	Coef	SE Coef	T	P
Constant	-0.5777	0.3157	-1.83	0.067
inClass	-0.04353	0.04317	-1.01	0.313
isMale	0.06196	0.02379	2.60	0.009
engFirstLang	0.05854	0.03693	1.59	0.113
firstVerbal	-0.16142	0.07968	-2.03	0.043
firstTwtNO	-0.9020	0.5626	-1.60	0.109
firstTwtO	0.3080	0.2573	1.20	0.231
firstFBNO	0.7198	0.2295	3.14	0.002
firstFBO	0.1263	0.1367	0.92	0.356
firstCMA	-0.03287	0.09812	-0.34	0.738
firstTxt	0.13780	0.04293	3.21	0.001
usedVerbal	-0.16112	0.05530	-2.91	0.004
usedTwtO	-0.3167	0.1364	-2.32	0.020
usedFBNO	-0.0234	0.1581	-0.15	0.882
usedFBO	0.01471	0.09188	0.16	0.873
usedCMA	0.04434	0.07822	0.57	0.571
usedTxt	0.00981	0.04255	0.23	0.818
usedEmail	-0.08082	0.02603	-3.10	0.002
hiCMUB	0.2228	0.1271	1.75	0.080
hiCMUDorm	0.2061	0.1279	1.61	0.107
hiCMUAB	0.3026	0.1243	2.43	0.015
hiOCIP	0.2475	0.1254	1.97	0.049
hiOCOP	0.1853	0.1394	1.33	0.184
hiCMUNPitt	0.1896	0.2141	0.89	0.376
shNo	0.6293	0.2468	2.55	0.011
shYesTxt	0.2504	0.2550	0.98	0.326
shYVerbal	0.6814	0.2457	2.77	0.006
shYFB	0.9671	0.3076	3.14	0.002
shYTwt	0.8312	0.2677	3.10	0.002
shYEmail	0.7718	0.2674	2.89	0.004
lvlFaculty	0.0819	0.1136	0.72	0.471
lvlGrad	0.07076	0.03904	1.81	0.070
lvlOther	0.23328	0.09708	2.40	0.016
lvlStaff	0.1125	0.1085	1.04	0.300
suEMNo	-0.00186	0.08145	-0.02	0.982
suEMPhone	-0.00583	0.03456	-0.17	0.866
suEMText	0.00509	0.04363	0.12	0.907

```
srv2           -0.1358   0.1192  -1.14  0.255
srv3           -0.0413   0.1722  -0.24  0.811
srv4            0.0582   0.1220   0.48  0.634
srv5            0.0097   0.1218   0.08  0.937
srv6            0.0627   0.1208   0.52  0.604
srv7           -0.0709   0.1156  -0.61  0.539
srv8            0.0954   0.1122   0.85  0.396
srv9           0.02499  0.05708   0.44  0.662
srv10         -0.04715  0.07732  -0.61  0.542
srv11          0.01192  0.05978   0.20  0.842
srv12         -0.10019  0.06833  -1.47  0.143


S = 0.489530   R-Sq = 6.1%   R-Sq(adj) = 3.6%


Analysis of Variance

Source            DF        SS      MS     F      P
Regression        47   27.9231  0.5941  2.48  0.000
Residual Error  1797  430.6330  0.2396
Total           1844  458.5561


Source        DF  Seq SS
inClass        1  0.1642
isMale         1  1.6411
engFirstLang   1  0.1115
firstVerbal    1  1.2761
firstTwtNO     1  0.2542
firstTwtO      1  0.4978
firstFBNO      1  1.4353
firstFBO       1  0.0195
firstCMA       1  0.4466
firstTxt       1  0.4734
usedVerbal     1  1.9107
usedTwtO       1  1.6310
usedFBNO       1  0.0732
usedFBO        1  0.0994
usedCMA        1  0.1560
usedTxt        1  0.8712
usedEmail      1  2.1043
hiCMUB         1  0.1408
hiCMUDorm      1  2.4652
hiCMUAB        1  1.2752
hiOCIP         1  0.1964
hiOCOP         1  0.2422
hiCMUNPitt     1  0.0931
shNo           1  0.8069
shYesTxt       1  0.0418
shYVerbal      1  0.0655
shYFB          1  0.2224
shYTwt         1  1.1119
```

```
shYEmail       1  2.0379
lvlFaculty     1  0.0289
lvlGrad        1  0.1347
lvlOther       1  1.0788
lvlStaff       1  0.6042
suEMNo         1  0.0103
suEMPhone      1  0.0500
suEMText       1  0.0015
srv2           1  0.7352
srv3           1  0.0169
srv4           1  0.0102
srv5           1  0.0000
srv6           1  0.0024
srv7           1  2.2402
srv8           1  0.2439
srv9           1  0.1938
srv10          1  0.0266
srv11          1  0.1651
srv12          1  0.5152


Unusual Observations

 Obs  inClass  lrndTstLT5M      Fit  SE Fit  Residual  St Resid
   1     0.00       1.0000   1.0252  0.2810   -0.0252     -0.06 X
   2     0.00       1.0000   1.0548  0.2643   -0.0548     -0.13 X
   3     0.00       1.0000   0.3626  0.2681    0.6374      1.56 X
   4     0.00       1.0000   0.9247  0.2793    0.0753      0.19 X
   5     0.00       0.0000   0.1564  0.1566   -0.1564     -0.34 X
   9     0.00       1.0000   0.0576  0.1671    0.9424      2.05RX
  12     0.00       1.0000   0.5607  0.1968    0.4393      0.98 X
  13     1.00       1.0000   0.3428  0.1691    0.6572      1.43 X
  14     0.00       1.0000   0.4939  0.1938    0.5061      1.13 X
  15     0.00       0.0000   0.2985  0.1479   -0.2985     -0.64 X
  19     0.00       0.0000   0.1417  0.1544   -0.1417     -0.31 X
  21     0.00       1.0000   0.5208  0.1483    0.4792      1.03 X
  24     0.00       1.0000   0.4860  0.1421    0.5140      1.10 X
  28     0.00       0.0000   0.2914  0.1849   -0.2914     -0.64 X
  29     0.00       0.0000   0.3088  0.1675   -0.3088     -0.67 X
  31     0.00       0.0000   0.0627  0.1754   -0.0627     -0.14 X
  33     0.00       0.0000   0.4423  0.1957   -0.4423     -0.99 X
  37     0.00       1.0000   0.9433  0.2304    0.0567      0.13 X
  38     0.00       0.0000   0.1950  0.1725   -0.1950     -0.43 X
  44     0.00       1.0000   1.0210  0.2245   -0.0210     -0.05 X
  45     0.00       1.0000   0.3947  0.1445    0.6053      1.29 X
  48     0.00       0.0000   0.0267  0.1384   -0.0267     -0.06 X
  50     0.00       0.0000   0.5173  0.1478   -0.5173     -1.11 X
  52     0.00       1.0000   0.4644  0.1444    0.5356      1.14 X
  53     0.00       1.0000   0.8993  0.2382    0.1007      0.24 X
  56     0.00       1.0000   0.9843  0.2269    0.0157      0.04 X
  59     0.00       0.0000   0.0230  0.1723   -0.0230     -0.05 X
  60     0.00       1.0000   0.5816  0.2373    0.4184      0.98 X
  61     0.00       1.0000   0.6464  0.1690    0.3536      0.77 X
```

