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Online Media Use and Adoption by Hurricane Sandy Affected Fire and Police Departments

Apoorva Chauhan
Utah State University

UtahStateUniversity
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ONLINE MEDIA USE AND ADOPTION

BY HURRICANE SANDY AFFECTED

FIRE AND POLICE DEPARTMENTS

by

Apoorva Chauhan

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

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Approved:

_____   _____
Dr. Amanda Hughes   Dr. Daniel Watson
Major Professor   Committee Member

_____   _____
Dr. Kyumin Lee   Dr. Mark R. McLellan
Committee Member   Vice President for Research and
                                                                        Dean of the School of Graduate Studies

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ABSTRACT

Online Media Use and Adoption by Hurricane Sandy Affected

Fire and Police Departments

by

Apoorva Chauhan, Master of Science

Utah State University, 2014

Major Professor: Dr. Amanda Lee Hughes
Department: Computer Science

This thesis work examines the online communications of 840 fire and police

departments during Hurricane Sandy (2012). Using a mixed methods approach, this

research combines interviews with fire and police department members and quantitative

data around online media use and adoption to better understand different features of these

departments and their online communications.

The research provides the following contributions: (1) an examination of how and

why affected fire and police departments used (or did not use) online communication

media for public communications during Hurricane Sandy and (2) an examination of how

a large-scale disaster event like Hurricane Sandy affects online communication media use

and adoption by affected fire and police departments.

(75 pages)

PUBLIC ABSTRACT

Online Media Use and Adoption by Hurricane Sandy Affected

Fire and Police Departments

Apoorva Chauhan

In this thesis work, I examine the use and adoption of online communication media by 840 fire and police departments that were affected by the 2012 Hurricane Sandy. I began by exploring how and why these fire and police departments used (or did not use) online media to communicate with the public during Hurricane Sandy. Results show that fire and police departments used online media during Hurricane Sandy to give timely and relevant information to the public about things such as evacuations, damages, weather, and cleanup and to engage in two-way communications with their constituents. In their messages, fire and police departments sought to make the information provided more credible by referencing, rebroadcasting, and recommending other authoritative entities. Though some departments saw online media as a useful and effective means of communication with members of the public, other departments found them difficult to use given the challenging circumstances of Hurricane Sandy such as flooding and power outages.

Next, I explore how a large-scale disaster event like Hurricane Sandy affects online media adoption by affected fire and police departments. I found an increase in online activity over Facebook, Twitter, and Nixle by the affected fire and police departments compared to before Hurricane Sandy. However, it is unclear whether this

increase in online activity can be attributed to Hurricane Sandy or a natural increase over

time.

DEDICATION

To my dear parents Mr. Rajeev Singh Chauhan – Mrs. Archana Chauhan, and my brother Rishabh, for all the support and patience, they have given towards the completion of this project.

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Foremost, I take this opportunity to acknowledge God for all the strength and help He gave me to accomplish this research. I also thank God for all the nice people He surrounded me with.

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I would like to extend my thanks and gratitude to all the fire and police departments who agreed to participate in an interview. These interviews were immensely valuable to answering my research questions.

I also want to thank my family, my parents and my brother Rishabh, for all their support, their sacrifices, their endless prayers and their best wishes through emails and Skype calls we had in the past two and half years. I acknowledge them for making me smile and laugh, even on the days I was a little tensed. I also thank them for letting me come to the United States to make my dreams come true. My uncle, Dr. Sanjay Singh Chauhan, is none less than my father. I feel blessed to have an uncle like him! His

contributions in my life are hard to be expressed in words. His guidance, love and support have always motivated me to be a better person. Last but not least, I would also like to thank my aunt, Mrs. Sandhya Chauhan, and my cousin Shashank for all their support and contributions towards the completion of this project.

Apoorva Chauhan

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CHAPTER 1
INTRODUCTION

Recent advancements in and the nearly ubiquitous adoption of online

communication media—particularly social media like Facebook and Twitter—have

introduced new ways for members of the public to participate in crisis events. During

these types of events, research reports that members of the public use online media to

share photos [1], [2], distribute important crisis-related information [3]–[6], and update

friends and family about their well-being [7].

In response to this online media use by members of the public, emergency

responders are considering how these media can contribute to situational awareness

around disaster events [8], [9] as well as assist in public communication responsibilities

[10]. For instance, the London Metropolitan Police (MET) and the Greater Manchester

Police (GMP) used Twitter during the London Riots of 2011 to communicate with the

public about their response efforts and the dangers to public safety [11]. Though research

like Denef et al. [11] and others [10], [12]–[14] have begun to study how emergency

responders are using online communication media, much is still unknown about how

these media work (or do not work) within an emergency management context. Thus, the

primary focus of this research is to further investigate how emergency responders use

online communication media, with the aim of informing future emergency management

practice and technology development.

1.1 Research Problem

This research builds upon and expands the results of a recent study [12] that examined the online communications of fire and police departments during Hurricane Sandy (2012). In this study, researchers identified 840 fire and police departments located in the coastal regions within a 100 mile radius of Hurricane Sandy's landfall. For each of these departments, data were collected around the four most commonly used types of online communication media: a website, a subscriber-based notification service (Nixle), a microblogging service (Twitter), and a social networking service (Facebook). Researchers collected 676 websites, 930 Nixle posts, 3033 tweets, and 4652 Facebook posts. The data were then coded for content (e.g. damage, evacuation, status, etc.) which provided insight into the kinds of information fire and police departments shared with the public during Hurricane Sandy. Next, researchers evaluated the level of online engagement for each fire and police department during Hurricane Sandy, and found that the departments fell into one of three groups: the *Inactive Group*, *Non-Sandy Active Group*, and S*andy Active Group*. Members of the *Inactive Group* (46% of departments) either had no online account(s) or their account(s) were in disuse. The *Non-Sandy Active Group* (25% of departments) consisted of departments that showed recent online account activity, but they did not use these accounts to communicate about Hurricane Sandy. Lastly, members of the *Sandy Active Group* (29% of departments) had online accounts that they used to communicate with the public during Hurricane Sandy. The research reports low overall use of online communication media during Sandy, and suggests better

understanding of the reasons for this low use could reveal opportunities to increase its use

and value to the emergency management community.

Though the research by Hughes et al. [12] provides a description of the types of

online activity police and fire departments engaged in (or did not engage in) during

Hurricane Sandy, the research was limited in that it could not fully report (without more

data collection and analysis) on *how* and *why* these departments behaved the way they

did. Further, Hughes et al. [12] did not collect data around how these departments used

online media both before and after the Hurricane Sandy event, so department use over

time could not be evaluated. Examining online communication use over time could reveal

important insights into how emergency managers adopt online technologies and barriers

to that adoption process; however, no research to-date has conducted this kind of study.

1.2 Purpose and Objectives

The purpose of this thesis research is to expand upon Hughes et al. [12], by

collecting the data needed to answer questions about *how* and *why* fire and police

departments used (or did not use) online communication media to communicate with the

public during Hurricane Sandy. The Hughes et al. [12] study classified fire and police

departments into *Inactive*, *Non-Sandy Active*, and *Sandy Active* engagement groups based

on the data collected around each department's online communication activity, but it

could not explain the reasons why each department fell into these categories. The

research conducted here helps to identify these reasons and answer important questions

like the following: Why—despite having active online accounts—did *Non-Sandy Active*

departments not use their accounts to communicate with the public about Hurricane

Sandy? Answers to this question could reveal social and technical barriers that prevent

online media use by these departments, barriers that could be overcome through emergency management policy changes or the development of new technology solutions. This work also has the advantage that over a year has passed since Hurricane Sandy, which allows for longitudinal study of how online communications by the fire and police departments affected by Sandy have changed over time. Longitudinal study increases understanding around how emergency responders adopt online communication media and offers insight into how a large-scale disaster event like Hurricane Sandy affects online communication media use.

1.3 Research Questions

This thesis answers the following research questions:

R1: How and why did affected fire and police departments use (or not use) online communication media to communicate with the public during Hurricane Sandy?

R2: How does a large-scale disaster event like Hurricane Sandy affect online communication media use and adoption by affected fire and police departments?

1.4 Research Design

This study is exploratory and takes a mixed methods approach, combining both qualitative and quantitative data collection and analysis. The qualitative component of this research involves conducting interviews with a sample of the fire and police departments examined in Hughes et al. [12]. Interviews focused on understanding how these departments communicated with the public during Hurricane Sandy (addresses R1). To supplement data from Hughes et al. [12], I also collected additional quantitative data to better understand different features of the departments and their online communications. The new data collected include the population of the jurisdiction that

each department supports, the current status of each online communication account, and the online communication activity of each department in the year both before and following Hurricane Sandy. The additional data collection helped to shape a more complete picture of how emergency responders use (or do not use) online communications to communicate with the public during large-scale disaster events. I also conducted further data coding and analysis on the data from Hughes et al. [12] and the additional data collected for this research (as described above). Research data and methods are described in greater detail later in this thesis.

1.5 Thesis Overview

This thesis document contains four additional chapters following this introductory chapter. Chapter 2 contains a review of the relevant literature and background. Chapter 3 explores how and why fire and police departments used online communications during Hurricane Sandy (addresses R1). Next, Chapter 4 looks at how a large-scale disaster event like Hurricane Sandy affects online communication media use and adoption by fire and police departments (addresses R2). Finally, Chapter 5 concludes with recommendations for emergency management practice and technology development and offers suggestions for future work.

