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Social Media-Based Crisis Communication: Analysis of Twitter Data from Local Agencies During Hurricane Irma

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SOCIAL MEDIA-BASED CRISIS COMMUNICATION: ANALYSIS OF TWITTER DATA FROM LOCAL AGENCIES DURING HURRICANE IRMA

by

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ABSTRACT

As social media platforms have become vital means of communications, it has become imperative for emergency managers and policy makers to understand how people are interacting with different agencies on these platforms for enhancing community response coordination during disasters. Although many public agencies have already adopted social media platforms for crisis communication purposes, empirical evidence on whether and how these agencies are effectively engaged on these platforms is lacking. This research aims to examine crisis communication activities of a variety of agencies on Twitter in response to Hurricane Irma in 2017. In this study, we analyzed 13,353 hurricane-related tweets posted by the local agencies from eight counties in East Central Florida as well as federal, state, and other levels of organizations during the hurricane response period. An engagement metric was applied on these tweets to determine which agencies were most active in disseminating information during Hurricane Irma. The results revealed the most engaged local agencies in Twitter during Hurricane Irma for crisis communications and the Emergency Support Functions (ESFs) associated with them in coordinating disaster response activities. We further investigated Twitter profiles and relevant attributes of these actively engaged agencies, and the contents of the hurricane-related tweets during Hurricane Irma. The study found that local agencies remain active and engaged in Twitter during a disaster compared to other levels of agencies. The ESF representing communication (ESF #2) was one of the most frequent ESFs associated with these active agencies. The results also provided insights on crisis communication performance of these agencies in terms of the three dimensions of social media engagement including popularity, commitment, and virality, which are correlated to the counts of like, reply, and retweet of each

post, respectively. The study includes recommendations to local government and partner organizations and emergency managers to improve crisis communication in social media and suggests future research directions.

ACKNOWLEDGMENTS

I would like to thank my advisor Samiul Hasan for his support and guidance throughout my graduate education. I would also like to thank Ratna Okhai, Dr. Naim Kapucu, and Dr. Yue Ge for their contributions to this study. Furthermore, I express my utmost gratitude to the U.S. National Science Foundation and UCF Office of Research and Commercialization Fellowship for partially supporting this research project.

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CHAPTER ONE: INTRODUCTION

Background and Motivation

Natural disasters have become more frequent, and bolstering community resilience has become an urgency for government agencies and public leaders. Building community resilience is considered as a shared responsibility and collaboration among all sectors—allowing a community to efficiently function during and after disasters and increase its adaptive capacities through coordinated networked resources (*1*, *2*). But building community resilience is a complex process which requires continuous communication and coordination among participant organizations and partner agencies. One of the primary objectives of community resilience is to successfully recover from a disaster with coordinated actions. Crisis communication, therefore, plays a critical role within the broader community resilience framework. It is a crucial feature of emergency management, and poor communication can result in great harm in financial, physical, health and other forms for people and businesses (*3*–*5*).

Collecting, organizing, and disseminating timely information in response to emergencies and crises are critically important for effective disaster response and recovery (*6*). Disasters of different severity and sizes, such as catastrophic disasters of extreme events, can overwhelm emergency managers in coordinating response efforts. Specially, during large-scale natural disasters such as hurricanes, response tasks become more complicated and require effective coordination among various agencies (*7*). To execute this coordination among different agencies at federal, state, and local levels, Emergency Support Functions (ESFs) have been utilized in frameworks and emergency management plans. ESFs provide the structure of integrating response tasks, service, and resource support by grouping the various functions such as

communication, firefighting, transportation, and public works to save lives, protect properties, assets, and the environment, and reduce the amount of suffering (*7–9*).

The wide adoption of smartphones, apps and online social media platforms has facilitated communication to a great extent (*10–12*). Taking proactive actions during a disaster requires the affected population to be constantly informed regarding potential threats of a disaster. Emergency managers at all levels also need updates for the constantly changing needs of a community during different stages of a disaster (*13*). Social media platforms allow this two-way communication (*13, 14*) in real time, which differs from traditional media and communication strategies, allowing a disaster-impacted community to be well-connected and better-informed throughout a disaster.

Many public agencies have already adopted social media platforms for crisis communication (*10, 15–18*). Despite being widely adopted, we still need to examine how local organizations are utilizing these platforms for communication during disaster response. Although previous studies considered crisis communication among social media users in general and public organizations (*13, 19–22*), to the best of our knowledge, no study has focused solely on the engagement of local agencies on social media. Specifically, previous studies have not investigated the role of ESFs in crisis communication in social media, which can provide valuable insights for future emergency management planning, policies, and practice.

Research Questions

In this thesis, we aim to answer the following research questions:

1. *Which local agencies are leading in disseminating crisis information during a disaster in social media?*

2. *How to measure engagement activities of local agencies in social media for effective crisis communication?*
3. *How are the Emergency Support Functions (ESFs) associated with the engagement of the agencies that are active through their crisis communication posts?*

For this study, we considered crisis communication in Twitter as a social media platform during Hurricane Irma in the East Central Florida region (Lake, Sumter, Seminole, Orange, Marion, Osceola, Brevard, and Volusia counties). Hurricane Irma was first identified as a potential threat on August 27th, 2017 and hit Florida Keys as a Category 4 storm on September 10th, 2017 (*23–25*). It resulted in almost 129 direct and indirect deaths and an estimated damage of $50 billion, making Irma the fifth costliest hurricane in the United States (*24*, *25*). We analyzed 13,353 hurricane-related tweets posted by 299 agencies during Hurricane Irma to assess the engagement activities of these organizations in Twitter. We adopted a metric from the literature to gauge the engagement activities made by each agency in Twitter. From the results, we identified which specific local agencies were leading in disseminating information during Hurricane Irma in Twitter. We also assessed which specific Emergency Support Functions (ESFs) were frequently associated with the active agencies. Besides the three primary research objectives mentioned above, we also analyzed the attributes of the agency profiles and the content of the tweets that gained high engagement during Hurricane Irma.

Contributions

This thesis contributes to the literature on the use of social media for crisis communication. The contributions that will be discussed as a result of this study are as follows:

- This study has adopted a social media engagement metric from literature, applied it on a comprehensive list of agency profiles, and further utilized it in a novel way by correlating with different characteristics (levels, verified status, ESFs, etc.) of these agencies.
- It provides empirical evidence on how local agencies are engaging with the public in Twitter during a hurricane for crisis communication—demonstrating their roles and significance beyond federal and state level agencies in bolstering community resilience.
- The study identifies the local agencies who showed the most engagement in Twitter during Hurricane Irma. These findings will aid emergency managers to improve crisis management decisions on these platforms during future disasters. They will be able to boost the outreach of the crisis awareness posts to the local public by letting them know which local agency profiles to follow to get authentic information fast during different phases of a hurricane.
- The findings also show the performance of the agencies along three important dimensions of social media-based communication – popularity, commitment, and virality. This will make local agencies aware of the aspects of their social media-based crisis communication where they can be more effective and engaged in future.
- The study sheds light on examples of tweets that gained greater engagement from the users during Hurricane Irma—allowing local agencies to improve the content of their crisis communication posts to gain more engagement on Twitter during future disasters.

CHAPTER TWO: LITERATURE REVIEW

Crisis Communication and Social Media

From an organizational perspective, a crisis can be defined as: "an unpredictable event that threatens important expectancies of stakeholders and can seriously impact an organization's performance and generate negative outcomes" (*26*). Crisis response strategies are defined as the words and actions used by crisis managers while a crisis occurs (*26–29*). An effective crisis response from managers must include three categories of information: instructing information (tells people how to physically protect themselves from the crisis), adjusting information (helps people to cope with the crisis psychologically), and internalizing information (lets people formulate an image of the organization) (*29–32*).

As a two-way communication platform, social media is a channel to fit all these categories of information. Users can post status updates, comment on others' posts, share what others have posted, and tag other users to posts—allowing it to be an effective media for information dissemination. With its ever-evolving nature, social media is defined to be internet-based applications "that allow the creation and exchange of user generated contents" (*33*). Social media is considered as digital tools and applications that allow an interactive communication as well as exchange of contents between organizations and stakeholders (*34*).

Past surveys and studies indicated increasing use of social media during crises, making public participation on social media a crucial form of emergency management (*20*, *34*). A survey conducted by the American Red Cross in 2010 found that "74% of the 1,058 adults expect response agencies to answer social media calls for help within an hour" (*34*, *35*). During a crisis, social media allows the victims and stakeholders to provide emotional support to each

other alongside informational and technical support (*36*). Hence, social media platforms have undoubtedly become a vitals means of crisis communication.

Sweetser et al. found that launching a blog in response to a crisis can be an effective crisis management tool for the organizations (*37*). Organizational profiles on social media can also improve their relationships with stakeholders through responsiveness and humanness (*31*). Thus, social media profiles of organizations can help provide mass mental support to the people during a disaster as they have a large number of followers. From the Social-Mediated Crisis Communication (SMCC) model proposed by Jin et al. based on the American Red Cross interviews, it is apparent how a single organization can be the central source for information dissemination during a crisis (*34*). The model also considers influential social media creators and followers as important components of the crisis communication framework, providing insights on how emergency managers from organizations should engage with social media users during crises (*34*). These findings suggest that to bolster resilience on a community level, organizations must integrate social media into their emergency management strategies.

With increasing availability of internet all over the world, social media platforms are being widely used during natural disasters. Earlier studies focused on the role of Twitter users, tweet hashtags, and tweet keywords in building up situational awareness and community resilience during these disasters. During the 2007 wildfires in Southern California, it came to light how hashtags had the potential to be used for information dissemination during disasters (*38, 39*). Right after that, the Tweak the Tweet (TtT) syntax was proposed which was designed for filtering and classifying emergency related tweets during any disaster (*38*, *40*). Since then, this method has been utilized in numerous studies. In a study of the Red River Flood, researchers analyzed Twitter data by searching disaster related terms and demonstrated how people use

social media differently during disasters that might serve to boost situational awareness (*41*). After the Great East Japan Earthquake in 2011, a study (*42*) of earthquake related hashtags and keywords showed how users who posted tweets on the topic played the roles of (i) stranded commuters and (ii) supporters (public, families, and friends) and sometimes both. These studies showed how Twitter has been useful in building community resilience against natural disasters.

Previous studies focused on assessing how emergency management agencies and citizens can coproduce disaster risk communication during overwhelming disasters (*34*, *43*, *44*). Simultaneously, researchers were concerned about which characteristics, guidelines, and principles make social media-based crisis communication effective during disasters. In 2018, Mats Eriksson (*45*) reviewed 104 research articles published between 2004 and 2017 and identified five 'lessons' which show that effective social media crisis communication is about: (i) right message, source, and timing, (ii) being prepared, understanding social media logic, and increasing friends, (iii) utilizing social media for monitoring, (iv) prioritizing traditional media, and (v) just using social media as a strategic crisis communication.