62	0.00	1.0000	0.4207	0.1505	0.5793	1.24	X
64	0.00	0.0000	0.5793	0.1467	-0.5793	-1.24	X
65	0.00	0.0000	0.1189	0.1409	-0.1189	-0.25	X
66	0.00	1.0000	0.7035	0.1851	0.2965	0.65	X
67	0.00	1.0000	0.5038	0.1843	0.4962	1.09	X
68	0.00	1.0000	0.4484	0.1665	0.5516	1.20	X
69	1.00	1.0000	0.6163	0.2644	0.3837	0.93	X
70	0.00	1.0000	0.7351	0.2703	0.2649	0.65	X
71	0.00	0.0000	0.3117	0.1628	-0.3117	-0.68	X
72	0.00	0.0000	0.1101	0.1726	-0.1101	-0.24	X
73	0.00	0.0000	0.1261	0.1974	-0.1261	-0.28	X
74	0.00	0.0000	0.1064	0.1743	-0.1064	-0.23	X
75	0.00	0.0000	0.2046	0.1587	-0.2046	-0.44	X
76	0.00	0.0000	0.2037	0.1732	-0.2037	-0.45	X
77	0.00	0.0000	0.4153	0.2891	-0.4153	-1.05	X
78	0.00	0.0000	0.1632	0.1589	-0.1632	-0.35	X
79	0.00	0.0000	0.3518	0.1677	-0.3518	-0.77	X
127	0.00	0.0000	0.3131	0.1786	-0.3131	-0.69	X
140	1.00	1.0000	0.3827	0.1843	0.6173	1.36	X
152	0.00	0.0000	0.0628	0.1502	-0.0628	-0.13	X
226	0.00	0.0000	0.4757	0.2071	-0.4757	-1.07	X
233	1.00	1.0000	0.3050	0.1430	0.6950	1.48	X
246	0.00	0.0000	-0.0000	0.4895	0.0000	*	X
252	0.00	0.0000	0.0239	0.2337	-0.0239	-0.06	X
260	0.00	0.0000	0.0939	0.2350	-0.0939	-0.22	X
278	1.00	0.0000	0.1999	0.1863	-0.1999	-0.44	X
311	0.00	1.0000	0.3569	0.1374	0.6431	1.37	X
344	0.00	0.0000	0.0650	0.1466	-0.0650	-0.14	X
383	0.00	0.0000	0.1030	0.1436	-0.1030	-0.22	X
387	0.00	0.0000	0.4136	0.1825	-0.4136	-0.91	X
407	0.00	0.0000	0.6988	0.2714	-0.6988	-1.71	X
455	0.00	1.0000	0.8845	0.1837	0.1155	0.25	X
489	0.00	1.0000	0.6015	0.1879	0.3985	0.88	X
512	0.00	0.0000	0.1129	0.1427	-0.1129	-0.24	X
515	1.00	0.0000	0.4212	0.1532	-0.4212	-0.91	X
621	0.00	0.0000	0.5819	0.2099	-0.5819	-1.32	X
667	1.00	0.0000	0.2354	0.1386	-0.2354	-0.50	X
732	1.00	1.0000	0.7025	0.1895	0.2975	0.66	X
734	0.00	1.0000	0.9984	0.2719	0.0016	0.00	X
786	0.00	0.0000	0.1620	0.1409	-0.1620	-0.35	X
797	0.00	1.0000	0.6294	0.1413	0.3706	0.79	X
823	0.00	1.0000	1.1522	0.2313	-0.1522	-0.35	X
827	1.00	0.0000	0.6116	0.1960	-0.6116	-1.36	X
843	0.00	0.0000	0.1342	0.2384	-0.1342	-0.31	X
864	0.00	0.0000	0.5241	0.1422	-0.5241	-1.12	X
883	0.00	0.0000	0.3874	0.1632	-0.3874	-0.84	X
899	0.00	0.0000	0.5743	0.1424	-0.5743	-1.23	X
930	0.00	0.0000	0.2983	0.1439	-0.2983	-0.64	X
957	1.00	1.0000	1.2175	0.3853	-0.2175	-0.72	X
967	0.00	0.0000	0.4649	0.1868	-0.4649	-1.03	X
1032	0.00	1.0000	0.3947	0.1590	0.6053	1.31	X
1088	0.00	0.0000	0.6939	0.1458	-0.6939	-1.48	X
1097	0.00	1.0000	0.6123	0.1456	0.3877	0.83	X