CHAPTER 2

LITERATURE REVIEW AND BACKGROUND

A severe, widespread crisis event like Hurricane Sandy requires large-scale information coordination between many different organizations and affected stakeholders [15]–[17]. Hurricane Sandy's response included official emergency response organizations (e.g., police, fire, emergency medical services, the Federal Emergency Management Agency (FEMA)), organizations that provide information or public services (e.g., the National Weather Service (NWS)s, public health departments, electric companies, transportation authorities), elected government officials (e.g., state governors, city mayors), and non-profit relief organizations (e.g., American Red Cross) among others. During a crisis event, these entities—organizations, institutions, and individuals—must work together to provide timely, relevant, and accurate information to members of the public. The particular focus of this research is on the fire and police departments that were most affected by Hurricane Sandy.

2.1 Crisis Informatics

This research contributes to an area of study called *crisis informatics* [7], [18]—an area of research which examines how people use information communication technology (ICTs) to communicate and share information during crisis events. While much of the crisis informatics literature focuses on the role that members of the public can play with ICTs during a disaster event [5], [7], [14], [19], [20], a growing number of studies are expanding this scope to look at how emergency managers are incorporating ICT into their practice [10]–[13]. An early study by Latonero and Shklovski [13]

interviewed the public relations liaison for the Los Angeles Fire Department—an early adopter of social media for emergency public communications. They found that having a social media evangelist in the department greatly helped to speed the rate of social media adoption for the department overall. Denef et al. [11] examined Twitter use by two different police departments during the London Riots of 2011 and found that each department employed a different strategy in their communications: one was expressive and personal while the other was more instrumental and formal. Hughes and Palen [10] looked at the role of the emergency public information officer (PIO) and how their role has been affected by social media. This study found that though technologies like social media show great potential for emergency response, their adoption poses many challenges such as issues of credibility and trust, lack of support from management, lack of resources, and lack of training. Much of the research in this area has observed slow adoption by emergency responders and a tendency for those who have adopted social media to use them as a one-way communication stream to push information to the public [12], [13], [21], [22].

A few recent studies have looked at how emergency responders use social media within a wider crisis response effort. Sutton and colleagues [23] examined Twitter use by emergency responders during the 2010 Deepwater Horizon oil spill. By examining network structure and conversational features, they could better understand how information was exchanged and disseminated. Results showed that health and public safety organizations tend to be more centrally located in social media networks, which makes them ideal communication partners for information distribution. More recently,

Sutton et al. [24] looked at the Boston Marathon Bombings and how emergency

responders amplified messages sent through Twitter by retweeting these messages.

These studies expound upon how emergency managers use social media, but they tend to

only report on advanced, heavy users of the technology. The approach taken in the

Hughes et al. [12] Hurricane Sandy study is novel because it explains online

communication behavior across a large sample of emergency responders (both those that

used and did not use online communications), which allows for commentary on the

overall adoption of this kind of communication in an emergency context. The research

proposed here seeks to push these understandings further by examining why emergency

managers used or did not use online communication media.

2.2 Event of Study - Hurricane Sandy

Hurricane Sandy began as a Category 1 hurricane in the Caribbean Sea on Oct 22,

2012. The hurricane then tracked north, hitting Jamaica, Cuba, and Haiti before making

US landfall in Brigantine, New Jersey as a Category 2 hurricane on Oct 29, 2012.

Hurricane Sandy is one of the most deadly (117 deaths) and costly (estimates near $50

billion USD) hurricanes in United States history [25].

The extreme conditions of Hurricane Sandy resulted in severe disruption to the

US northeast coast, damaging or destroying over 650,000 homes [25] and displacing

roughly 776,000 people [26]. Almost 7.9 million businesses and households were without

electricity in 15 states and the District of Columbia (D.C.) for several days. The hurricane

suspended transportation systems (i.e., the commuter rail, bus services, metro and airlines

all over New York, New Jersey, D.C., and Southeastern Pennsylvania), leaving close to

11 million commuters without service. Many places faced gas shortages because gas

stations were without power. In addition, the New York Stock Exchange remained closed

for two consecutive days and all U.S. Federal offices in D.C. and the United Nations

headquarters in Manhattan were closed to the public for several days.

CHAPTER 3

ONLINE MEDIA USE DURING HURRICANE SANDY

The goal of the research reported in this chapter is to understand *how* and *why* affected fire and police departments used (or did not use) online communication media to communicate with the public during Hurricane Sandy (research question R1). The research results described in this chapter are conceptually divided into two parts. The first part reports *how* departments used online media during Hurricane Sandy. In this part, I examine the content of the online communications that fire and police departments sent during Hurricane Sandy. The second part seeks to understand *why* departments used (or did not use) online media during Hurricane Sandy. In this part, I look for correlations between jurisdiction population and online media use and report why these departments used online media from the results of an interview study.

3.1 Research Data & Methods

The data for this chapter come from datasets used in the Hughes et al. [12] paper as well as new data that I collected around online media use. First, I further coded and analyzed the data collected in the Hughes et al. [12] study. This activity also included additional data collection around interesting phenomenon found in the data (described below). Next, I collected population data and explored possible correlations between online media use and the population size of a fire or police department's jurisdiction. Finally, I conducted semi-structured interviews with fire and police departments to better understand how and why they used online communications during Hurricane Sandy. In the remainder of this section, I outline the methods used to collect and analyze these data.

3.1.1 Existing Data from Prior Research

I obtained access to the data and analysis materials for the Hughes et al. [12] study in the form of several spreadsheets. One spreadsheet includes the names, addresses, department websites and details of the Nixle, Facebook and Twitter accounts for 272 police and 568 fire departments. Additional spreadsheets contain the online communications collected for this study (930 Nixle posts, 3033 tweets, and 4652 Facebook posts), their content coding (see Table 2) and the engagement level of each online account—Inactive, Non-Sandy Active and Sandy Active (see Table 1).

I revisited the data from the Hughes et al. [12] study. In particular, I reexamined the content categories. This examination pointed to the *reference* content category as a place for further research. A reference is defined by Hughes et al. [12] as a "reference to an external information source" (see Table 2). This definition was too restrictive and not wholly representative of the types of information-coordination happening in these messages. Therefore, I examined these messages further, as described in the next subsection.

3.1.2 Mention Behavior in Online Communications[1]

When studying the messages that Hughes et al. [12] identified as *references*, I wanted to understand the intent of the messages as well as the message features that indicated membership in or awareness of a larger response community. The term "mention" was chose to describe those instances where a fire or police department referred to an organization, institution, or individual. Under this broad term, several subcategories were identified to be more descriptive of each mention's intent.

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[1] The mentioning behavior content found in this thesis has been submitted as a research paper to iConference 2015.

Table 1: Inactive, Non-Sandy Active, and Sandy Active Account Definitions –
Reproduced from Hughes et al. [12] with Permission from the Authors

Level	Description
Inactive	No account found OR account found but not used
Non-Sandy Active	Account used to share information, but not used to share information about Hurricane Sandy
Sandy Active	Account used to communicate information about Hurricane Sandy

Table 2: Facebook, Twitter, and Nixle Content Coding Scheme – Reproduced from
Hughes et al. [12] with Permission from the Authors

Category	Description
cleanup	Clearing of hurricane debris
closures	Closure/re-opening of public offices, transportation services, access routes, and scheduled events
damage	Storm damage information
donations	Donations of time (volunteering), money, or supplies to relief efforts
engagement	Invitations to engage with department on social media or direct responses to public posts/tweets
evacuation	Evacuation order and shelter information
preparation	Storm preparation information
protocol	Formal response protocol information (e.g. when to call 9-1-1 versus 3-1-1)
reassurance	Reassurance to the public that first responders are prepared for or actively monitoring the storm
reference	Reference to an external information source
relief	Storm assistance or relief information
response	Specific incidents or response efforts during the hurricane
resources	Information about supplies needed or available
rumor	Misinformation and rumor
safety	Safety precautions or conditions
services	Power , phone, internet, or cable services information
status	Changing storm condition information
support	Expression of gratitude or support
weather	Weather updates
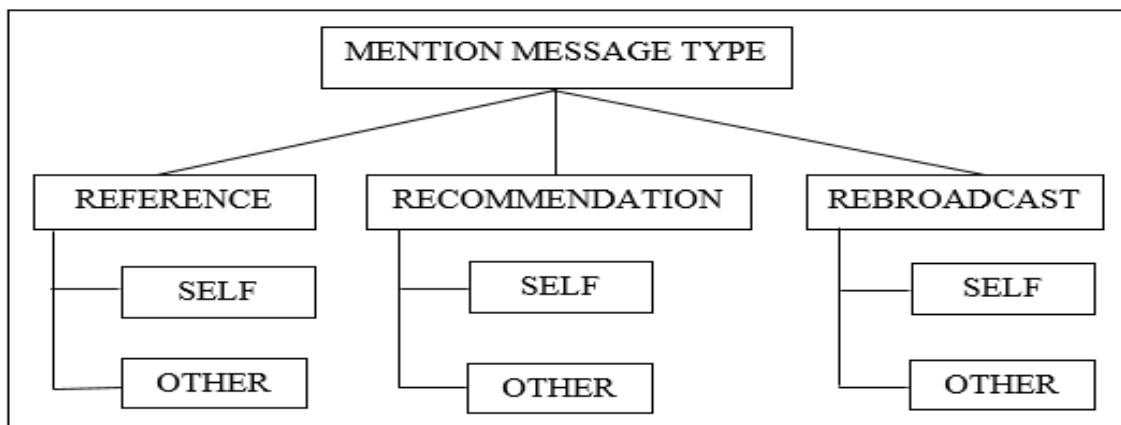
Figure 1: Mention Message Types

To start the coding process, I revisited all Facebook (4652), Twitter (3033), and Nixle (930) messages to determine whether these messages mentioned an organization, institution, or individual. A coding scheme (see Figure 1), through an iterative pair-coding process and discussion, was developed for the intent of each mention. After finalizing the coding scheme, all the mention messages were coded accordingly.