Agencies and Social Media-based Crisis Communication

Past research also focused on public agencies and their use of social media platforms during disasters. Chatfield and Reddick (*20*) conducted a case study on the Twitter usage of New York City Fire department (FDNY) during the 2012 Hurricane Sandy. This research on FDNY's use of #sandy tweets provided significant results about how their active and efficient tweets during the hurricane were continuously retweeted by their huge number of followers including other government agencies. Their effort of active information sharing was appreciated not only by the public but also by media like CNN. The research emphasized the need of the government

agencies to actively use social media during disasters while paying attention to the information quality of the content, emergent needs of the citizens, the reach and speed of their posts to targeted stakeholders, and management of prompt response (*20*). Ahmed et al. (*21*) published a Twitter-based COVID-19 study on six major public organizations during the period of February to June 2020 demonstrating how they engaged users in Twitter by analyzing the topic dynamics of their tweets communicating health risk information. The results showed a significant difference among each organization's tweet patterns. MacKay et al. conducted an extensive literature search in 2021 and identified seven key features of guiding principles for social media-based crisis communication that help to maintain public trust (*46*), which include call to action, clarity, compassion and empathy, conversational tone, correction of misinformation, timeliness, and transparency. They monitored three Facebook pages belonging to three nationally trusted Canadian public health and news media organizations based on their posts from the early COVID-19 period and concluded that the guidelines were not consistently implemented, resulting in a lot of negative comments from the people (*46*). These studies show how social media-based crisis communication of various organizations can be implemented and bring different results, and why it is important to look at their shared contents in order to understand what needs to be improved.

However, it is yet to be known how different agencies at regional and local levels are utilizing social media platforms for crisis communication. In 2015, Neely et al. (*47*) conducted a survey on the local government in Florida regarding the adoption of social media for crisis communications. The survey was administered in collaboration with the Florida City and County Management Association (FCCMA) and managers of 180 cities were contacted. Only 83 usable responses were gained and among them 42 (50.6%) agencies reported that they do not use any

social media platforms for crisis communications. Facebook was found to be the most frequently used social media tool (used by 49.4% of the agencies), and Twitter was used by 27.7%. The study concluded that social media adoption among local government agencies was lower compared to federal and private sector agencies. They suggested that further in-depth research, especially on a county level, is necessary to confirm the concern that local agencies lack proper digital and management skills to utilize the social media platforms in ways that meet people's expectations during a disaster. However, in the recent times following some major hurricanes in Florida (e.g., Matthew in 2016, Irma in 2017, Michael in 2018, Dorian in 2019, Ida in 2021), a few studies have focused on social media use of local agencies (county and regional level) for crisis communication. A recent study (*48*) on local emergency management's use of social media during Hurricane Irma found that, out of the 24 county-level After Action Reports (AARs) from Florida, 95% of the county AARs discussed the usage of social media before and during disasters in positive terms. About 81% of the counties mentioned only pushing information on these platforms and only 48% discussed implementing two-way communication on social media. Many counties reported facing problems to effectively manage these two-way communication tools (*48*). As such, emergency managers face numerous technological, financial, and managerial challenges while adopting these social media platforms during disasters (*48*).

Review Summary

Prior research has provided a general overview of how local agencies are using social media during disasters, but these studies have not investigated the engagement activities of local agencies on their social media profiles. In this thesis, we aim to understand the engagement activities of a variety of agencies through their crisis communication posts, considering Twitter as a social media platform and Hurricane Irma as a disaster event. .

CHAPTER THREE: DATA AND METHODS

Overall Methodological Approach

The goal of this study was to obtain an overall perspective of crisis communication during disasters, through online engagement of different local agencies using a social media platform. For that, it was important to take both a qualitative approach to analyze the characteristics and content of their social media profiles, and a quantitative approach to assess their overall engagement performance. The step-by-step methodological approach adopted in this research is shown in Figure 3.1.

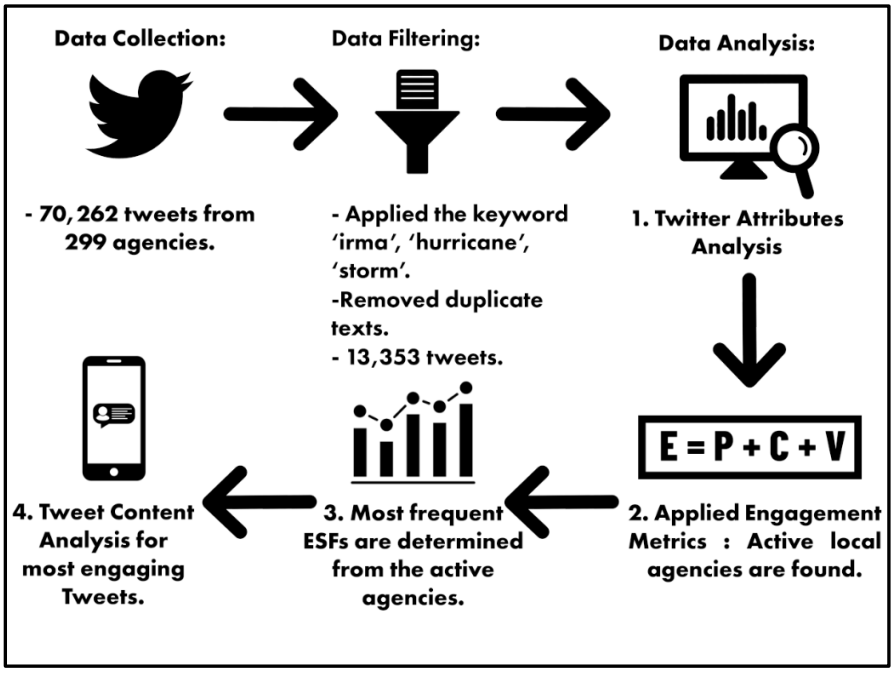


Figure 3.1: Methodological Approach and Workflow Diagram.

Data Description

For this study, Twitter was selected as the social media platform as it is widely used for crisis communication. Additionally, Facebook historical data from individual profiles is unavailable to the public for use. The local study testbed includes eight counties in the East

Central Florida region of USA including Brevard, Lake, Marion, Orange, Osceola, Seminole, Sumter, and Volusia (Figure 3.2).

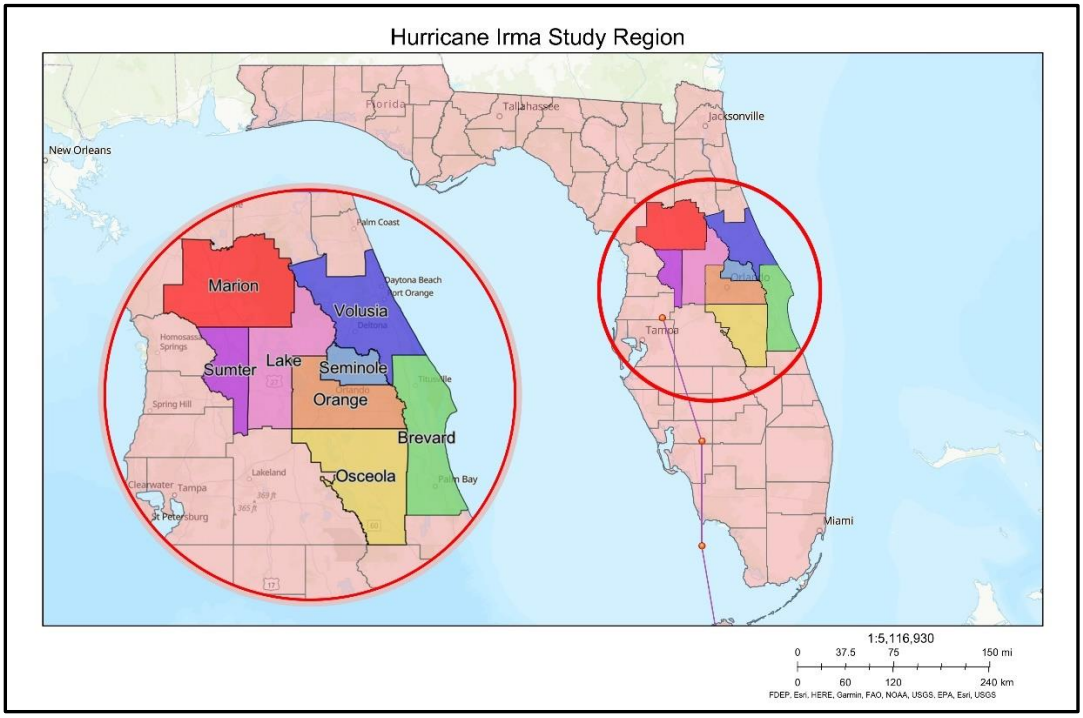


Figure 3.2: Hurricane Irma Study Region Map (8 Counties) [*Source: ARCGIS Online*].

For the data collection, we first created a list of 377 organizations (including county, regional, state, federal, international, and non-public sector) and searched their corresponding social media accounts (i.e., Twitter screennames or IDs). The names of the agencies and their county-wise Emergency Support Functions (ESFs) were then manually collected from a 'Content analysis codebook'(*49*).

Content Analysis Codebook and ESFs

The Content Analysis Codebook was collected from Dr. Naim Kapucu and Ratna Okhai from the School of Public Administration, UCF (*49*). This codebook was utilized to ensure that the list of local agencies used for this thesis is exhaustive and consistent throughout the data

analysis and visualization process. In addition, this codebook included a listing of which agencies performed similar core functions and served particular purposes. (e.g., ESFs). The codebook extensively analyzed Comprehensive Emergency Management Plans (CEMPs) to extract the essential descriptive information of agencies contained within the documents, as well as any similarity factors. (i.e., the same response transaction for an ESF) (*49*). Any agencies listed inside this codebook that reflect ESFs for social media engagement purposes were then added to the dataset for this thesis.

The federal ESFs are governed by the FEMA National Response Framework, which specifies 15 functions that must be considered during disasters (*8*). The State of Florida, however, has an additional 3 ESFs in addition to these 15. Although FEMA has designated 15 core ESFs, state and local agencies have flexibility in dividing ESFs further as long as these 15 support functions are reflected in their plans. The State of Florida has 18 functions, for example, where local law enforcement is kept apart from military support, animal protection is included, and volunteers and donations are separated from mass care. For purposes of comparison, the state ESFs were used in this thesis for designating the agencies in the dataset, but certain county-level agencies (that had ESFs past #18) were also included due to their significance (for example, local agencies with ESF #19: Damage Assessment).

Collecting Historical Tweets and Twitter Attributes

Twitter gave us access to its historical archive known as 'Search tweets v2' archive (*50*) through its academic research program. Using Twitter's API credentials, we searched for the tweets posted by 377 agencies during the one-month period of Hurricane Irma (30th August 2017 to 30th September 2017). A total number of 70,262 tweets were collected from 299 agencies out of the initial 377 agencies. Tweets could not be found for the rest of the 78 agencies due to

reasons such as the Twitter profile was created after the hurricane period or the Twitter profile did not post any tweet during that time period. Among these 299 agencies, there were 42 federal, 21 national, 44 state, 161 county, 1 federal-state-county, 21 regional, and 9 other types of agencies. Therefore, the total number of local (county and regional level) agencies was 182. Here 'federal' indicates U.S. government agencies under the federal government, 'national' indicates all other agencies that have a national presence, and 'regional' indicates all agencies that have presence across the East Central Florida region. The overall percentage of verified profiles was only 39% (118 organizations out of 299). For each tweet posted by an agency, this dataset contains the tweet text and the number of likes, replies, and retweets. These collected tweets include retweeted tweets by the profiles besides their original tweets, and the retweet count for those tweets was associated with the source tweet. Using Twitter API, we also collected the attributes of these agency profiles, including the counts of their friends and followers.