1228	0.00	1.0000	0.4314	0.1761	0.5686	1.24	X
1229	0.00	0.0000	0.6112	0.1437	-0.6112	-1.31	X
1238	0.00	0.0000	0.3506	0.1763	-0.3506	-0.77	X
1291	0.00	1.0000	0.4292	0.2027	0.5708	1.28	X
1378	0.00	1.0000	0.5119	0.2685	0.4881	1.19	X
1403	0.00	1.0000	0.5861	0.1859	0.4139	0.91	X
1410	0.00	0.0000	0.0187	0.2348	-0.0187	-0.04	X
1429	0.00	0.0000	0.2317	0.1412	-0.2317	-0.49	X
1444	0.00	0.0000	0.1211	0.1444	-0.1211	-0.26	X
1452	0.00	1.0000	0.6494	0.1635	0.3506	0.76	X
1468	0.00	1.0000	0.4234	0.1785	0.5766	1.26	X
1469	0.00	1.0000	0.2038	0.1735	0.7962	1.74	X
1475	0.00	1.0000	0.5981	0.1440	0.4019	0.86	X
1574	0.00	0.0000	0.7409	0.1446	-0.7409	-1.58	X
1611	0.00	1.0000	0.6539	0.1821	0.3461	0.76	X
1659	0.00	0.0000	0.4822	0.1757	-0.4822	-1.06	X
1681	1.00	0.0000	0.3735	0.1532	-0.3735	-0.80	X
1695	0.00	0.0000	0.2967	0.1382	-0.2967	-0.63	X
1718	0.00	0.0000	0.3365	0.1775	-0.3365	-0.74	X
1742	0.00	0.0000	0.5076	0.1391	-0.5076	-1.08	X
1761	0.00	0.0000	0.5580	0.1451	-0.5580	-1.19	X
1764	0.00	1.0000	0.4311	0.1372	0.5689	1.21	X
1768	0.00	1.0000	0.6482	0.1482	0.3518	0.75	X
1788	0.00	0.0000	0.4617	0.1902	-0.4617	-1.02	X
1809	0.00	1.0000	0.5635	0.1729	0.4365	0.95	X
1819	0.00	1.0000	0.7155	0.1441	0.2845	0.61	X

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.