The intent of each mention fell into one of three categories: reference, recommendation, or rebroadcast. A *reference* message cites an entity with the purpose of identifying where information has been or can be obtained. A *recommendation* message endorses an entity as suitable for a particular purpose, role, or type of information. Lastly, a *rebroadcast* message redistributes a previously sent message.

In addition, I differentiated whether each mention referred to a third-party (Other) or to the sender of the message containing the mention (Self). This distinction was important because I encountered many instances where fire and police departments would mention themselves and I wanted to analytically separate this activity from third-party mentions.

Table 3: Entity Types, Definitions, and Examples

Type	Definition	Examples
Fire	Organization that fights fire and provides emergency medical services	FDNY[2], Surf City VFC
Police	Civil organization for maintaining order, preventing and detecting crime, and enforcing laws	Cranford PD, Vineland PD
Emergency Management Agency (EMA)	Organization responsible for preparedness, response & recovery before, during & after a disaster	FEMA, Ready NJ, NJOEM
Humanitarian	Organization dedicated to public relief and welfare	Red Cross, NY Blood Center
Media	Traditional broadcast news - Radio, TV, Newspaper	USA Today, NBC, QAC TV
Utilities	Public services organization – water, gas, power	JCP&L, PSE&G, NJNG
School	Education institution	Springfield Schools
Weather	Organization responsible for monitoring and/or reporting the weather.	NHC, NWS, NOAA
Transport	Public transportation authority	NJ Transit, MDTA
Company	Business	Google, Xfinity, Tide
City	Incorporated municipality	Bay Head, Neptune City
County	County Agency	Salem County, Union County
State	State Agency	NJ.Gov, Delaware.Gov
Federal	Federal Agency	FDA, CDC, Energy.Gov
Politician	Elected government official	Gov. Christie, Gov. Markell
Private	Personal Account	Social Justice Worker, Writer

I further coded for the different types of entities—organizations, institutions, and

individuals—found in each mention. I first identified the mentioned entities in each

message. After collecting the entity names, they were iteratively grouped into categories,

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[2] I have anonymized the names of private individuals and organizations, while the names of public entities remain unchanged.

resorting and regrouping until there was complete agreement around the final codes.

Table 3 contains the resulting entity coding scheme.

3.1.3 Population Data Collection

Next, I retrieved population information from the US Census Bureau[3] for the

jurisdiction of each of the 840 fire and police departments. I collected this data to see if a

correlation exists between the population size that a department supports and its online

media use. Population data for each police department was easy to collect because each

department is associated with a particular jurisdiction. However, population data for fire

departments was more difficult to find, and so I was able to find population data for 528

fire departments (out of 568). Of the remaining 40 fire departments, 26 were located in

unincorporated communities[4] which have no official population (at least not through the

US Census Bureau), and I could find no data for the remaining 14 fire departments—

most likely because these departments support a special population, like a neighborhood

or community within a larger city or township.

3.1.4 Interview Data Collection & Analysis

Finally, I conducted hour-long telephone interviews with fire and police

departments. I intended to conduct 30 interviews (10 each from the Inactive group, Non-

Sandy Active group and Sandy Active group) with the fire and police departments

identified by Hughes et al. [12]. Before I began with the interviewing, I submitted a

human subject's research protocol and obtained the approval from the USU Institutional

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[3] http://www.census.gov/

[4] Unincorporated Community: "In law, an unincorporated area is a region of land that is not governed by its own local municipal corporation, but rather is administered as part of larger administrative divisions, such as a township, parish, borough, county, city, canton, state, province or country" – source: WIKIPEDIA

Review Board. To find interview participants, I created a list of 50 departments on the basis of their online engagement level. Each of these departments were contacted via email (see Appendix A and Appendix B for sample recruitment emails) or phone. When someone agreed for an interview, I made an appointment for a phone interview. Since I could not get the 30 targeted interviews from the first round of interview solicitations, I created several other lists of 50 departments each and contacted them via phone (see Appendix C for a sample phone script), email, and Facebook. In total, I contacted 320 different departments. Despite much effort, I could only obtain 7 interviews. More information about each of these interview participants can be found in Appendix E.

Prior to each interview, I reviewed the collected data for the interview participant's department. For example, I would visit the department's website, Facebook page, Twitter account, and Nixle account (if they exist), as well as review the department's online engagement levels during Hurricane Sandy. This background work helped me prepare for the interview by allowing me to ask questions about their specific behavior patterns.

Interviews were semi-structured: questions developed beforehand (see Appendix D) guided the interview, but the interviewer also pursued more interesting or relevant questions based on the progression of the interview. Interview questions gathered basic information about the participant and their role in the department, before turning to questions about how they used online media (or did not use it) during Hurricane Sandy. Interviews were audio-recorded with permission from the interviewee, and I took notes as well. Following each interview, I created a cleaned and extended set of notes that

summarized any insights or observations that I was unable to capture during the interview.

I did the interview analysis by listening to each interview and transcribing those sections that addressed my research questions. The interesting and relevant pieces of information from the interviews were written on a single note card. The affinity diagram method [27] was then used to group and cluster the cards together around common ideas and themes (see Appendix F). Using this method, I inductively derived answers to my research questions.

3.2 How Departments Used Online Media

This section describes the results of the different data analyses conducted to better understand how fire and police departments used online media during Hurricane Sandy. First, I analyzed the way that the online message content changed during the data collection window. Next, I looked for mentions of entities–organizations, institutions or individuals—in messages to understand how fire and police departments fit within a larger crisis public information strategy. Finally, I grouped all the mentioned entities into categories and analyzed these categories to see what they can tell us about how fire and police departments use online media. The following sections discuss these data analyses in detail.

3.2.1 Message Content Trends over Time

To see *how* the affected fire and police used online media for public communication during Hurricane Sandy, I analyzed how the message content changed over time and how this change in content reflected the status of the storm and its

response. I created a frequency distribution of all 19 content categories derived by

Hughes et al. [12] (see Figure 2).

Figure 2 reports a high frequency of *preparation*, *evacuation* and *weather*

messages during the initial days of data collection. However, during the later days, a high

frequency of *cleanup*, *donations*, *relief* and *support* messages were seen. Messages such

as *closures*, *engagement*, *reference*, *reassurance*, *protocol*, *services* and *status* were seen

throughout the data collection timeframe. These findings portray how message content

evolved throughout the collection timeframe and help us to understand the changing

needs of the public during Hurricane Sandy. Figure 2 also shows active participation of

these fire and police departments across the different phases of disaster.

3.2.2 Mentioning Behavior

Next, to understand *how* the fire and police departments mentioned entities in

their messages. I first revisited all the Facebook (4652), Twitter (3033), and Nixle (930)

messages to see if they contain mentions.

Table 4 reports that across Facebook, Twitter, and Nixle, nearly half (49.7%) of

the messages sent by fire and police departments during Hurricane Sandy contain at least

one mention. Twitter messages (tweets) contain the most mentions (64.1%), likely

because tweets are limited to 140 characters in length. This limitation means that fire and

police departments tended to use Twitter to point to other information sources rather than

as an information source by itself. Facebook messages were the next most likely to

contain a mention (43.1%) and Nixle messages were the least likely (36.7%).
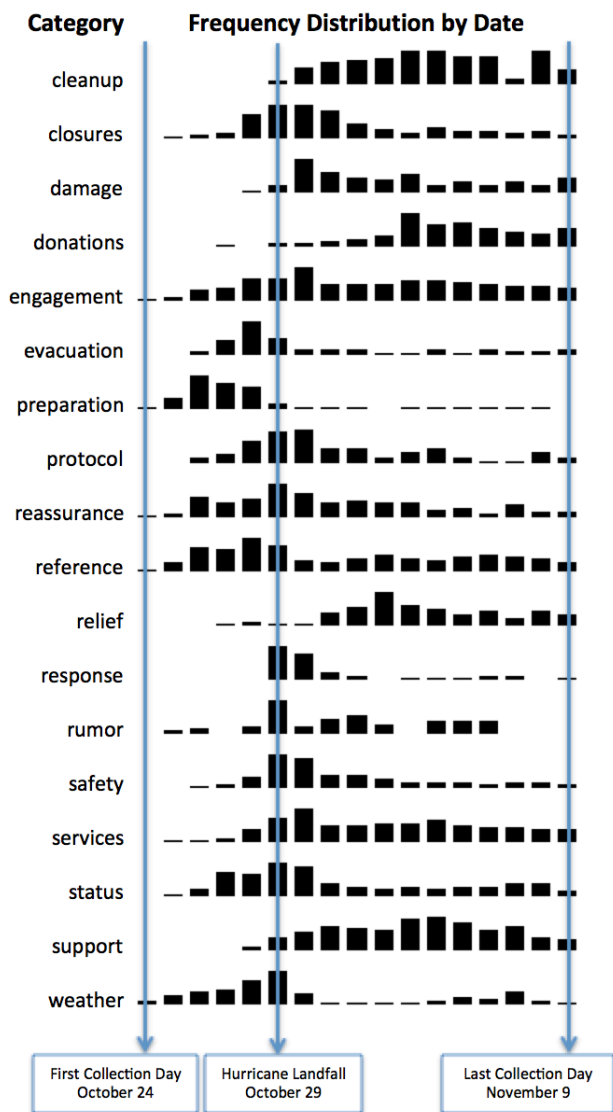
Figure 2: Frequency Distribution of Categories in Twitter, Nixle, and Facebook between October 24, 2012 and November 9, 2012

When breaking down mentions by type (see Table 5), the data show that Nixle has the highest percentage of reference (29.6%) and recommendation (4.3%) messages. Nixle messages in this dataset often read like press releases—lengthy messages that contain information about the response effort status, actions that should be taken by the public, and resources available for public assistance. Thus, these messages contain more references to and recommendations of different emergency response organizations, institutions, or individuals.