Data Filtration

For the Data Filtration, the keywords of 'irma', 'hurricane', and 'storm' (case insensitive) were applied on the primary dataset of tweets. After removing duplicate tweets, 13,353 tweets related to Hurricane Irma were found. For comparison purposes, in addition to the agencies from East Central Florida region, we considered federal/national, state, international, and other levels of organizations.

Analyzing Twitter Attributes

To understand overall activities and reach of an agency in Twitter, we first analyzed the basic attributes of their Twitter profiles. By Twitter attributes, we refer to the total number of followers, friends, tweets, retweets, likes, and replies. Followers count refers to the number of

users following a profile and Friends count refers to the number of profiles a certain user/profile is following. After collecting these attributes using Twitter API, the 299 organizations were sorted according to each of the attribute counts from the highest to the lowest. We plotted these counts in correspondence with the levels of agencies in a bar chart for each of the Twitter attributes and the percentage of verified Twitter profiles among the 299. The followers and friends counts are based on the time of our data collection period (April, 2022) but the other attributes (tweets, retweets, likes, replies) are based on the time period during Hurricane Irma. This is because the historical record of a tweet provided by Twitter does not contain the number of followers and friends at the time when the tweet was posted, rather it reports the current number of followers and friends when data query is made.

Applying Engagement Metrics

To measure the engagement of all levels of agencies beyond their individual-level Twitter attributes, we need an appropriate metric (*19*). We sought the literature to check whether any method had been used to measure social media engagement in related studies. Bonson and Ratkai (*51*) proposed a set of metrics to assess stakeholder engagement of corporate Facebook pages. These metrics included Popularity, Commitment, and Virality (*51*). Recently, Kankanamge et. al (*22*) utilized these three metrics to determine social media user Engagement (Facebook and Twitter) of three Australia-based organizations. Table 1 shows the metrics adopted in this study and the formula to calculate these metrics.

Table 1: Engagement Metrics to gauge engagement of local agencies, adopted from Kankanamge et. al (*22*).

Metric	**Formula**	**Significance**
Popularity (P)	$\frac{\frac{Total\ Number\ of\ Likes}{Total\ Number\ of\ Tweets}}{Follower\ Count}$ x 1000	Represents the attractiveness of the tweets posted by an agency profile through 'Likes'.
Commitment (C)	$\frac{\frac{Total\ Number\ of\ Replies}{Total\ Number\ of\ Tweets}}{Follower\ Count}$ x 1000	Represents deeper engagement of agencies with other users through 'Replies'.
Virality (V)	$\frac{\frac{Total\ Number\ of\ Retweets}{Total\ Number\ of\ Tweets}}{Follower\ Count}$ x 1000	Represents other users' interest in sharing the content of the tweets posted by an agency profile through 'Retweets'.
Engagement (E)	P + C + V	Represents the overall engagement performance of an agency profile through cumulative results of popularity, commitment, and virality scores.

In this study, we applied this simple formula on our dataset to gauge the Engagement Score (E) of the agencies. We first removed all the organizations who posted less than 10 tweets during the Hurricane Irma's period. Without this condition, the results would indicate some agencies as the most engaged ones even with one or two viral posts during the hurricane. Then, we also removed the agencies with zero followers, as required by the formula shown in Table 1. This led to the final 180 'active' agencies for the study. After that, the Popularity (P), Commitment (C), and Virality (V) scores were calculated applying formula given in Table 1. The P, C, and V scores were then normalized to be scaled in a range between 0 to 1 and compared. Otherwise, there were instances where one score was largely greater than the other two scores, resulting in Engagement Scores that were not comparable across agencies. After the

normalization, the final Engagement Scores (E) were calculated. The active agencies were then sorted according to their engagement scores from the highest to the lowest. Furthermore, we visualized which levels of government (federal/ national/ state/ regional/ county/ others) and sectors they belong to. Among the 180 active agencies, 101 were found to be local (county and regional). We determined which local agencies had the highest engagement scores and their corresponding ESFs.

Analyzing ESFs and Tweet Content

From the 180 active agencies, we determined which ESFs had been most frequently found on Twitter during Hurricane Irma. We also found out the most frequent ESFs among local agencies specifically. Finally, we analyzed the tweets shared by the most engaged local agencies during Hurricane Irma's period. From this manually observed content analysis, the most prominent topics and trends of tweets were determined. Moreover, the difference in the dynamics of tweet sharing among the topmost leading agencies was noted. This step shed light on which contents attract the most engagement from people in Twitter during a disaster situation. Having examples of these tweet contents from past disasters will allow emergency managers perform better in disseminating information during future disasters.

CHAPTER FOUR: RESULTS

General Observations on the Twitter Attributes

As mentioned in the previous chapter, the 299 agencies were sorted according to each of the Twitter attribute counts from the highest to the lowest and visualized in the form of bar plots demonstrating the levels of the agencies. For the convenience of visualization, among 299 agencies, only the top 50 agencies are shown in Figure 4.1.-4.7. We observe in Figure 4.1 that federal / national / international level organizations have a higher number of followers. It was also noted that all these leading Twitter profiles (in terms of followers count) are verified (Figure 4.2). A verified Twitter profile is more likely to have a large number of followers. However, in terms of total friends count (Figure 4.3), the regional and county level organizations are also as active as the federal/national and state level ones. Although local agencies have lower numbers of followers compared to the federal and national ones, they are active in following others in Twitter to establish an active communication network. As mentioned earlier, these followers and friends counts are from the current status of their Twitter profiles, not necessarily from the Hurricane Irma's period.

While analyzing the other Twitter attributes (total tweets, likes, replies, retweets from the Hurricane Irma's period), it becomes evident that beyond the federal/national and state-level agencies, several county-level and regional agencies are also leading in crisis information sharing (Figure 4.4). It is further noteworthy that although county and regional level organizations were very active in posting tweets, similar to the other levels of organizations, federal/national and state-level organizations seem to have higher numbers of retweets, replies, and likes (Figures 4.5-4.7). The only exception occurred in the case of City of Cape Canaveral-Government in terms of total retweet counts during Hurricane Irma, having the second highest

number of retweets among all the agencies. However, agencies from Orange, Osceola, and Brevard counties have appeared leading in all these four attributes in general.

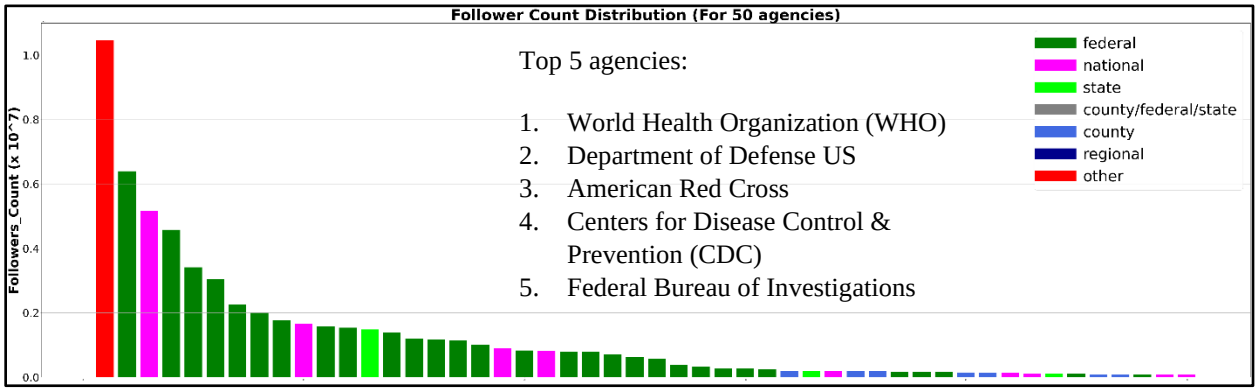


Figure 4.1: Distribution of the Number of Followers for 50 top agencies.

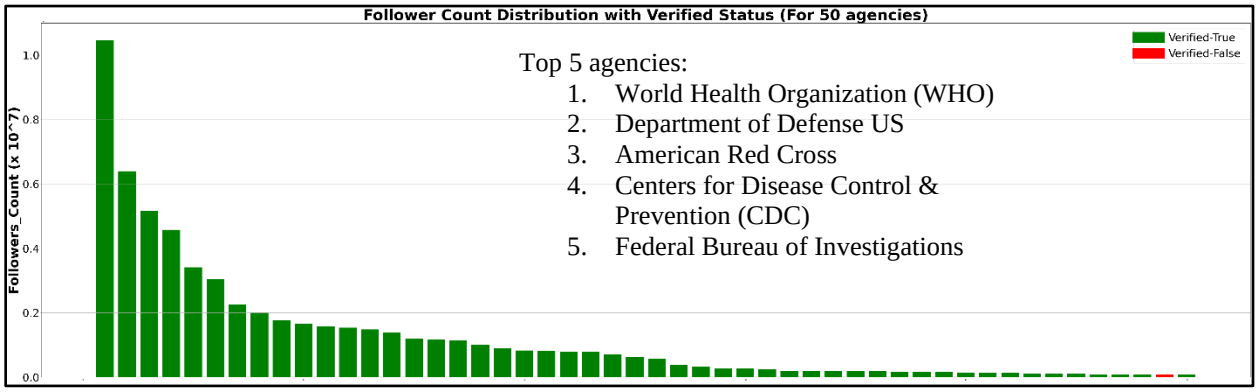


Figure 4.2: Distribution of the Number of Followers for 50 top agencies (with Verified Status)

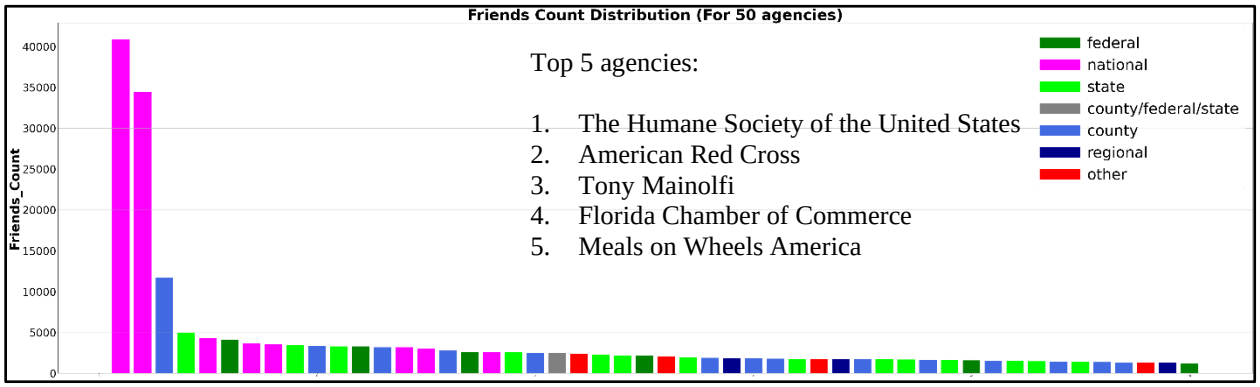


Figure 4.3: Distribution of the Number of Friends for 50 top agencies.