4.3.2 Appendix B – Index of Terms for Regression Analysis

Index of terms

key	category	subcategory
timestamp	Timestamp	
lrndTstLT5M	How long ago did you first learn of the message about this test of the CMU emergency alert system?	
inClass	Were you in class when you first learned of the message about the test of the CMU emergency alert system?	
isMale	Gender	
engFirstLang	Is English your first language?	
firstVerbal	How did you FIRST learn of this message about the test of the CMU emergency alert system?	Heard about it verbally
firstTwtNO	How did you FIRST learn of this message about the test of the CMU emergency alert system?	Read non-official CMU tweet
firstTwtO	How did you FIRST learn of this message about the test of the CMU emergency alert system?	Read official CMU tweet
firstFBNO	How did you FIRST learn of this message about the test of the CMU emergency alert system?	Read on non-CMU Facebook page
firstFBO	How did you FIRST learn of this message about the test of the CMU emergency alert system?	Read on official CMU alert website
firstCMA	How did you FIRST learn of this message about the test of the CMU emergency alert system?	Read on official CMU Facebook page
firstTxt	How did you FIRST learn of this message about the test of the CMU emergency alert system?	Received a text
firstEmail	How did you FIRST learn of this message about the test of the CMU emergency alert system?	Received an e-mail
usedVerbal	How else did you learn about this message about the test of the CMU emergency alert system?	Heard about it verbally
usedTwtNO	How else did you learn about this message about the test of the CMU emergency alert system?	Read non-official CMU tweet
usedTwtO	How else did you learn about this	Read official CMU tweet

	message about the test of the CMU emergency alert system?	
usedFBNO	How else did you learn about this message about the test of the CMU emergency alert system?	Read on non-CMU Facebook page
usedFBO	How else did you learn about this message about the test of the CMU emergency alert system?	Read on official CMU alert website
usedCMA	How else did you learn about this message about the test of the CMU emergency alert system?	Read on official CMU Facebook page
usedTxt	How else did you learn about this message about the test of the CMU emergency alert system?	Received a text
usedEmail	How else did you learn about this message about the test of the CMU emergency alert system?	Received an e-mail
hiCMUB	Where were you when you first learned about this test of the CMU emergency alert system?	In a CMU building on the Pittsburgh campus (not an academic building or dorm)
hiCMUDorm	Where were you when you first learned about this test of the CMU emergency alert system?	In a dorm on the CMU Pittsburgh campus
hiCMUAB	Where were you when you first learned about this test of the CMU emergency alert system?	In an academic building on the CMU Pittsburgh campus
hiOCIP	Where were you when you first learned about this test of the CMU emergency alert system?	Off campus in the Pittsburgh area
hiOCOP	Where were you when you first learned about this test of the CMU emergency alert system?	Off campus outside the Pittsburgh area
hiCMUNPitt	Where were you when you first learned about this test of the CMU emergency alert system?	On a CMU campus other than the Pittsburgh campus
hiCMUOutdoors	Where were you when you first learned about this test of the CMU emergency alert system?	Outdoors on the CMU Pittsburgh campus
shNo	Did you share this message about the test of the CMU emergency alert system?	No
shYesTxt	Did you share this message about the test of the CMU emergency alert system?	Yes - I sent texts

shYVerbal	Did you share this message about the test of the CMU emergency alert system?	Yes - I told people verbally
shYFB	Did you share this message about the test of the CMU emergency alert system?	Yes - I Posted it on Facebook
shYTwt	Did you share this message about the test of the CMU emergency alert system?	Yes - I sent a tweet
shYEmail	Did you share this message about the test of the CMU emergency alert system?	Yes - I sent e-mails
lvlFaculty	Academic Level	Faculty
lvlGrad	Academic Level	Graduate student
lvlOther	Academic Level	Other
lvlStaff	Academic Level	Staff
lvlUndergrad	Academic Level	Undergraduate student
suEMNo	Have you signed up for CMU emergency messages?	No
suEMPhone	Have you signed up for CMU emergency messages?	Yes, I signed up for emergency phone calls
suEMText	Have you signed up for CMU emergency messages?	Yes, I signed up for emergency text messages
srv1	Was the entry in survey 1	
srv2	Was the entry in survey 2	
srv3	Was the entry in survey 3	
srv4	Was the entry in survey 4	
srv5	Was the entry in survey 5	
srv6	Was the entry in survey 6	
srv7	Was the entry in survey 7	
srv8	Was the entry in survey 8	
srv9	Was the entry in survey 9	
srv10	Was the entry in survey 10	
srv11	Was the entry in survey 11	
srv12	Was the entry in survey 12	
srv13	Was the entry in survey 13	