Table 4: Number and % of Mentions across Facebook, Twitter, and Nixle

Online Media	# Total Messages	# Mention Messages	% Mention Messages
Facebook	3776	1626	43.1%
Twitter	2553	1636	64.1%
Nixle	889	326	36.7%
Total	7218	3588	49.7%

Table 5: Number and % of Reference, Recommendation, and Rebroadcast Messages in Facebook, Twitter, and Nixle

Mention Type	Facebook		Twitter		Nixle	
	# msgs	% all msgs	# msgs	% all msgs	# msgs	% all msgs
Reference	397	10.5%	77	3.0%	263	29.6%
Recommendation	88	2.3%	65	2.5%	38	4.3%
Rebroadcast	1169	31.0%	1509	59.1%	53	6.0%

Twitter and Facebook rebroadcast percentages (59.1% and 31.0%, respectively) are considerably higher than Nixle (6.0%)—with Twitter percentages almost double that of Facebook. Both Twitter and Facebook have built-in mechanisms for rebroadcasting messages, which seems to explain at least some of this behavior. In addition, many departments have a website, blog, or other online account that allows them to post a link to Facebook and/or Twitter every time they make an update; we coded these posts as self-rebroadcasts. In this data set, many examples of this cross-posting behavior between Facebook, Twitter, and Nixle exist.

The following subsections detail the different types of mentions: references, recommendations, and rebroadcasts. Following this accounting, I report on the types of entities mentioned by fire and police departments during Hurricane Sandy.

3.2.2.1 Reference messages

Those mentions categorized as a reference captured the broadest scope of intent and behavior. If a message mentioned an entity as a source where more information could be obtained, it was categorized as a reference. Entities that were cited as a source of information were also labeled references.

Messages marked as self-references were those where the author of the message was cited as a service or source of information. Usually these references were made in the third-person:

> *@StaffordPolice (10/28/12 13:08) via **Twitter**: anyone needing transportation to the Shelter at Southern Regional HS please contact Stafford Police at 555-1234[5]*

From the data (see Table 6), we see that self-references are less common in Facebook (1.2%) and Twitter (1.8%) than in Nixle (7.3%).

When a message referred to a third-party entity as a source of information or a source through which more information could be obtained, the mention was coded as an other-reference. An example follows:

> *New Jersey State Police (10/29/2012 15:12) via **Nixle**: NJ STATE OFFICES CLOSED TUESDAY OCT. 30. INFO: WWW.READY.NJ.GOV*

Other-reference messages (see Table 6) are more common in Facebook (9.8%) and Nixle (26.0%) than in Twitter (1.3%). Facebook and Nixle both support message lengths far longer than the 140-character limitation of tweets. Support for longer messages is probably why Facebook and Nixle messages have more other-references; these media simply have more room to include references to third-party entities.

Referencing a third-party can help to lend credibility to the information shared in a message, especially if the fire or police department sending the message does not have expertise in that area. For example, many other-reference messages cited the National Weather Service (NWS) or the National Oceanic and Atmospheric Administration (NOAA) for information concerning Hurricane Sandy's approach and expected severity. By citing these organizations as the source of weather information, fire and police

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[5] This phone number has been anonymized.

departments gave the information credibility and authenticity that could not have been

achieved if they had simply given the information with no reference to the source.

3.2.2.2 Recommendation messages

Messages that contain a recommendation advertise an entity as accurate, timely,

and/or credible. In particular, self-recommendation messages promote the author of the

message as a trustworthy source:

> *@SpotswoodFD (10/27/12 22:29) via **Twitter**: The Spotswood Fire Department is now on Twitter, follow us at @SpotswoodFD. Information on Sandy will be shared from here.*

Table 7 shows that these self-recommendation messages are the least likely to occur of all

mention message types (Facebook at 0.7%, Twitter at 0.8%, and Nixle at 1.1%).

Other-recommendations describe instances where a fire or police department

recommends a third-party entity for information and/or services:

> *Freehold Township Ind. Fire Company #1 (10/28/2012 21:13) via **Facebook**: For trustworthy updates during the storm and going forward, visit and like two pages: https://www.facebook.com/#!/MonmouthCountyFireEmsPoliceNjspMedevacOps?f ref=ts and https://www.facebook.com/#!/JerseyShoreHurricaneNews*

In this particular case, the author of the message is trying to invoke trust-by-proxy;

meaning, if the author trusts these organizations and you trust the authors, then you

should also trust these organizations.

Table 6: Number and % of Reference Messages in Facebook, Twitter, and Nixle

Reference Type	Facebook		Twitter		Nixle	
	# msgs	% all msgs	# msgs	% all msgs	# msgs	% all msgs
Self	44	1.2%	46	1.8%	65	7.3%
Other	370	9.8%	34	1.3%	231	26.0%
Total	397	10.5%	77	3.0%	263	29.6%

Overall, messages that contain recommendations are the least likely to occur. Yet, recommendation behavior is still important because it paints a picture of the bigger relief effort and the organizations and other responders that a particular organization trusts.

3.2.2.3 Rebroadcast messages

Fire and police departments played an important role in the larger response effort by redistributing information from other responders. To be labeled as containing a rebroadcast, a message needed to be either a word-for-word redistribution of another message or a link to another message.

Table 8 shows that self-rebroadcasts were common through Facebook (7.6%) and especially so through Twitter (34.3%). Nixle messages contained few self-rebroadcasts (1.2%). An example of a self-rebroadcast is given below:

> *Felton Community Fire Company, Inc. (10/28/2012 18:35) via* **Facebook***: We have added some useful links to our website. http://feltonfirecompany.org/message.cfm?id=82*

Table 7: Number and % of Recommendation Messages in Facebook, Twitter, and Nixle

Recommendation Type	Facebook		Twitter		Nixle	
	# msgs	% all msgs	# msgs	% all msgs	# msgs	% all msgs
Self	28	0.7%	20	0.8%	10	1.1%
Other	70	1.9%	46	1.8%	30	3.4%
Total	88	2.3%	65	2.5%	38	4.3%

Table 8: Number and % of Rebroadcast Messages in Facebook, Twitter, and Nixle

Rebroadcast Type	Facebook		Twitter		Nixle	
	# msgs	% all msgs	# msgs	% all msgs	# msgs	% all msgs
Self	286	7.6%	876	34.3%	11	1.2%
Other	883	23.4%	636	24.9%	36	4.0%
Total	1169	31.0%	1509	59.1%	53	6.0%

Self-rebroadcasts in Facebook and Twitter typically linked to messages that had been posted elsewhere by the same department (e.g., website, blog, Nixle, etc.). A self-broadcast in Nixle usually consisted of a press release that had been given to the broadcast media and then copy-and-pasted into Nixle for redistribution to the public.

Other-rebroadcasts redistributed information from a third-party. An example of an other-rebroadcast follows:

> *@FDNY (10/29/12 18:00) via **Twitter**: RT @NYCMayorsOffice: Mayor: Stay inside, avoid using elevators and stay away from windows. #Sandy*

These messages appeared frequently in Facebook (23.4%) and Twitter (24.9%), but not in Nixle (4.0%). In Facebook, rebroadcasting is usually done by sharing a post. In Twitter, rebroadcasting is accomplished through retweets. Nixle, however, does not provide a built-in mechanism for rebroadcasting.

Rebroadcasting seems to serve at least three purposes. First, it redistributes information to a broader audience. Second, it authenticates information sources as trustworthy and accurate. If fire or police departments did not trust the sender of a message, they would not redistribute it. Third, at a meta-level, rebroadcasts also say something about who fire and police departments want to be seen trusting and supporting—perhaps to create a sense of solidarity with the greater emergency response effort (or at least the illusion of it).

3.2.3 Mentioned Entities

Next, to understand *what* entities fire and police departments were referencing, recommending, and rebroadcasting, I first collected the names of all the entities mentioned in the messages. Then through an iterative approach, I classified each entity

into an appropriate category or class. Understanding the subject of these mentions

provides insight into the complexity of a large-scale crisis event—specifically what kinds

of organizations and individuals do fire and police departments interact with and trust.

I identified 16 different entity types that capture the diversity of organizations,

institutions, and individuals involved in an event like Hurricane Sandy (see Table 9).

Represented here are many of the groups traditionally associated with a crisis response

(Fire, Police, EMA, Humanitarian, Media), followed by institutions that represent the

public systems affected by Hurricane Sandy (Utilities, School, Weather, Transportation).

Also appearing are government organizations and individuals at various levels of

jurisdiction (City, County, State, Federal, Politician) and those representing the private

sector (Private, Company).