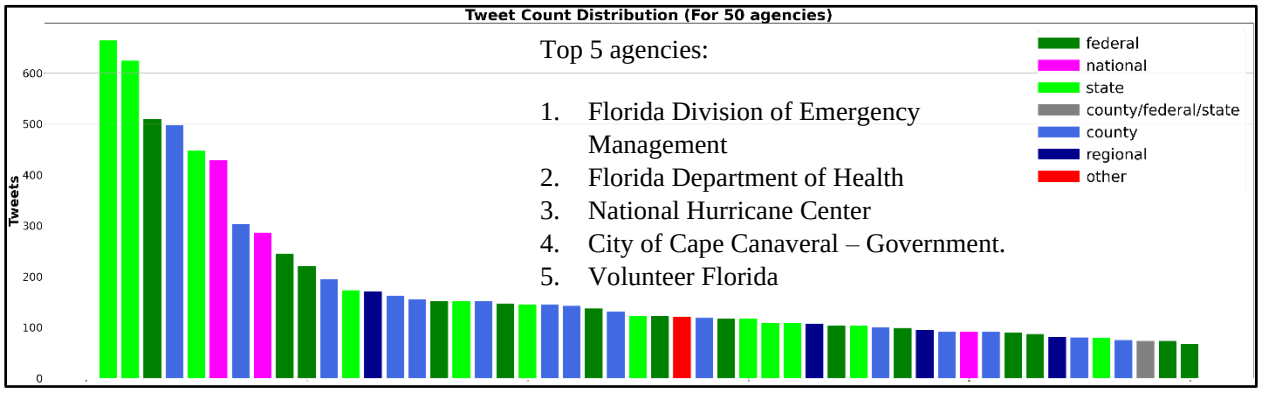


Figure 4.4: Distribution of the Number of Tweets for 50 top agencies.

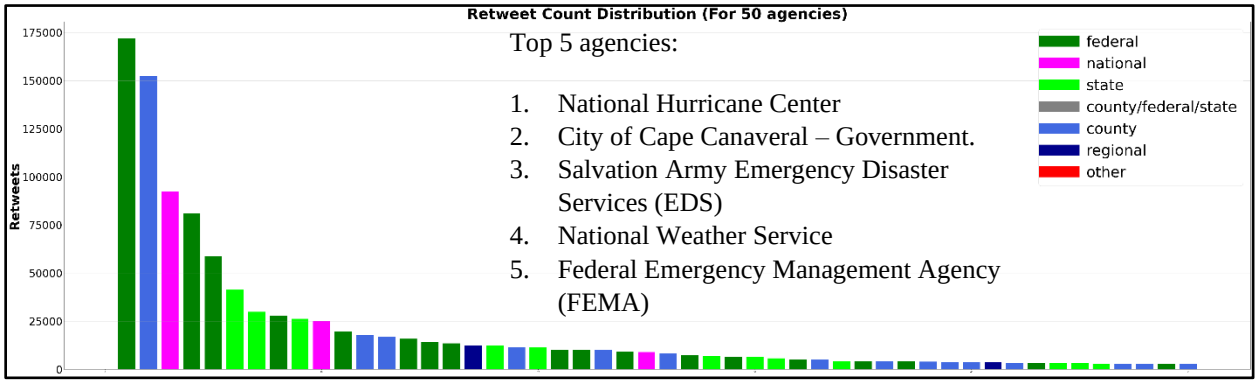


Figure 4.5: Distribution of the Number of Retweets for 50 top agencies.

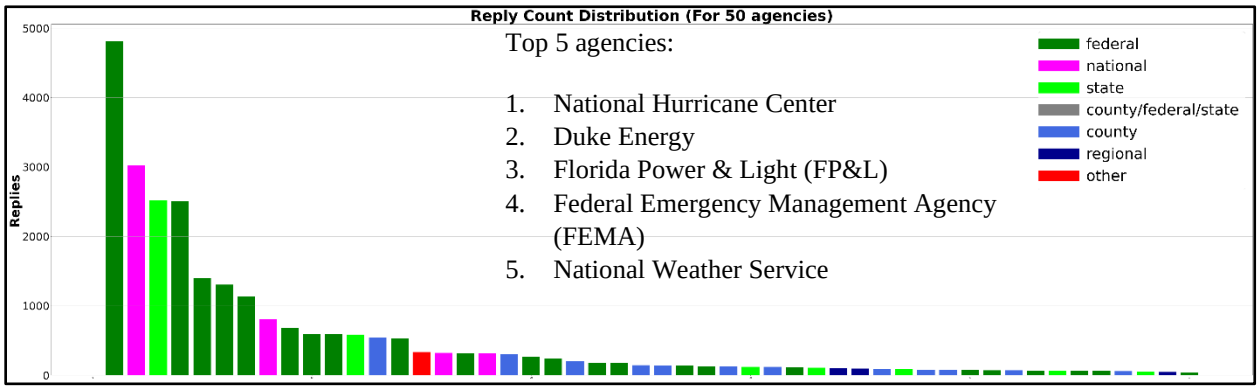


Figure 4.6: Distribution of the Number of Replies for 50 top agencies.

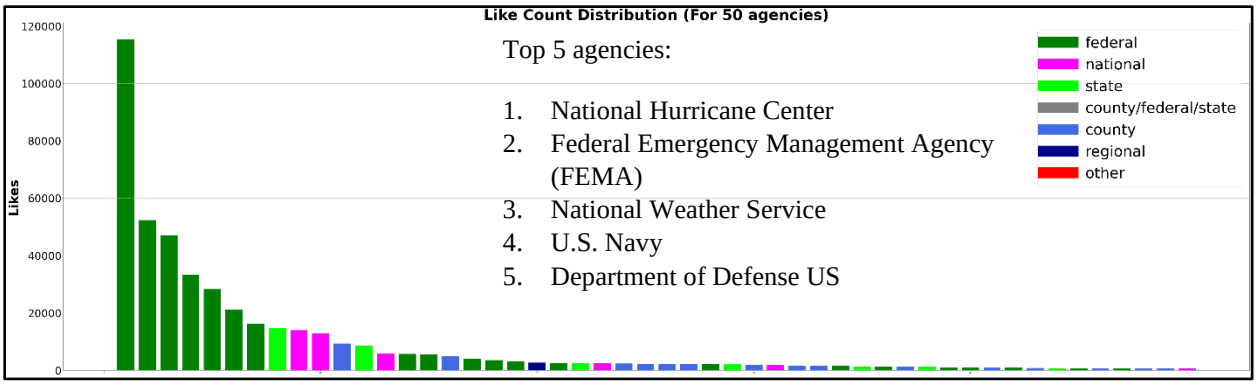


Figure 4.7: Distribution of the Number of Likes for 50 top agencies.

Engagement of Local Agencies

After applying the engagement metrics from Table 1 on the 180 active agencies, they were sorted from the highest to the lowest based on their overall engagement in Twitter (i.e., the Engagement Score, E). From the results, it was clear that local agencies such as the county-level and regional agencies were much more engaged in Twitter compared to the federal/ national/ state levels of organizations during the Hurricane Irma's period based on their Engagement Scores (E). Among these 180 agencies, about 49% (n=89) were verified profiles.

For the purpose of visualization, Figures 4.8-4.11 show only the top 50 active agencies according to the four engagement metrics (Engagement, Popularity, Commitment, and Virality), respectively. These results show that county and regional level agencies are leading in terms of not only the Engagement Scores, but also the other three metrics (Popularity, Commitment, and Virality), separately. Many agencies with a very high engagement score did not have a verified profile. This indicates that a higher engagement score is not necessarily associated with the verified status of a profile.

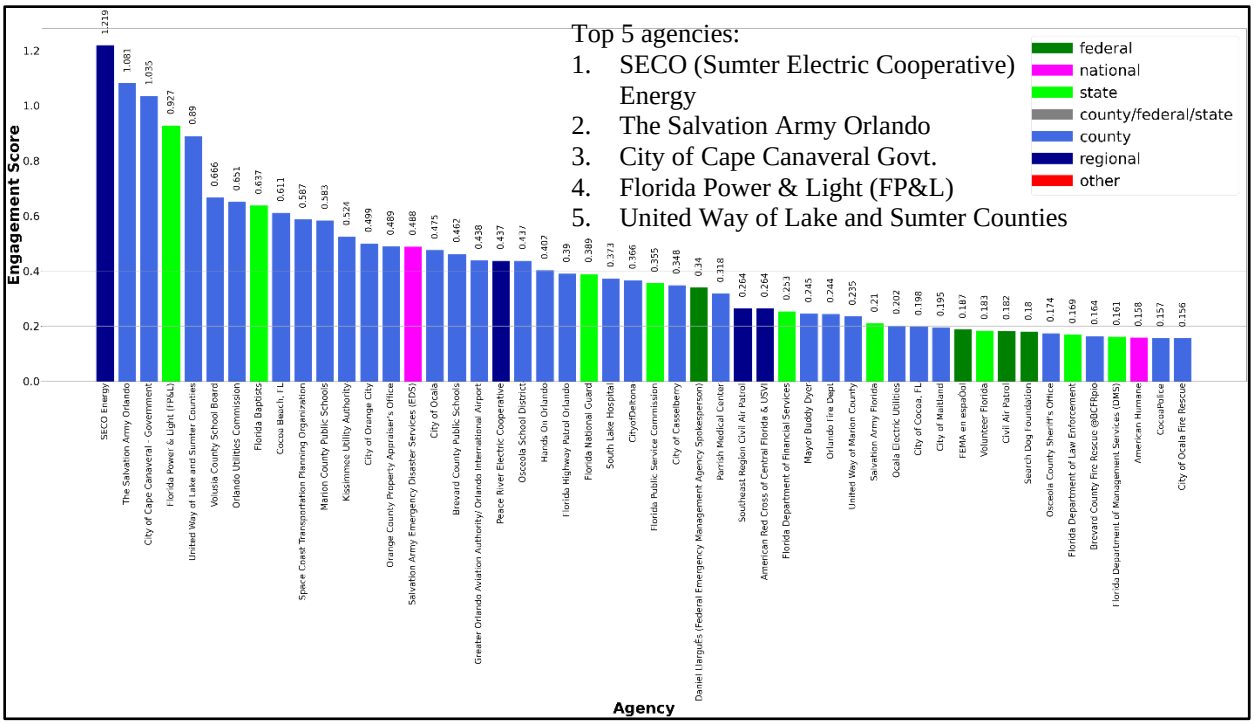


Figure 4.8: Engagement Scores of 50 active agencies.