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5 Overall Project Conclusions

Social media can be a powerful tool in emergency messaging, but only if the interest and infrastructure are present. This research has found conflicting opinions and data both in support of and at opposition to social media usage in emergency messaging. However, this divergence was expected as the question asked was whether or not social media could be effective in emergency messaging. Interviewing emergency response managers, conducting a survey over sweeping demographics, and performing experiments targeting a single college, produced large amounts of data from people of different strata of the society Regardless of these differences, we have found three overarching themes, applicable to each of the three groups.

The first overarching conclusion suggests that social media is not yet the primary method being used in emergency messaging. While social media usage rates are growing, traditional methods of communication are still preferred. According to the results found by the group exploring emergency communications by various levels of authority (Chapter 2), social media is used in tandem with current systems of communication at all levels. Instead of taking a leading role, social media is used to supplement existing systems, and in some cases, it is not used at all. Social media was only found to be a primary source of communication for those organizations that exist solely online. The group exploring public preferences towards social media (Chapter 3) also found data to support this claim. In communicating information during an emergency, respondents to the public preference survey tended to favor more traditional communication methods, including phone calls, texting and email. The final chapter used experiments to explore the boundaries of social media use in emergency messaging found that social media functions as a secondary source of communication. In both experiments, traditional methods of communication such as emailing and SMS texting were preferred by a significant amount of subjects in comparison to social media channels. All groups found that social media are less preferred and less effective in communicating information in the event of an emergency.

Our second class-wide conclusion suggests that traditional tools (media) appear to be more effective in terms of reaching a larger audience in the event of an emergency, while social media provides a more rapid flow of information. The group studying public preferences found that social media is not widespread enough to be an effective form of communication in the event of an emergency. This implies that major groups in the community who are not connected to social media could be left out of vital information communications. Social media is also not used by a wide enough population range to support a focus on social media as a communication tool for emergency messaging. Traditional methods of communication in emergency messaging tend to reach a wider audience; however, the group also found that social media messaging created a more “real-time” interaction between the message senders and receivers.

Our third overall conclusion relates to the fact that social media outlets are still useful as a backup method to disseminate information. We have found that while social media is not used

as a primary method of communication, their effectiveness indicates that they should not be dismissed as a tool for communication. Most organizations use social media as a supplementary tool to their legacy system to reach as broad of an audience as possible. Many interviewed officials explicitly stated that legacy systems could not be dissolved, but that social media provided an excellent way to broaden potential audiences. Most social media are not used universally, but we also found that social media is used by a majority of some classes of respondents, implying that social media should not be neglected as an additional emergency messaging tool. Its self-correcting mechanism and its ability to rapidly disseminate information make social media a valuable supplement to emergency messaging systems.

Emergency situations can be broken down into three main stages: prevention, real-time, and recovery. Drawing from our overarching conclusions, we have found that the most useful social media varies with each stage. The first stage can be defined as prevention/education. Social media seems to be a useful tool in raising awareness concerning various emergencies among large populations. Through sites like Facebook and YouTube, various educational materials on how to prepare for natural disasters can be effectively distributed.

The second stage of an emergency occurs in real-time as the emergency is taking place. Social media has the potential to be an effective tool in this stage; however, this paper has found that traditional forms of communication, such as phone calls, emails, and EMS still exceed the capabilities of social media during an emergency. It should be noted that the popularity of SMS messaging provides a distinct opportunity to bridge the gap between social media usage and traditional communications.

The final stage can be defined as the recovery stage. During this stage, large groups of people who are involved in or have personal interests in an emergency use social media to connect with one another and report non-critical information. This stage has the most potential to implement social media as a primary communication tool in the near future. Specifically, we believe that Twitter and Facebook will be the most frequented social media sites in this final stage.

These conclusions illustrate the commonalities found among our three diverse groups. Although the goals and methods used by each group varied greatly, they all came to similar conclusions about the use of social media in emergency situations. Above all we have found that while emergency managers have yet to use social media as a primary method of communication, its effectiveness in informal peer-to-peer communications, its resilience to network congestion, and its speed indicates that it should not be dismissed as a tool for emergency communication.