Table 9: Number and % of Messages for Each Entity Type

Entity	# References		# Recommends		# Rebroadcasts		Total #
	Self	Other	Self	Other	Self	Other	Mentions
Fire	51	14	13	2	186	30	296
Police	105	59	45	3	987	66	1265
EMA	0	250	0	33	0	381	664
Humanitarian	0	18	0	2	0	48	68
Media	0	24	0	41	0	291	356
Utilities	0	77	0	6	0	67	150
School	0	12	0	2	0	9	23
Weather	0	86	0	15	0	288	389
Transportation	0	11	0	2	0	23	36
City	0	110	0	23	0	72	205
County	0	24	0	8	0	54	86
State	0	37	0	1	0	49	87
Federal	0	58	0	2	0	27	87
Politician	0	50	0	0	0	113	163
Company	0	11	0	1	0	24	36
Private	0	0	0	0	0	21	21

Table 9 contains the number of references, recommendations, and rebroadcasts (both self and other) for each type of mentioned entity. Self-references, self-recommendations, and self-broadcasts only occur in the fire and police categories because we only analyzed messages from fire and police departments. Interestingly, the highest number of mentions was the 987 self-rebroadcasts from police departments. If we unpack this number, we find that four police departments were responsible for over half of this activity (532), with the heaviest police user contributing 240 self-broadcasts. Thus, the data seems to be skewed from heavy use of a few users. Yet, even if we disregard data from the heaviest self-broadcast contributors, the remaining number of self-broadcasts (455) is more than found in any other category. This finding suggests that fire and particularly police departments frequently use social media as a means to redistribute their own information to a larger audience.

The entities with the most third-party mentions include Emergency Management Agencies—or *EMA*s—(664 mentions), institutions that report *Weather* data (389 mentions), and broadcast *Media* (356 mentions). EMAs are responsible for the overall management of an event like Hurricane Sandy; they are specifically trained to provide information and assistance in times of crisis. Thus, EMAs were a frequent subject of fire and police mentions. Because the crisis event involved a hurricane, accurate and timely weather information was particularly important which explains why institutions that could provide that information were often mentioned. Finally, broadcast media, such as local TV channels, radio stations, and newspapers, remain an important information channel for the public during any event. Fire and police departments would often share

stories produced by broadcast media or recommend that the public follow broadcast media channels for information updates.

The data reveals strong patterns associated with the particular circumstances of Hurricane Sandy, which leads us to hypothesize that the mentioned entities would differ across different types of crisis events. For example, the large number of *Weather* mentions found during Hurricane Sandy would likely not exist around an earthquake or a terrorist attack. Similarly, one would expect more *Fire* mentions during a wildfire or more *Police* and *Politician* mentions around a political riot. Empirical investigation of these mention patterns is a topic for future research.

3.3 Why Departments Used or Did Not Use Online Media

This section explores *why* fire and police departments used (or did not use) online media to communicate to the public during Hurricane Sandy. First, I examine population to see if it can explain why departments used online media. Then, I report results from an interview study where I asked fire and police departments about their use of online media during Hurricane Sandy.

3.3.1 Population and Online Engagement Level

To explore possible correlations between online media use by fire and police departments and the population supported by each department, I collected population data from the US Census Bureau website. I wanted to see if we could use the population size of a fire or police department's jurisdiction to predict the department's online behavior. I generated a scatter plot (see Figure 3) comparing the population supported by each fire and police department to each department's online engagement level during Hurricane Sandy. Online engagement levels were determined by Hughes et al. [12] and consist of

three possible values: *Sandy Active*, *Non-Sandy Active*, and *Inactive*. A *Sandy Active*
department is one that had online account(s) and they used them for public
communications during Hurricane Sandy. A *Non-Sandy Active* department is one that
showed recent online account activity, but they did not use these accounts to
communicate about Hurricane Sandy. Lastly, an *Inactive* department is one that did not
have any online accounts.

Figure 3 shows no significant correlation between online use and population size.
However, there does appear to be a trend toward more departments being *Sandy Active*
when they support populations over 500,000. But, since there are only 16 departments in
this category (see Table 10), this finding may not hold true with a larger sample size.

To further analyze correlations between population and online engagement, I
narrowed the wide population range represented in Figure 3 into smaller population
brackets (see Table 10). The population brackets are the locality size classes defined by
the United Nations[6]. For each bracket, I determined the number and percentage of
Inactive, *Non-Sandy Active* and *Sandy Active* fire and police departments. This table
shows that for most of the population brackets (except bracket X), the percentage of
Inactive accounts is always less than the percentage of *Non-Sandy Active* and *Sandy
Active* accounts. The data reveals that the majority of fire and police departments studied
here have at least one active online account (with the exception of population bracket X).

While I did not find a correlation between the online media use of fire or police
departments and the population that they support, the data does seem to show that online
media can be useful for many different jurisdiction sizes.

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[6] http://unstats.un.org/unsd/demographic/sconcerns/densurb/densurbmethods.htm
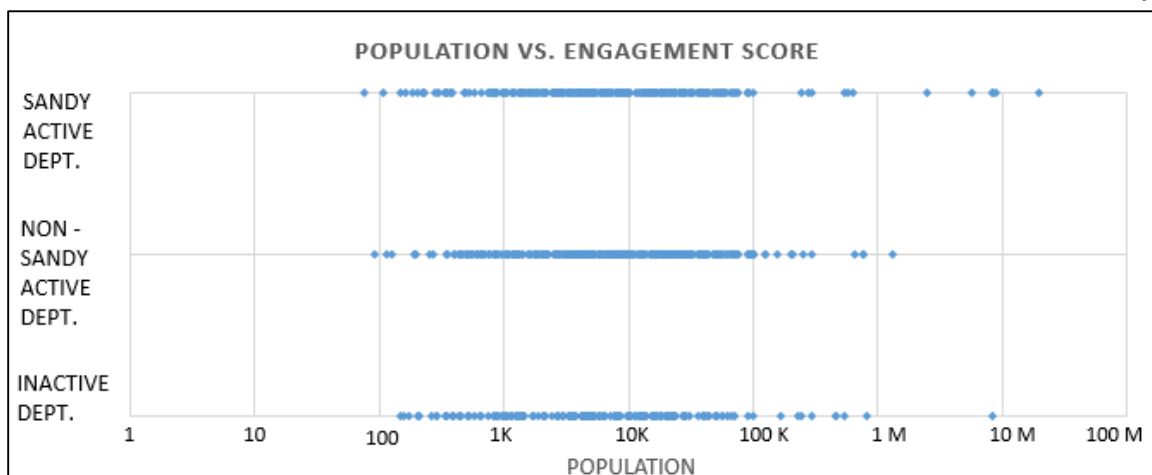
Figure 3: Populations Supported by Fire and Police Departments Compared to Their Respective Engagement Level

Table 10: Number and % of Inactive, Non-Sandy Active, and Sandy Active Departments by Population Bracket

Pop. Bracket	# of inhabitants	# Dept.	Inactive Departments		Non-Sandy Active Departments		Sandy Active Departments	
			#	%	#	%	#	%
I	1-199	13	3	23.1%	5	38.5%	5	38.5%
II	200-499	41	12	29.3%	13	31.7%	16	39.0%
III	500-999	50	12	24.0%	22	44.0%	16	32.0%
IV	1,000-1,999	77	20	26.0%	25	32.5%	32	41.6%
V	2,000-4,999	146	32	21.9%	63	43.2%	51	34.9%
VI	5,000-9,999	122	25	20.5%	54	44.3%	43	35.2%
VII	10,000-19,999	113	26	23.0%	48	42.5%	39	34.5%
VIII	20,000-49,999	132	27	20.5%	51	38.6%	54	40.9%
IX	50,000-99,999	72	9	12.5%	35	48.6%	28	38.9%
X	100,000-499,000	18	6	33.3%	9	50.0%	3	16.7%
XI	500,000 or more	16	3	18.8%	4	25.0%	9	56.3%

3.3.2 Fire and Police Department Interviews

Interviews revealed many challenges that fire and police departments experienced during Hurricane Sandy. In some locations, departments had minimal disruption (e.g., a few downed trees). While in other locations, Hurricane Sandy was an unprecedented, devastating event. These locations experienced destruction of homes and businesses,

flooding that caused significant water damage, clogged roads, downed electrical poles, damaged gas lines, and loss of power. A heavily affected interviewee described having 4-5' deep water and sand in the middle of his town; the sand accumulation was the result of heavy flooding. Another interviewee talked about how a mandatory evacuation was issued for the town where he works. Only the fire, police, emergency medical services, and other critical staff were allowed to stay there; the rest of the town was evacuated. For months, this town was open only for local residents and business owners. On being asked if he took any pictures or gave any status updates during that difficult time, his reply was no, because he did not want to keep those days in his memory. Another interviewee discussed how his town was without power for 12 days, which, in turn, also shut off all local services such as gas stations, grocery stores, and postal services.

Most fire and police departments had extended responsibilities during the event, which often required working beyond regular hours. One of the major responsibilities was to staff their local Emergency Operation Center (EOC) and coordinate with their Regional Operation Intelligence Center (ROIC). Other extended responsibilities included clearing roadways, tracking flooded roads and roads closures due to downed trees, evacuating and rescuing people, securing boundaries, and imposing extra patrols and curfews at night to prevent theft and looting.

In response to Hurricane Sandy, fire and police departments used numerous methods to communicate important information to the public. The more traditional means of communication included community meetings, sirens, patrolling police cars with loudspeakers, local TV news, radio stations, and newspapers. The online means of communication used were social media accounts such as Facebook and Twitter,

department websites, and mass notification services such as Nixle, Blackboard Connect, Global connect, Code Red, First Alert, and others (Nixle was the most commonly used of these notification services).

Social Media, particularly Twitter and Facebook, served as two-way communication channels between fire and police departments and local citizens. To ensure responsiveness, most of the interviewees indicated that their department social media accounts were regularly monitored by dedicated personnel—either a single person or a team of people. These personnel distributed updated information across department social media channels. They also monitored social media for false rumors and misinformation so they could provide corrected information as quickly as possible.