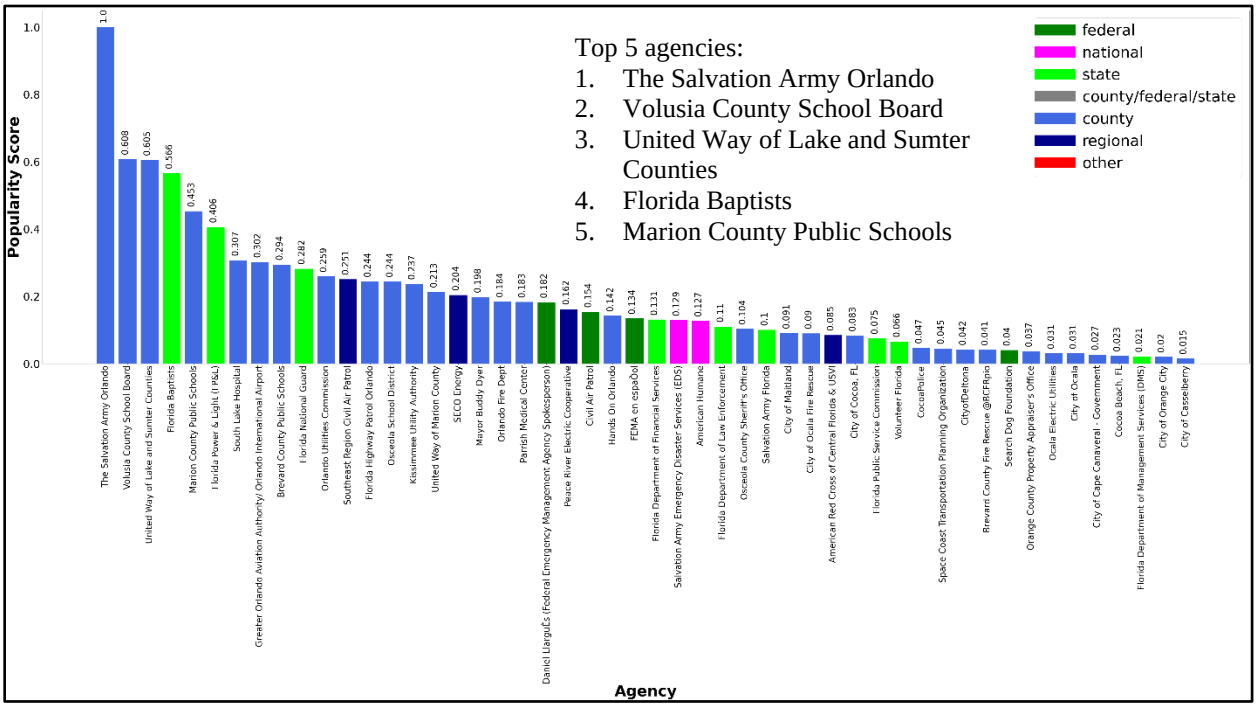


Figure 4.9: Popularity Scores of 50 active agencies.

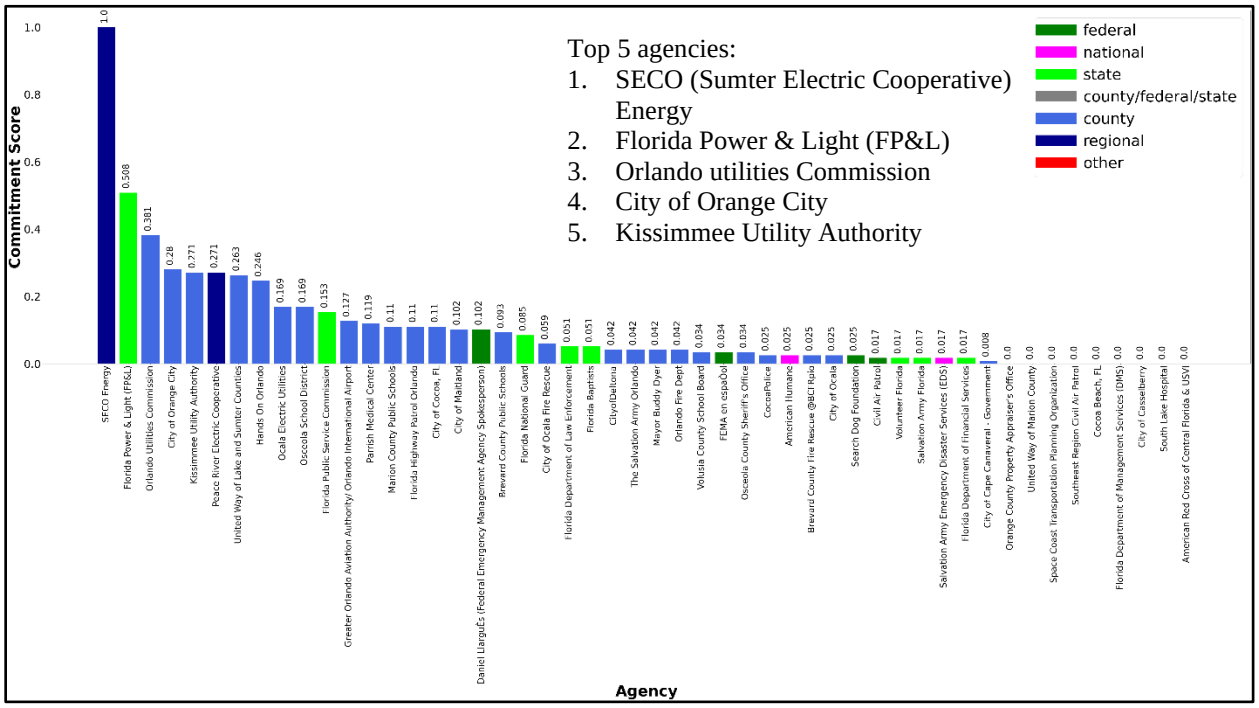


Figure 4.10: Commitment Scores of 50 active agencies.

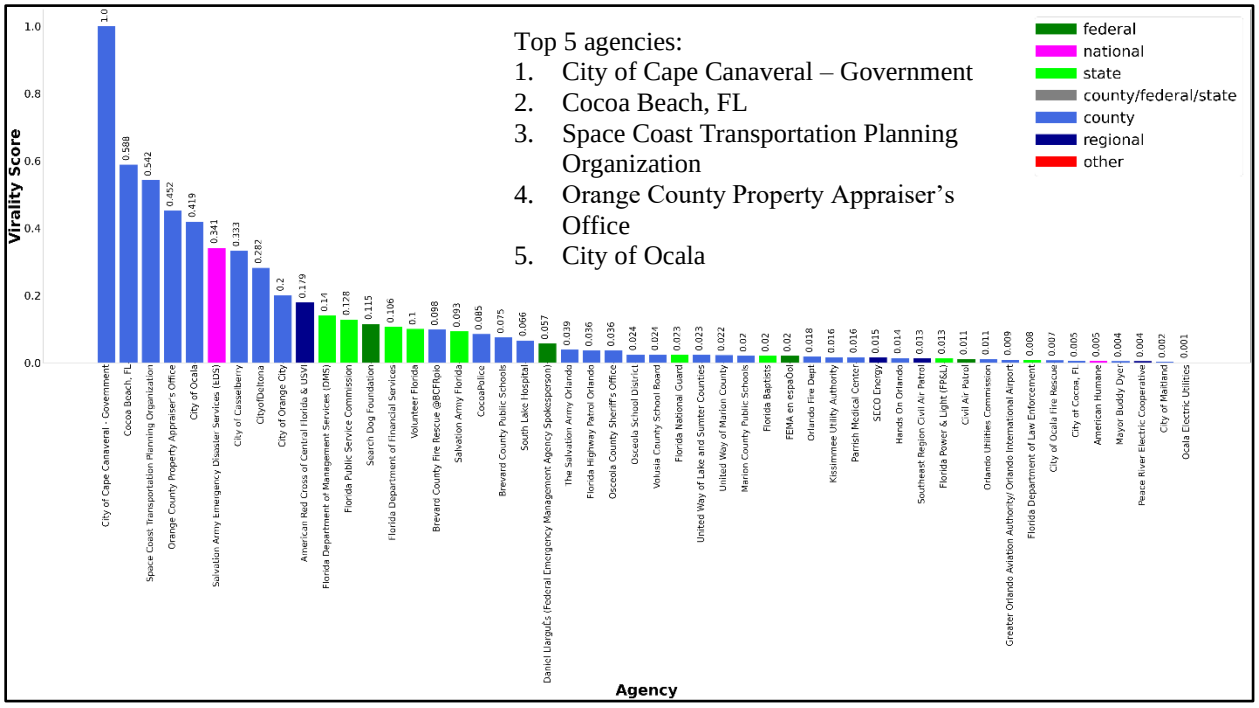


Figure 4.11: Virality Scores of 50 active agencies.

For comparison purposes, Figure 4.12 demonstrates which levels, counties, and sectors the 180 active agencies belong to. Among these active agencies, public agencies have a greater presence than non-profit ones. However, the results from the engagement metrics show that many of the non-profit agencies appear among the highest engaged agencies. Some of these non-profit agencies include SECO Energy, The Salvation Army Orlando, United Way of Lake and Sumter Counties, and Florida Baptists.

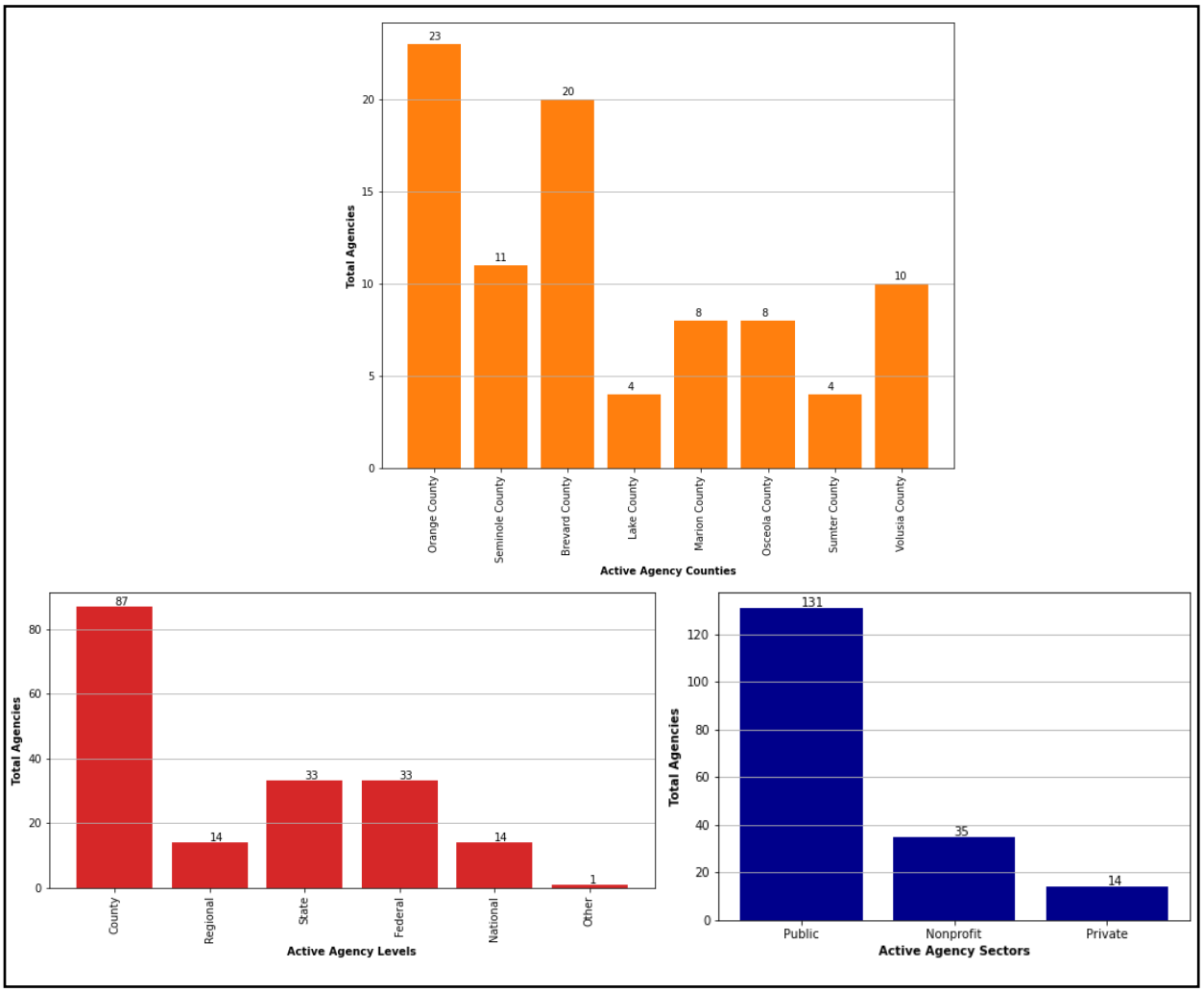


Figure 4.12: Number of agencies from different counties and their corresponding organizational levels and sectors among the 180 active agencies.

Table 2: Top 30 Local Active Agencies with respect to Engagement Score and corresponding ESFs

Agency Name	E	P	C	V	ESFs
SECO Energy	1.219	0.204	1.000	0.015	12
The Salvation Army Orlando	1.081	1.000	0.042	0.039	3, 6, 8, 10, 11, 15, 16, 19, 22
City of Cape Canaveral - Government	1.035	0.027	0.008	1.000	2,5,7
United Way of Lake and Sumter Counties	0.89	0.605	0.263	0.023	6, 11, 15
Volusia County School Board	0.666	0.608	0.034	0.024	19
Orlando Utilities Commission	0.651	0.259	0.381	0.011	3, 4, 8, 9, 10, 12, 20
Cocoa Beach, FL	0.611	0.023	0.000	0.588	2,5,7
Space Coast Transportation Planning Organization	0.587	0.045	0.000	0.542	1, 2, 5, 7
Marion County Public Schools	0.583	0.453	0.110	0.020	6
Kissimmee Utility Authority	0.524	0.237	0.271	0.016	3, 4, 8, 9, 10, 12, 18
City of Orange City	0.499	0.020	0.280	0.200	19
Orange County Property Appraiser's Office	0.489	0.037	0.000	0.452	3, 5, 19
City of Ocala	0.475	0.031	0.025	0.419	2, 5, 7
Brevard County Public Schools	0.462	0.294	0.093	0.075	1, 6, 11, 15, 19
Orlando International Airport	0.438	0.302	0.127	0.009	1, 14
Peace River Electric Cooperative	0.437	0.162	0.271	0.004	3, 4, 8, 9, 10, 12, 20
Osceola School District	0.437	0.244	0.169	0.024	1, 2, 6, 7, 11, 13, 15, 17
Hands On Orlando	0.402	0.142	0.246	0.014	15
Florida Highway Patrol Orlando	0.39	0.244	0.110	0.036	16
South Lake Hospital	0.373	0.307	0.000	0.066	8
City of Deltona	0.366	0.042	0.042	0.282	19
City of Casselberry	0.348	0.015	0.000	0.333	8, 10
Parrish Medical Center	0.318	0.183	0.119	0.016	6, 8
Southeast Region Civil Air Patrol	0.264	0.251	0.000	0.013	4, 6, 9, 13, 19
American Red Cross of Central Florida & USVI	0.264	0.085	0.000	0.179	1, 2, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19
Mayor Buddy Dyer	0.245	0.198	0.042	0.004	2, 5, 7
Orlando Fire Dept	0.244	0.184	0.042	0.018	4
United Way of Marion County	0.235	0.213	0.000	0.022	6, 11, 15
Ocala Electric Utilities	0.202	0.031	0.169	0.001	12, 19
City of Cocoa, FL	0.198	0.083	0.110	0.005	2,5,7

Table 2 presents a list of the top 30 local agencies (among the 180 active agencies) in terms of their engagement scores and their ESFs. Some of the most prominent leading local agencies include **utility agencies** (SECO Energy, Orlando Utilities Commission, Kissimmee Utility Authority), **charity-based organizations** (The Salvation Army, United Way of Lake and Sumter Counties), **city governments** (City of Cape Canaveral – Govt., Cocoa Beach, FL, City of Orange City), and **county school boards** (Volusia County School Board, Marion County Public Schools).

Table 3: Statistical Values of the Four Engagement Metrics

Engagement Metric	Maximum	Minimum	Mean	Median	Standard Deviation
Popularity (P)	1	0	0.077	0.038	0.123
Commitment (C)	1	0	0.039	0.013	0.099
Virality (V)	1	0	0.042	0.008	0.113
Engagement (E)	1.219	0	0.158	0.084	0.212

Table 3 gives a basic statistical perspective of the metric values derived from the engagement analysis. It can be immediately noted that despite the maximum values of P, C, and V metrics being 1 individually, the maximum value of engagement (E) for the 180 agencies is 1.219. It refers that a lot of agencies might not have performed equally high in terms of all three metrics (Popularity, Commitment, and Virality) separately. From table 2, we can find such instances as well. For example, Space Coast Transportation Planning Organization has a high overall engagement (E) score of 0.587 with a high V score of 0.542, while the P score is very low (0.045) and the C score is 0.

Here it should be mentioned that for this thesis, the ESFs following the definitions given by Florida State and the 8 counties found in the Content Analysis Codebook (*49*) were considered. Moreover, while assigning an ESF to an agency the following assumptions were made:

(a) While Twitter accounts represent the exact regional 'sub-agency' that is providing the information, many of the Comprehensive Emergency Management Plans (CEMPs) do not specify those exact regional sub-agencies. For instance, the "Salvation Army" was mentioned across multiple county CEMPs across a range of different ESFs, but the precise regional offices that are active on Twitter might not have been specified in the CEMPs. However, tweets originate from specific accounts, which, in this case, might have been from a regional sub-agency of the Salvation Army (e.g., 'The Salvation Army Orlando'). Therefore, this thesis included the ESFs that reflected the overarching agency (e.g., Salvation Army) mentioned in the CEMPs as the ESFs of the 'active' regional sub-agency on Twitter.

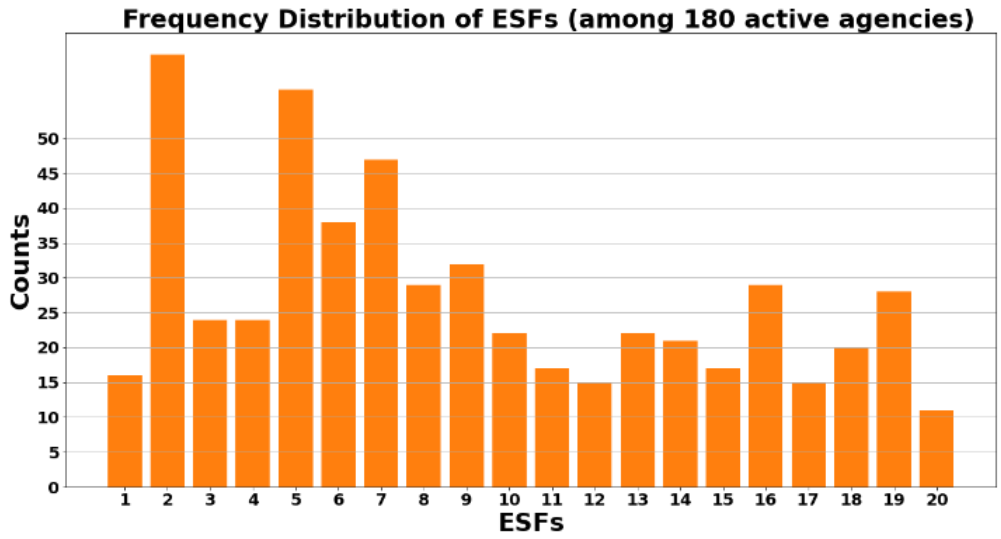
(b) While counties follow a standard format when developing CEMPs for possible emergencies and crises, they also have the flexibility to include as much or as little information as they see fit. In this instance, there is a notable variation in the ESFs under which similar types of agencies are utilized in various counties. For example, the ESFs for the school boards of the various counties are often different from each other because the CEMPs of each county utilize the school boards for diverse purposes. Therefore, the dataset of active Twitter agencies used for this thesis may contain a variety of school boards with distinct ESFs, as each county's CEMPs designated these distinct ESFs for their school boards.

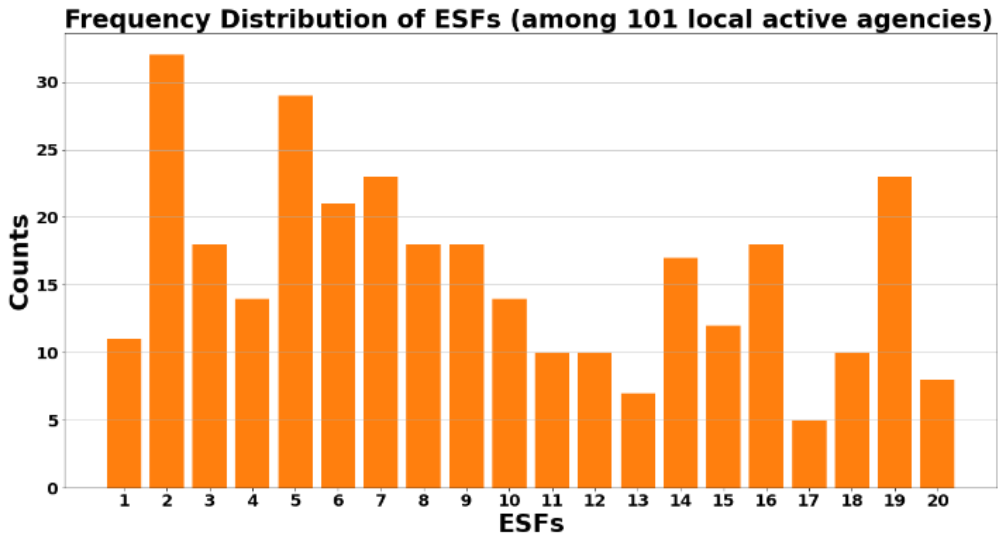
(c) There are some discrepancies between the CEMP and Twitter agency lists because social media is often a complementary communication strategy to other existing ones. Hence,

there are naturally certain agencies and/or sub-agencies that are designated for this specific mode of strategy. For those specific agencies which are found as active during the disaster on Twitter, but not reflected in the CEMPs (e.g., some charity agencies, specific city profiles, Mayor's office profile, news media profiles, etc.), the 'general' ESFs that highlight communication (#2), information and planning (#5), mass care (#6), and logistical/resource support (#7) have been utilized.