Several barriers prevented interviewees from using online media in their public communication strategies. Some departments did not use online media because Hurricane Sandy minimally affected their jurisdiction; there simply was not a need for such communications. Other jurisdictions were severely affected. Departments in these areas were often prevented from using online media because of power outages or damage to department facilities. One interviewee reported having power outages and all phone networks down throughout his area. He further added that only people with smartphones and Verizon phone service were able to access online media posts. Other barriers to using online media by fire and police departments included the lack of accounts or the trained staff to use them.

3.4 Discussion

Fire and police departments during Hurricane Sandy used online media to distribute information to the affected public. Figure 2 shows a continuous flow of

relevant messages throughout the event. Whenever required, these fire and police departments also mentioned entities (both themselves and others) to cite, redirect, endorse, and retransmit information. In some cases, fire and police departments asked citizens to send pictures through their Facebook and Twitter online accounts. There were also instances where fire and police departments addressed the concerns and questions of their local residents. Thus, online media provided a two-way communication channel between fire and police departments and local residents.

Though online media worked well for many departments, other departments encountered barriers to their use. Interviews revealed that the existence of other well-established public communication means, power outages, limited reach of online media in the affected areas, and untrained and limited staff contributed to poor or no online media use by these fire and police departments during Hurricane Sandy.

I also explored the online mentioning behavior of these fire and police departments during Hurricane Sandy and found that a significant portion of their online communications contain mentions (49.7%). The intent of each mention fell into one of three categories: a reference, a recommendation, or a rebroadcast. Results demonstrate that the social media of study (Facebook, Twitter, and Nixle) support the three types of mentions with varying degrees of effectiveness. For instance, reference and recommendation mentions were more common in Nixle messages, while rebroadcast mentions were more common in Facebook and Twitter messages.

In the remainder of this section, I address the broader implications of the research described in this chapter. Specifically, I show how online communication media

supported the vetting of emergency information, the visibility of emergency response efforts, and the self-promotion of fire and police departments.

3.4.1 Information Vetting

Before, during, and after Hurricane Sandy made landfall, fire and police departments provided information that was relevant to their communities within the context of the disaster. For example, before Hurricane Sandy they distributed links to preparation information and weather forecasts about the predicted path and severity of the storm. Through these actions, the departments vetted information by providing relevant and accurate information.

The mentions that fire and police departments included in their social media communications also served as a vetting mechanism for public information. In their online messages, these departments would reference and recommend organizations, institutions, and individuals as credible and trustworthy sources of information. They also redistributed the information they felt was most important through rebroadcasts. Fire and police departments know their jurisdictions well, and mentions allow them to tailor their communication streams to best fit the needs of their citizens.

3.4.2 Visibility of Emergency Response Efforts

The online mentioning behavior of fire and police departments offer digital glimpses of how these departments operated during Hurricane Sandy. By identifying the subject of each mention, we could see the many different stakeholders involved in a large-scale crisis response. Rarely—at least not without concentrated effort—can the public obtain such a view. Also visible were the relationships between emergency

stakeholders. The messages these departments choose to reference, recommend, and rebroadcast demonstrated whom they trusted and whom they thought was most credible. Emergency response organizations have never been so visible or accessible to the public before. However, with these new levels of transparency, come new levels of public accountability. Emergency responders must be more conscious of the way they portray themselves and their actions through social media. Similarly, responders must be more aware of the entities that they mention in their communications and the information they provide. If they reference, recommend, or rebroadcast entities that supply information or services of dubious quality, their credibility in the eyes of the public will likely decrease. Likewise, a department's reputation could be damaged if they provide poor or incorrect information.

3.4.3 Self-Promotion

Through the significant number of self-mentions found in our data, fire and police departments engaged in self-promotion while also attempting to distribute their messages to a much broader audience. Self-promotion behavior marks a significant shift from the past when the broadcast media would typically handle the promotion and distribution of crisis information. While broadcast media still play a large role, emergency responders now have much more control over the way public information is distributed to the public during times of crisis. Responders no longer have to rely upon the broadcast media to communicate with the public. In this context, self-promotion then becomes necessary because responders find they must make the public aware of the information services they provide and show themselves as accurate, credible sources of information. Consequently, these responders are taking on new responsibilities that require new

skills—those of promoting and distributing information. Future research should focus on how responders use social media as a tool for self-promotion and distribution of messages (beyond the use of mentions) and the skills required to accomplish these tasks.

3.5 Summary

In this chapter, I examine how and why affected fire and police departments used (or did not use) online communication media to communicate with the public during Hurricane Sandy. I found that the departments used online media to give real-time, relevant updates to their communities. They also used online media as a two-way communication channel between the departments and the public. Frequently, these departments mentioned entities in their online messages to lend credibility to the information they provided. While many departments used online media during Hurricane Sandy, many did not because they were only lightly affected by the event, untrained in online media use, or severely affected to the point where online use was impossible. The chapter concludes with a discussion of the broader implications of online communication use by fire and police departments.

CHAPTER 4

ONLINE MEDIA ADOPTION AROUND HURRICANE SANDY

This chapter aims to understand *how* a large-scale disaster event like Hurricane Sandy affects online communication media use and adoption by affected fire and police departments (research question R2). To answer this question, I collected and analyzed data around when each fire and police department adopted and used online media before, during, and after Hurricane Sandy occurred.

4.1 Research Data & Methods

I began this analysis by determining the present status of each fire and police online account from the Hughes et al. [12] study. Next, I determined when these fire and police departments created their online media accounts and how their online activity had changed following Hurricane Sandy. I describe these data and their collection in the following subsections.

4.1.1 Online Account(s) Status

I first revisited all the fire and police department online accounts found by Hughes et al. [12] to determine if these accounts still exist and are active. I then searched Facebook, Twitter, and Nixle to determine if the fire and police departments that did not have an online account(s) have since created one. I categorized the status of each online communication media for each of the departments as either *New*, *Not Found*, or *No Change* (for account status category definitions, see Table 11). Study of this data reveals insight into the online media adoption rate by the affected fire and police departments over time.

4.1.2 Online Account Join Dates

Next, I determined when each fire and police department joined Facebook and Twitter to better understand when departments adopted these media. I was unable to obtain join dates for Nixle so this data was not analyzed. Account join dates for Facebook were determined by visiting each department's Facebook page (if it exists) and join dates for Twitter (if applicable) were collected using the Twitter API.

Once I collected the join dates for all the Facebook and Twitter accounts, I determined the number of accounts created during three time periods (see Table 12): *Pre-Hurricane Sandy* (the year prior to the event), *During Hurricane Sandy*, and *Post-Hurricane Sandy* (the year following the event). This information too offers insight into the adoption rate of Facebook and Twitter over time by the affected fire and police departments.

Table 11: Account Status Categories and Definitions

Account Status	Definitions
New	Present-day Online Communication Media accounts that did not exist during Hurricane Sandy.
Not Found	Online Communication Media accounts that existed during Hurricane Sandy, but are no longer in use.
No Change	Online Communication Media accounts with the same status since Hurricane Sandy

Table 12: Hurricane Sandy Event Timeline

Period	Time Frame
Pre-Hurricane Sandy	October 25, 2011 - October 24, 2012
During Hurricane Sandy	October 25, 2012 - November 9, 2012
Post-Hurricane Sandy	November 10, 2012 – November 9, 2013

4.1.3 Changes in Online Activity

To study the impact Hurricane Sandy may have had on the adoption and use of social media during and following these types of events, I collected all the Facebook, Twitter, and Nixle messages posted by these departments in the *Pre-Hurricane Sandy* (i.e., the year prior to Hurricane Sandy) and the *Post-Hurricane Sandy* period (i.e., the year following Hurricane Sandy). I used the Graph API to obtain the Facebook data and the Twitter REST API to collect the Twitter data. Nixle information was obtained using a Python script that scraped message data from the Nixle website.

After I finished collecting all the messages posted through Facebook, Twitter, and Nixle, I compared the number of *Pre-Hurricane Sandy* messages to the number of *Post-Hurricane Sandy* messages and determined whether the number of messages had *Increased*, *Decreased*, or remained *Unchanged* (for definitions of these categories, see Table 13).

To avoid categorizing minor differences in the number of Pre-Hurricane Sandy and Post- Hurricane Sandy messages as *Increased* or *Decreased* online activity, I set a threshold for *Unchanged*. I divided the number of messages Pre-Sandy by the number of messages Post-Sandy to get a change ratio. If this ratio was between 0.9 and 1.1, the corresponding account was marked as Unchanged. The algorithm shown in Figure 4 was used to categorize a department's online activity.

Table 13: Online Media Activity Categories and Definitions

Account Activity	Definition
Increased	#msgs in Post- Hurricane Sandy period > #msgs in Pre-Hurricane Sandy period.
Decreased	#msgs in Post- Hurricane Sandy period < #msgs in Pre-Hurricane Sandy period.
Unchanged	#msgs in Post- Hurricane Sandy period ~ #msgs in Pre-Hurricane Sandy period.

```
if (numPreSandyMsgs == 0){
    if (numPostSandyMsgs== 0)
        cout << "Unchanged";
    else
        cout << "Increased";
}
else if (numPostSandyMsgs== 0) {
    if (numPreSandyMsgs == 0)
        cout << "Unchanged";
    else
        cout <<  "Decreased";
}
else {
    prePostRatio= numPreSandyMsgs /numPostSandyMsgs;
    if (prePostRatio > 1.1)
        cout << "Decreased";
    else if (prePostRatio < 0.9)
        cout << "Increased";
    else
        cout << "Unchanged";
}
```

Figure 4: Algorithm Used to Categorize Changes in Online Activity

4.2 Results

This section reports the data analyses conducted to understand the impact of

Hurricane Sandy on the use and adoption of online communication media by affected fire

and police departments. I begin by reporting the present status of the fire and police

online accounts found in Hughes et al. [12]. Next, I show when each of these departments

joined the different online media. Finally, I determine if the online activity by these fire

and police have increased, decreased, or remain unchanged.