Frequency Distribution of the Emergency Support Functions (ESFs)

We determined which ESFs were most frequent during Hurricane Irma's period among the 180 active agencies and among 101 local (county and regional level) agencies (Figure 4.13). Figure 4.13 shows that ESF #2 (Communication) was the most frequent while considering all 180 active agencies during Hurricane Irma's period. ESF #5 (Information and Planning), #6 (Mass Care), and #7 (Resource Support) were also prominently active. Similarly, when it comes to the 101 local active agencies, ESF #2 (Communication) was still the most frequent one. Besides ESFs #5, #6, and #7, ESF #19 (Damage Assessment) was also highly frequent. These findings answer the third research question about how the Emergency Support Functions (ESFs) are correlated with the engagement of the local agencies on social media platforms when it comes to crisis communication. This can further support what type of crisis information is most sought after on social media such as Twitter.





ESF Legends			
ESF 1: Transportation ESF 2: Communication ESF 3: Public Works ESF 4: Firefighting ESF 5: Information and Planning ESF 6: Mass Care	ESF 7: Resource Support ESF 8: Health and Medical ESF 9: Urban Search and Rescue ESF 10: HazMat ESF 11: Food and Water ESF 12: Energy	ESF 13: Military Support ESF 14: Public Information ESF 15: Volunteers and Donations ESF 16: Law Enforcement	ESF 17: Animal Protection & Agriculture ESF 18: Business and Economic Stabilization ESF 19: Damage Assessment ESF 20: Public Utilities (Orange County)

Figure 4.13: Most Frequent ESFs during Hurricane Irma.

Analyzing the Tweet Content of the Most Engaged Local Agencies

To understand the types of tweet contents that may have contributed to a higher engagement score of the local agencies, we investigated their highly retweeted posts. Some of the noteworthy observations and tweet examples are demonstrated in Figures 4.14-4.17.

Figure 4.14: Tweets posted by the most engaged Utility related local agencies in the study region during Hurricane Irma.

Figure 4.14 shows that among the utility-related local agencies, SECO Energy gained most engagement from users through retweeting a post from NWS (National Weather Service) Tampa Bay. They also posted some original tweets, but these tweets did not gain much engagement from the users. On the contrary, Orlando Utilities Commission (OUC) was active during different stages of Hurricane Irma and posted original tweets regarding public contacts, water/ electric outage reports, restoration, and repairs. They also conveyed support, gratitude, and positivity to the users through their tweets. All their original tweets had gained significant engagement from the users. Among the charity-related local agencies, the Salvation Army Orlando also posted many original tweets throughout the hurricane period regarding topics of hurricane preparation, the personnel working in emergency management, recovery crew, and providing meals at different places (Figure 4.15).

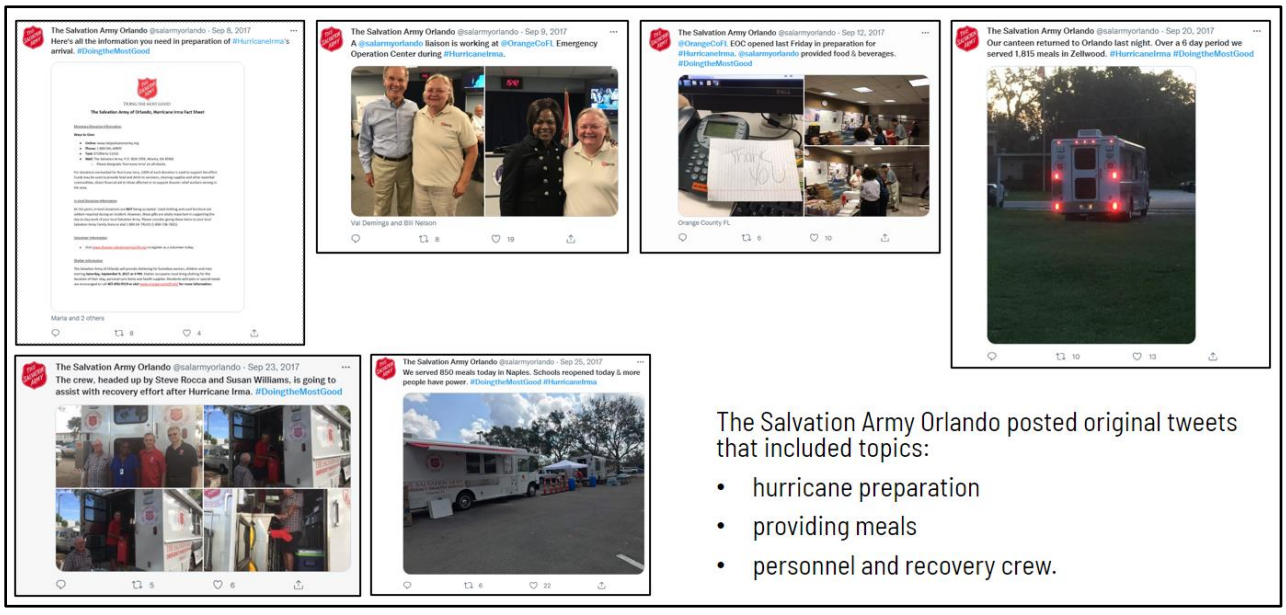


Figure 4.15: Tweets posted by the Salvation Army Orlando during Hurricane Irma.

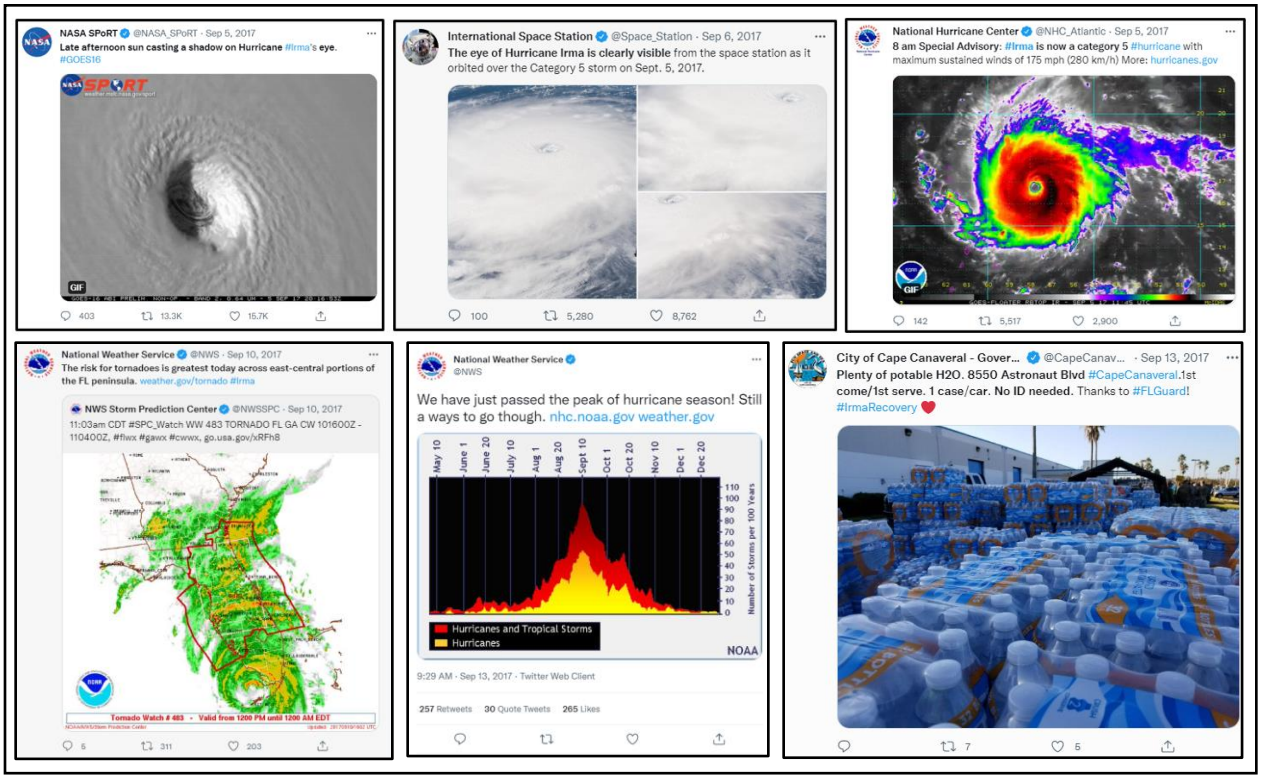


Figure 4.16: Tweets posted by the city government profiles during Hurricane Irma.

Some city government profiles (City of Cape Canaveral – Govt., Cocoa Beach, FL, City of Orange City) retweeted posts from federal/national and state agency profiles (Figure 4.16) to gain attention from the users. Even though some city profiles posted some original tweets (e.g., City of Cape Canaveral's water supply related tweets), these did not gain much attention as the retweeted tweets.

County School profiles (Volusia County School Board, Marion County Public Schools) mostly engaged through original tweets regarding class operation times, shelter information, voluntary work, free resources, hurricane updates, etc. (Figure 4.17).

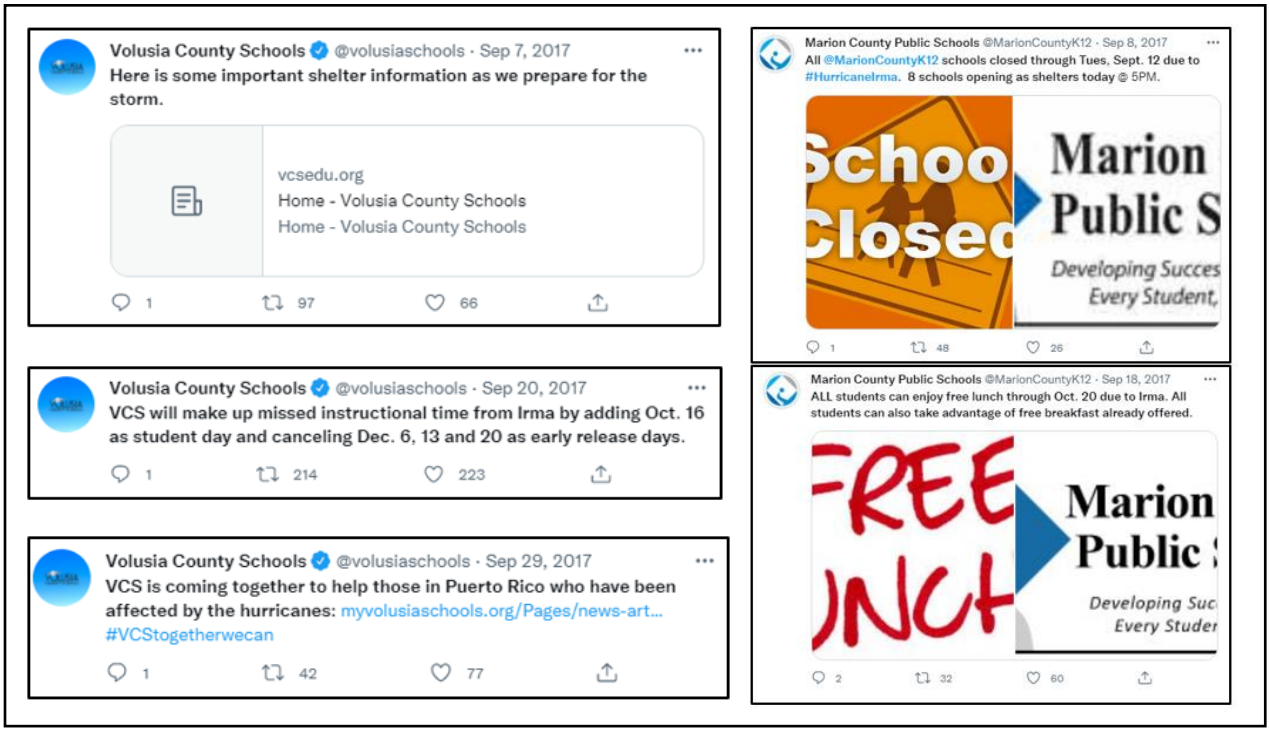


Figure 4.17: Tweets posted by the county school profiles during Hurricane Irma.

CHAPTER FIVE: DISCUSSIONS

Local Agencies and Social Media-based Crisis Communication

Despite the overall increase in the usage of social media in the context of crisis communications by organizations, there remain questions regarding the efficiency of their shared contents on these platforms during natural disasters, especially at a local level. As local agencies are the immediate emergency management contacts of a community when a disaster strikes, it is important to understand the significance of their roles beyond federal and state level agencies during these disasters. Therefore, the engagement of their social media crisis-communication posts must be analyzed both in a qualitative and a quantitative way to see whether they are utilizing these platforms in the best possible manner to reach people during these times. The engagement metric used in this study has been utilized in previous studies to assess the social media contents of certain public agencies. However, to the best of our knowledge, it has not been yet adopted in case of crisis communication posts of local agencies. Analyzing the Twitter attributes of the profiles of these local organizations, along with the results found from the application of engagement metrics on their tweets posted during Hurricane Irma, we report some important insights. Analyzing the Twitter attributes of the profiles, we found that federal/national, and state level organizations had higher numbers of followers. However, many of the local agencies had a high number of friends count indicating that they are as active as the well-known federal/national and state level agencies in following Twitter profiles for building a network on the platform. Although county and regional level agencies were very active in posting tweets similar to the other levels of agencies, the numbers of retweets, replies, and likes were generated more for the federal/national and state level agencies due to a higher number of followers. Another important finding was that agencies with a high number of followers had

verified Twitter profiles. Hence, it is suggested that county-level and regional agencies should receive a verified status from Twitter to generate more followers and gain more attention to their posts. Furthermore, a verified status will allow these local agencies to counteract misinformation during a disaster and to boost their overall engagement with public in terms of other Twitter attributes such as number of retweets, replies, and likes. However, the verified status of the profiles did not seem to have any influence on the engagement scores of the leading agencies. From the engagement metrics, we observed that local agencies were more engaged in Twitter during Hurricane Irma compared to other levels of organizations not only in terms of the Engagement score, but also in all three other metrics (Popularity, Commitment, and Virality). These findings provide evidence that the local agencies of the East Central Florida region play a substantially significant role in terms of social media-based crisis-communications during a natural disaster besides the federal and state level agencies by engaging with people and bolstering community resilience.

Most Engaged Local Agencies on Twitter During Hurricane Irma

When major natural disasters cause severe damage, it often overwhelms the capacity of local emergency management agencies, and it becomes difficult for them to provide updates and/or respond to community members individually. Hence, it is highly beneficial to identify agencies which can provide timely and correct information to people during a disaster through social media platforms. This refers to our first research question: *Which local agencies are leading in disseminating crisis information during a disaster in social media?* By implementing the engagement metrics, we were able to determine the 180 active agencies and further filter top local agencies in terms of the engagement scores. From the results, it was observed that despite

the non-profit agencies being only 35 in number among the 180 active agencies, they appeared frequently among the topmost 10 active agencies. Some of these local agencies include SECO Energy, the Salvation Army Orlando, and United Way of Lake and Sumter Counties. However, private agencies did not appear much among the topmost engaged agencies. Studies should be conducted on why these agencies lagged behind in terms of engagement with people during Hurricane Irma compared to public and non-profit agencies. Further research can focus on these private profiles for other disasters to confirm whether these results are consistent during each crisis, and if so, the underlying reasons should be analyzed. Therefore, by implementing this simple engagement metrics on the tweets posted by local agencies during different disaster contexts, local emergency managers can know which specific agencies to reach out to during a future disaster in order to convey correct information to more people in a short time through Twitter. Additionally, people can get the most reliable updates of the situation in their region by following these local agency profiles. Furthermore, these local agencies can build a network among themselves and boost public trust by sharing information through each other's profiles.

Performance of Agencies Along Three Dimensions of Engagement

While measuring the overall performance of a social media post, the most important factor is to analyze 'how' exactly people are engaging with the content. The methods of engagement include, but are not limited to, features such as likes, comments, retweets, etc. These dimensions indicate different levels and types of engagement that a post extracts from public. The engagement metrics used in the study consider these different dimensions of engagement and convert them into a quantitative score. The results included Popularity (P), Commitment (C), and Virality (V) scores of the local agencies, where the P, C, and V scores represent how the

local agencies have engaged in terms of likes, replies, and retweets respectively during the hurricane period. This answered the second research question: *How to measure engagement activities of local agencies in social media for effective crisis communication?* By knowing the performance of their profiles in each of these three metrics, agencies can be aware of their shortcomings in terms of their crisis communication posts on Twitter. For example, some of the highest engaged local agencies in Table 2 have a C score of zero (e.g., Cocoa Beach, FL). This suggests that these agencies should focus on improving their 'commitment' to the public during a disaster by engaging with them through replying to their tweets. On the other hand, it was noted that utility-related agencies had a higher C score (e.g., SECO Energy, Orlando Utilities Commission) which reflected the fact that people tend to engage more through the reply section when there are concerns regarding utility disruption during and after a disaster. Therefore, to improve overall engagement with the people and boost public trust, agencies should look more closely at their tweets in terms of all the three dimensions of the engagement metrics. Moreover, they should enhance the quality of their posts and engagement by utilizing existing strategies from literature regarding guidelines, lessons, and key features of social media-based crisis communication posts (as discussed in Chapter Two).

Correlation Between the Frequency of Active ESFs and Engagement of Agencies

Apart from identifying specific local agencies' profiles on social media platforms, it is also important to be aware of the Emergency Support Functions that are most frequently active on these platforms in terms of crisis communications. Having that knowledge allows local emergency managers to delegate tasks and updates faster through social media to people as they would know which agencies are disseminating the similar types of information. This refers to our

third research question: *How are the Emergency Support Functions (ESFs) associated with the engagement of agencies active in crisis communication posts?* ESFs #2 (Communication) was found to be the most frequent ESF while considering both the 180 active agencies and the 101 local active agencies. From Table 2, it is apparent that ESFs #2, #3, #4, #5, #6, #7, #10, #12, and #19 appeared frequently among the topmost local active agencies. However, we observe that some of the important ESFs appeared less frequently among the active agencies, including ESF #1 (Transportation) and ESF #17 (Animal Protection & Agriculture). Future research should investigate whether the agencies related to these ESFs are less active on Twitter. Similar research should also be done for other disasters to see if there is any change in the frequency of these ESFs among the active agencies.

Content of the Most Engaging Tweets During Hurricane Irma

Social media contents that gain greater engagement from people during a disaster can serve as lessons for preparing for future events. From the tweet content analysis of this study, it was found that retweeted posts from well-known federal/national and state-level organizations, such as National Hurricane Center, FEMA, and National Weather Service, contributed to a higher number of overall engagement of the profiles. This, again, might be since these profiles are verified and have a large number of followers. Although some utility, charity, and school-related agencies made some original posts that gained attention (e.g., Orlando Utilities Commission, the Salvation Army Orlando, and Volusia County School Board), many of the leading local agencies retweeted posts from federal/national and state-level organizations to gain more engagement from users. Many of these retweeted posts contained warnings about the hurricane path and information about hurricane preparation, along with images and animated

gifs. Besides getting their profiles verified in Twitter, local agencies can post more original tweets containing visual information to gain more engagement from the users. The results further showed that utility- and school-related agencies shared information concerning infrastructure (power, educational operations, etc.) disruptions and gained more engagement as people want to stay updated on the restoration and recovery process. Future research should systemically identify the key features and guidelines followed in these highly engaged tweets from this profiles and emergency managers can utilize those further in crisis-communication posts during future disasters.

CHAPTER SIX: CONCLUSION

Summary

This thesis presents the results of an exploratory analysis of the local agencies from eight counties of the East Central Florida Region on the engagement of their crisis communication posts in a social media platform. Although the focus was on local (county and regional level) agencies, we also considered federal, national, state, and other levels of agencies to compare the significance of the roles of local agencies in bolstering crisis communication in social media. The primary aim was to have a quantitative analysis to gauge the overall engagement of the agency profiles and find out correlating ESFs. We also undertook a qualitative approach to provide preliminary insights on the role of Twitter profile attributes and tweet contents on engagement metrics. Method and analysis demonstrate the critical role of collecting, organizing, and disseminating relevant information using crisis communication strategies in a timely manner from trusted sources for effective disaster response coordination.

The results show that local agencies were highly engaged in Twitter through their crisis communication posts during Hurricane Irma compared to other levels of agencies. The engagement metrics specified which local agencies were leading according to their Engagement, Popularity, Commitment, and Virality scores. These results will help local emergency managers to determine which Twitter profiles can provide the highest engagement with the public and disseminate information faster during a disaster. Moreover, having the knowledge of the most frequent Emergency Support Functions (ESFs) can further help in determining which group of local agencies may post same types of crisis communications. Additionally, the Popularity, Commitment, and Virality scores of the agencies can shed light on which aspects of communication need further improvements. Allowing local agencies to have this information

will improve the content of their crisis communication to local communities. These efforts can provide opportunities for emergency managers and partner agencies to develop new social media strategies and practices to further improve emergency management at local levels.

Limitations and Recommendations

This study has some limitations. We considered only one disaster (Hurricane Irma) and one social media platform (Twitter). Our results could vary for other hurricanes or other disasters such as the COVID-19 pandemic. Future research should consider multiple disasters to test the validity of our findings across different types of disasters and to obtain insights on which agency profiles should be followed during a specific type of disaster situation. Another limitation was that due to the limitations of Twitter API, the number of followers and friends of the agencies could not be extracted from Hurricane Irma's period. Therefore, when applying the engagement metrics, the current numbers of followers were used. It should be considered that the number of Twitter users has increased significantly over time. According to the official Twitter statistics, the total number of daily monetizable active users is currently 217 million, whereas it was only 110 million by the end of the year 2017 (the year of Hurricane Irma). Hence, it is recommended that future research collects and analyzes Twitter data immediately following an event as the historical data may not reflect the current follower counts of profiles.

Furthermore, some of the agencies were found to be active on Twitter but not found on the Content Analysis Codebook for which general ESFs (such as #2, #5, #6, and #7) were applied. Moreover, a limitation was that we could not determine the number of retweets an agency gained from their own followers when retweeting a post of a well-known agency. As such the specific contribution of an agency to the number of retweets is unknown. If the

information was available from Twitter on how many retweets an agency attained by retweeting a post, beyond what the source agency has attained, the corresponding engagement metric could be calculated more accurately.

In this study, we manually reviewed the contents of the highly retweeted posts. Future research can develop advanced machine learning models (e.g., topic models) to obtain quantitative insights on the prevalent topics during a disaster. Moreover, cross-sector partnerships among different local agencies on social media platforms should be analyzed to understand how their networking patterns are influencing the engagement of their crisis communication posts.

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