4.2.1 Account Status

Table 14 shows that the majority of Facebook (89.76%), Twitter (91.90%), and

Nixle (99.40%) accounts had no change in their account status since the analysis done by

Hughes et al. [12]. Only 2.02% Facebook, 0.95% Twitter and 0.12% Nixle accounts were

not found. These *not found* accounts either no longer exist or their profile information

such as their account names or screen names (in the case of Twitter) or profile privacy

has changed since the last data analyses done by Hughes et al. [12].

Though a vast majority of found accounts existed at the time of the Hughes et al. [12] study, there are *new* accounts that have been created since that time as well: Facebook (8.21%), Twitter (7.14%), and Nixle (0.48%). This suggests that fire and police departments are still exploring the various online media and that the adoption of media like Facebook, Twitter, or Nixle is likely to continue. However, the data does not indicate if the new online accounts were created in response to Hurricane Sandy.

4.2.2 Online Account Join Dates

Table 15 shows that the majority (more than 44% in all cases) of affected fire and police departments created their Facebook and Twitter accounts before October 25, 2011. The next largest number of accounts (20.4% and 30.3% Facebook and 29.4% and 23.4% Twitter accounts, created by fire and police departments, respectively) were created during the Pre-Hurricane Sandy period. Interestingly, the number of new Facebook and Twitter accounts declined during the POST-Hurricane Sandy period. These results seem to suggest that adoption of Facebook and Twitter by these departments may have reached a saturation point, and the number of newly created accounts will only decrease moving forward. Future investigation is needed to see if these numbers continue to decrease.

Few fire and police departments created their Facebook and Twitter accounts during the Hurricane Sandy period—likely because it was a comparatively short period of time and also a time period in which they were heavily preoccupied by Hurricane Sandy.

In Table 16, we see that more fire and police departments have a Facebook account (53.9%) than a Twitter account (18.8%). This finding suggests that fire and

police departments find Facebook more useful for their public communication practices

and that there is more room for adoption growth in Twitter compared to Facebook.

Table 14: Number and % of the New, Not Found, and No Change Accounts

Online Media	NEW accounts		NOT FOUND accounts		NO CHANGE accounts	
	#accounts	% of all accounts	#accounts	% of all accounts	#accounts	% of all accounts
Facebook	69	8.21%	17	2.02%	754	89.76%
Twitter	60	7.14%	8	0.95%	772	91.90%
Nixle	4	0.48%	1	0.12%	835	99.40%

Table 15: Facebook and Twitter Accounts Join Dates for Fire and Police Departments

Online Media	Dept. Type	# Accounts before October 25, 2011	# Accounts in PRE-Hurricane Sandy Period	# Accounts in Hurricane Sandy Period	# Accounts in POST-Hurricane Sandy Period
Facebook	Fire	202 (61.6%)	67 (20.4%)	4 (1.2%)	55 (16.8%)
	Police	55 (46.2%)	36 (30.3%)	3 (2.5%)	25 (21.0%)
Twitter	Fire	38 (44.7%)	25 (29.4%)	5 (5.9%)	17 (20.0%)
	Police	35 (54.7%)	15 (23.4%)	2 (3.1%)	12 (18.8%)

Table 16: Total Number of Department Facebook and Twitter Accounts

Online Media	Total Number of Accounts
Facebook	453 (53.9%)
Twitter	158 (18.8%)

Table 17: Increased, Decreased, and Unchanged Online Activity across Facebook, Twitter, and Nixle in the Post Hurricane Sandy Period

Online Media	Increased		Decreased		Unchanged	
	# accounts	% of existing accounts	# accounts	% of existing accounts	# accounts	% of existing accounts
Facebook	236	78.7%	52	17.4%	12	4%
Twitter	86	60.9%	46	32.6%	9	6.3%
Nixle	22	61.2%	11	30.6%	3	8.4%

4.2.3 Changes in Online Account Activity

Most of the affected fire and police departments have increased their online

activity on Facebook (78.7%), Twitter (60.9%), and Nixle (61.2%) in the post Hurricane

Sandy period (see Table 17). Results show that online media use by these fire and police

departments is increasing.

4.3 Discussion

Around 90% of all the fire and police online accounts across Facebook, Twitter,

and Nixle remained unchanged in the year following Hurricane Sandy. While not

surprising, it does show that at least in the short-term these departments are not changing

or deleting their online accounts.

Online media adoption actually decreased following the hurricane, which seems

to imply that those departments who saw the value in online media were already using

them. Specifically, both the Facebook and Twitter adoption rate fell by about 10% when

comparing the year before and after Hurricane Sandy. This finding suggests that there is

no correlation between adoption and a large-scale disaster event, at least not in this case.

However, while adoption of new accounts have decreased the fire and police departments

have actually increased their online activity on Facebook, Twitter, and Nixle compared to

before Hurricane Sandy. This increased online use could either be because of their

experience during Hurricane Sandy or it could just be a natural increase over time.

Facebook, at least in this study, seems to be significantly more popular than

Twitter. Much of the research around online media use by emergency responders has

been directed at Twitter because of the ease of studying the Twitter medium. Yet, if

Facebook use is more common, both the emergency response and research community could greatly benefit from more study of its use.

4.4 Summary

In this chapter, I explore how a large-scale disaster event like Hurricane Sandy affects online communication media use and adoption by affected fire and police departments. I found that most of the fire and police departments with a Facebook or Twitter account created them before October 2011. Online media adoption has continued following 2011, but it appears to be slowing. Most of the fire and police departments have increased their online activity following Hurricane Sandy, however it is unclear whether this increase is linked to use during Hurricane Sandy.

CHAPTER 5

CONCLUSION

In this final chapter, I summarize the results of this thesis research. I also discuss implications for emergency management practice and technology design to support the online media needs of emergency responders. Finally, I consider the limitations of this research and offer suggestions for future work.

5.1 Thesis Summary

This thesis work explores online media use by fire and police departments during Hurricane Sandy 2012 with the purpose of informing future emergency response practice and technology design. I began by exploring how and why affected fire and police departments used (or did not use) online communication media to communicate with the public during Hurricane Sandy (Chapter 3). Research showed that fire and police departments used online media to give timely and relevant information to the public about things such as evacuations, damages, weather, and cleanup. In their messages, fire and police departments sought to make the information provided more credible by referencing, rebroadcasting, and recommending other authoritative entities. I found no correlation between a department's online media use and the size of the population that that department supports.

Online media supported two-way communication between fire and police departments and local residents. Data revealed that local citizens used online media to report eyewitness accounts of the storm and to share their personal and community concerns. Collected data also revealed numerous instances where fire and police

departments asked the public to follow or monitor their department's online media for regular updates and to share the posted information with other citizens who did not have online access. Some instances also show how these fire and police departments responded to the concerns and questions of their local residents.

Though some departments saw online media as a useful and effective means of communication with members of public, other departments found them difficult to use given the challenging circumstances of Hurricane Sandy. Interviews exposed numerous factors that contributed to poor or no online media use by fire and police departments, such as the existence of other well-established public communication means, power outages, limited reach of online media in the affected areas, and untrained and limited staff.

Next, I explored how a large-scale disaster event like Hurricane Sandy affects online communication media use and adoption by affected fire and police departments (Chapter 4). Data analysis showed that around 90% of the affected fire and police department's online accounts remained unchanged in the year following Hurricane Sandy. A few Facebook (8.21%), Twitter (7.14%) and Nixle (0.48%) accounts were created in the post Hurricane Sandy period (the year after Hurricane Sandy). Another data analysis reported an increase in online activity over Facebook, Twitter, and Nixle by the affected fire and police departments compared to before Hurricane Sandy. However, it is unclear whether this increase in online activity can be attributed to Hurricane Sandy or a natural increase over time.

5.2 Implications for Emergency Responder Practice

Results from this research have several implications for the online media practice of emergency responders like fire and police departments. First, results show that emergency responders have become more responsible for distributing information directly to the public, and for their own self-promotion. In the past, the traditional media (e.g., television and radio news, newspapers, etc.) have primarily filled this responsibility. With these new responsibilities emergency responders will need a new set of skills and increased training. For example, emergency responders will need to be better informed about the types of information that the public need and request during different types of emergency events so they can provide that information. If the emergency responder does not have this information, he or she should at least be able to refer the public to an individual or organization that does. In addition, emergency responders will need to develop new skills that help them to determine what online communication media are most appropriate in the given situation. For instance, online media may be an effective communication solution if the department has well-established accounts, enough trained staff, and a wide-spread public audience with online access. Finally, emergency responders will require new skills for crafting public messages that fit the constraints of different online media, such as the 140-character message limitation of Twitter.

As two-way interaction (enabled through online media) with the public increases, emergency managers will need to invest more time in building relationships with the public. This is important because if emergency responders want the public to contact them online during an emergency with their needs and concerns, they will need to make the public aware of their online existence and their ability to respond to online requests.

One way to build these relationships is to interact during non-emergency times as well by sharing interesting news articles, pictures, or videos that help them build rapport with their citizens.

5.3 Implications for Design

This research also has several implications for technology design to support the communication needs of emergency responders. One difficultly I encountered when conducting this research was identifying the online accounts of the fire and police departments located within a particular geographic region. In most cases, I had to know the name of the department to find its online accounts. Members of the public may not know the names of the fire and police departments that serve their location. Ideally, a citizen should be able to search for and find the online accounts of their local emergency responders using only their location. While there are services that provide similar search capabilities, such as Twitter's "Who To Follow" service, I found them insufficient for this type of location-based query. Therefore, one important future outcome from this research could be the design of an improved location-based search tool that would help the public find the online accounts of emergency responders.

Another area for improved technology design lies in the functions that let people endorse or share online media. Facebook, for example, has the "like" feature. One problem with the "like" feature is that it cannot support all the many different ways that a person may want to support, empathize, disagree, or relate to a Facebook message. Consider an example where somebody posts a message on Facebook that states that a hurricane has caused 1,000 deaths. If 500 people "like" the message, does it mean that they liked the content and they are happy because of these deaths? No. Most likely they

"liked" the message to show support or solidarity during a difficult time. Thus, we see that the word "like" can be problematic. Twitter has similar issues with its "favorite" feature. Possible solutions to this problem include renaming these options to be more generic so they can fit a wide-range of intent or expanding the number of options.

When examining the online media messages that fire and police departments sent during Hurricane Sandy, there were many similar types of messages. To improve consistency across this messaging and save time, we could design message templates. These templates could then be created beforehand. If carefully crafted, these templates could also help to make messages more machine readable.

5.4 Limitations & Future Work

This study is based on the use of online communication media by fire and police departments during Hurricane Sandy. To understand how different types of emergency response organizations (such as the national weather service or the American Red Cross) use online media, additional study is needed. This study is also limited in that it only analyzed Facebook, Twitter, and Nixle online activity. Thus, this work could be further extended by studying other recent social media and mass notification services.

In this study, I examined online media adoption over time. As more time passes, it would be informative to revisit online media adoption by the fire and police departments examined here.

Finally, to understand how the online media usage might differ during different kinds of emergencies, future studies could examine and compare online communication media use during different types of emergency events such as earthquakes, floods, or terrorist attacks. Further, to understand the correlation between online media use during

emergencies and the geographic location of event, a future study could examine different patterns in online media use during similar emergency types in different parts of the United States (village vs. city vs. major city) or different parts of the world (such as riots in Egypt vs. riots in Hong Kong vs. riots in Missouri, USA).

5.5 Conclusion

This thesis research investigates the use of online media by fire and police departments during Hurricane Sandy. By studying and learning more about how emergency responders use online media under these types of circumstances, we can inform practice and technology design and shape how these media might best be used in future response efforts.

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APPENDICES

Appendix A

RECRUITMENT EMAIL TEMPLATE

(FIRE & POLICE DEPARTMENTS)

TO: Select Fire and Police Departments

SUBJECT: Hurricane Sandy 2012 moments

BODY:

Dear <Name of Department or Public Information Officer>,

I am a Computer Science Master's student at Utah State University who is studying the public communications of emergency responders during Hurricane Sandy. My work is advised by Professor Amanda Lee Hughes (http://digital.cs.usu.edu/~amanda/).

I am contacting you because I would like to conduct a phone interview with someone from your department. Interview questions will focus on how your department communicated with the public during Hurricane Sandy and how you may have changed your communication policy since Sandy (if applicable). The phone interview will last no more than an hour.

If you would like to participate, please either reply to this email or email me directly (apoorva.chauhan@aggiemail.usu.edu).

Thank you for your consideration,

Apoorva Chauhan

Appendix B

RECRUITMENT EMAIL TEMPLATE

(OFFICE OF EMERGENCY MANAGEMENT)

TO: Select Office of Emergency Management (County/State)

SUBJECT: Hurricane Sandy 2012 Public Communication - Research Assistance

BODY:

Dear <Name of Office of Emergency Management (County/State)>,

I am a Computer Science Master's student at Utah State University whose work is advised by Professor Amanda Lee Hughes—a known research expert in the use of social media for emergency management (email: amanda.hughes@usu.edu, website: http://amandaleehughes.com). Currently, I am conducting an interview study that builds on past work by my advisor (please see the following link- http://amandaleehughes.com/HughesStDenisPalenAndersonPoliceFireSandy.pdf) and seeks to understand how fire and police departments communicated with the public during Hurricane Sandy and how they may have changed their communication policies since Sandy (if applicable). I conduct these interviews by phone and each interview lasts no more than 30 minutes. Results from this study will help the emergency management community better understand online communication use during crisis events and inform technology design and policy around this use.

I am contacting you because we have encountered great difficulty recruiting people to interview from fire and police departments in your jurisdiction. Much of this difficulty lies in the lack of good contact information, but we also suspect that departments are unsure about the validity of our requests (since we do not personally

know them). Would you be willing to forward this email to those in your fire and police

departments that could talk about public communication efforts during Hurricane Sandy

(perhaps a list of public information officers)? Of course, we only expect you would

assist us if you feel comfortable doing so.

Those who would be willing to participate in this interview study can contact me

or my advisor by email (apoorva.chauhan@aggiemail.usu.edu or

amanda.hughes@usu.edu). Also, please feel free to contact us to find out more about this

study. Any assistance is greatly appreciated.

Thank you for your consideration,

Apoorva Chauhan

Appendix C

TELEPHONE SCRIPT TEMPLATE

(FIRE AND POLICE DEPARTMENTS)

Hello <Name of Department or Public Information Officer>,

My name is Apoorva and I am a master's student at Utah State University, who is studying the public communications of emergency responders during Hurricane Sandy. Is there someone from your department that I could speak to about how you communicated with the public during Hurricane Sandy?

<After the person on phone answers this question>

I'd like to conduct a phone interview that will last no longer than an hour. During the interview, I'll ask questions about the methods and tools that you used to communicate with the public during Hurricane Sandy.

Thank you.

Apoorva Chauhan

Appendix D

INTERVIEW GUIDE

This interview guide consists of two sections. Section one has background information that I collected about the interview participant's department and their online media engagement. This information was aggregated and compiled before the interview to help guide the questions the interviewer asks. Section two comprises questions that the interviewer asked the interviewee.

Section I: Background Information

Name of Police/Fire Department:

County/Municipality/State of FD/PD:

Population of the department's jurisdiction:

Online communication activity during Hurricane Sandy:

Section II: Interview Questions:

What is your job title?

What is your work experience?

What is your Age?

What are your current responsibilities?

What problems did your city or county face during Hurricane Sandy?

What were your responsibilities during Hurricane Sandy?

How did your department communicate with the public during Hurricane Sandy?

What online resources did your department use to communicate with the public during

Hurricane Sandy?

If participant used online resources: What was your experience with these online

resources?

If participant did NOT use online resources: Why did your department not use online

media to communicate with the public?

Does your department has an officer on special duty for monitoring online account

activities?

How did public communicate with your department?

What did you learn from your public communication experience during Hurricane

Sandy?

How has your department changed its public communication strategy since Sandy (e.g.

stopped or started using social media)?

Would you like to share some memorable story or experience that you had during

Hurricane Sandy?

Appendix E

INTERVIEW PARTICIPANTS BACKGROUND

Table 18: Interview Participants' Details

ID	Job Title	Dept. Type	Dept. Online Engagement	Dept. Jurisdiction (population)	Interview Date
P1	Chief of Police Department	Police	Sandy Active	6,000	March 19, 2014
P2	Police Captain	Police	Sandy Active	40, 499	March 25, 2014
P3	Lieutenant in Police Department, 2nd in command and Public Information Officer (PIO)	Police	Sandy Active	982 (increases to 3,000 during summer)	March 28, 2014
P4	Senior Dispatcher	Police	Non-Sandy Active	Residential Population – 4,000 (Day time Population – 80,000)	March 28, 2014
P5	Lieutenant	Police	Sandy Active	15,063	April 1, 2014
P6	Emergency Planner	County EMA	-	39,000	9th May, 2014
P7	Emergency Planner	County EMA	-	47,798	15th May, 2014

Appendix F

AFFINITY DIAGRAM

Figure 5: Affinity Diagram

Affinity Diagrams Summary:

Below are the summary of findings from Affinity Diagrams:

- Hurricane Sandy did not have the same effect on all the affected areas, and this
  was reported by interviewees as well. Few interviewees reported having water
  damage, floods, clogged roads, power outage (for more than a week), no gas
  supply and severe destruction, in their localities. While the other interviewee
  reported just to have trees down and minor power outage.

- All interviewees reported to have extended responsibilities during hurricane
  sandy. Interviewees stated working more than their regular hours, coordinating
  with their local office of emergency management and maintaining watch in the

emergency operation center. Some additional responsibilities were evacuating and rescuing people, securing boundaries, controlling theft, maintaining roadways and tracking of flooded roads, roads closed due to down trees etc.

- Interviewees reported that they used number of different means of communication, for communicating with members of public, during Hurricane Sandy. They did interviews with local TV channels and radio stations to report their status. They used warning siren systems and did the patrolling with loud speakers. They also did community meetings with local citizens. Other than the above traditional communication means, fire and police departments also used notification services (such as Blackboard Connect, Global connect etc.), social media (such as Facebook, Twitter etc.) and their departmental websites to establish contact with their local citizens.

- Few interviewees reported to use online media (Facebook and Twitter) as two-way communication between emergency responders and their local residents.

- Interviewees reported, power outage, elderly population, limited access to internet and devices etc. as some of the barriers to online media use, during Hurricane Sandy.

- While few interviewees were satisfied with their current public communication strategies, others mentioned having the regular table top discussions on improvisation of their strategies. One interviewee also reported that their department is educating community about different information sources. Another interviewee reported that their department is exploring on social media, and will settle with the one, they will feel most satisfied with.