

5-2016

# Partners for the Future: Emergency Management and Technology

Alexandra L. Huston

Follow this and additional works at: <http://digitalcommons.apus.edu/theses>



Part of the [Emergency and Disaster Management Commons](#)

---

## Recommended Citation

Huston, Alexandra L., "Partners for the Future: Emergency Management and Technology" (2016). *Master's Capstone Theses*. 138.  
<http://digitalcommons.apus.edu/theses/138>

This Capstone-Thesis is brought to you for free and open access by DigitalCommons@APUS. It has been accepted for inclusion in Master's Capstone Theses by an authorized administrator of DigitalCommons@APUS. For more information, please contact [digitalcommons@apus.edu](mailto:digitalcommons@apus.edu).



## APUS Library Capstone Submission Form

This capstone has been approved for submission to and review and publication by the APUS Library.

Student Name [Last, First, MI] *	Huston	Alexandra	Leigh
Course Number [e.g. INTL699] *	EMDG699	Paper Date [See Title pg.]	June 2016
Professor Name [Last, First] *	Charter, Michael		
Program Name *	Master of Emergency and Disaster Management		
Keywords [250 character max.]	Emergency Management, Information Technology		
Passed with Distinction * Y or N	Y		
Security Sensitive Information *	N		
IRB Review Required * Y or N	N		
Turnitin Check * Y or N	Y		

If YES, include IRB documents in submission attachments.  
All capstone papers must be checked via Turnitin.

\* Required

### Capstone Approval Document

The thesis/capstone for the master's degree submitted by the student listed (above) under this title \*

PARTNERS FOR THE FUTURE: EMERGENCY MANAGEMENT AND TECHNOLOGY

has been read by the undersigned. It is hereby recommended for acceptance by the faculty with credit to the amount of 3 semester hours.

Program Representatives	Signatures	Date (mm/dd/yyyy)
Signed, 1 <sup>st</sup> Reader * [capstone professor]		08/07/2016
Signed, 2nd Reader (if required by program)		
Recommendation accepted on behalf of the <u>program director</u> *	<i>Terri L. Wilkin</i>	8/10/16
Approved by <u>academic dean</u> *	 <small>Digitally signed by mriccardi@apus.edu DN: cn=mriccardi@apus.edu Date: 2016.09.05 19:22:13 -06'00'</small>	

\* Required

A Master Thesis  
Submitted to the Faculty  
Of  
American Public University System  
by  
Alexandra Leigh Huston  
In Partial Fulfillment of the  
Requirements of the Degree  
of  
Master of Arts  
June 2016  
American Public University  
Charles Town, WV

The author hereby grants the American Public University System the right to display these contents for educational purposes.

The author assumes total responsibility for meeting the requirements set by United States copyright law for the inclusion of any materials that are not the author's creation or in the public domain.

© Copyright 2016 by \_\_\_\_\_ (Alexandra Leigh Huston)

All rights reserved.

## TABLE OF CONTENTS

CHAPTER	PAGE
I. INTRODUCTION.....	1
II. LITERATURE REVIEW.....	5
The Negative Impact of Missing Technology.....	5
Radio Frequency Identification Technology.....	6
Dual Use Technology.....	7
Datamining in Social Media.....	9
Information Sharing.....	11
Real-Time-Data Technology.....	12
Emergency Management Decision Support Software.....	13
Unifying Technology and Emergency Management.....	14
Information Communication Technology.....	17
III. THEORETICAL FRAMEWORK/APPROACH.....	18
Stress-Strain Theory.....	18
Socio-technic Theory.....	19
Unified Theory of Acceptance and Use of Technology.....	19
IV. Research Design/Methodology.....	22
Discovering Emergency Technology.....	22
Determinants of Technological Applications.....	23

	Information Criteria and Limitations.....	23
V.	Findings/Results/Discussion.....	26
	Purpose of Research.....	26
	Application of to the Information Technology.....	27
	Beneficial Opportunities for Emergency Management.....	44
	Key Determinants.....	47
	Suggestions and Conclusions.....	51
VI.	References.....	53

ABSTRACT OF THE THESIS

PARTNERS FOR THE FUTURE:

EMERGENCY MANAGEMENT AND TECHNOLOGY

by

Alexandra Leigh Huston

American Public University System

Charles Town, West Virginia

This research explores the relationship between emergency and disaster management and information technology. Information technology has the ability to improve the capabilities of emergency and disaster management, but has not been fully operationalized within the field. This research explores the information technology that holds potential to be applied to emergency and disaster management operations. The research examines the factors that influence the determination to utilize these technologies within the field to determine the influential determinants to adapt for the allowance of development and growth for information technology in emergency and disaster management.

## Partners for the Future:

### Emergency Management and Technology

Emergency and Disaster Management and Information Technology are both fields that have an acute focus on the current state of the world and the unmet requisites that are present within the world. Over the decades the world has seen an increase in the volume and magnitude of disaster scenarios; these scenarios range from man-made threats to disasters caused by nature. The more frequent and severe the threat is the greater the potential for loss of human life and monetary capital. The potential for damage and loss when emergency and disaster management abilities are strained or unprepared can be witnessed by viewing tragedies like the Indian Ocean Earthquake and Tsunami (Rodriguez, Wachtendorf, James, & Trainor, 2006) or Hurricane Katrina (Hutchins, Annulis, & Gaudet, 2008). The loss of life in both of these instances due to a lack of preparation and resources demonstrates the importance of efficient and effective emergency and disaster management. These occurrences have brought further attention to the development of the field of emergency and disaster management over the years. The advancements this focus has brought can be witnessed in instances such as the creation of the Federal Emergency Management Agency. Yet, there is potential for further development into the field of emergency and disaster management.

The modern world has transitioned to an era of technological growth that offers a veritable cornucopia of developments and opportunities. Santos, Borges, Canós, & Gomes (2011) stated, "Information technologies are not adequately exploited by emergency response organizations, especially those with limited resources (p.594)." Instances such as the Indian Ocean Tsunami and Earthquake demonstrate that the partnership between emergency management and information technology is underdeveloped and has created a potential turbulent

environment for the introduction of more efficient and productive methods to address the classic and emergent threats that ominously loom all over the world. This turbulent environment can be seen in the struggle for the adoption of information technologies within the field of emergency and disaster management. When this implementation of information technology does occur the methods are not widely adopted by other emergency and disaster centers and there is no wide-ranging uniformity in systems that are applied to emergency and disaster management centers to create ease of interoperability between centers and agencies (Santos et al., 2011). The field of emergency and disaster response is often found to be skeptical and reluctant to adopt new methodologies to address change and include information technologies that are being developed into the plans for the future. There are a variety of technological advances that could prove to be useful and valuable in all of the stages of emergency and disaster management. Emergency and disaster management does not operationalize the immense amount of technological opportunities present within the world or that have the potential for being developed to be further utilized to prevent and recover from disasters.

In the field of emergency and disaster management the best practices and procedures are in a constant state of flux due to constantly changing state of the environment and the needs created by this shift from an emergency management perspective. Time has shown that technology can offer the opportunity to assist in predicting these shifts for disaster responders to help make an impact before the actual event even occurs. Researchers have seen the positive impact that occurs when utilizing technology in the creation of early warning systems for several types of disasters; this can be observed with the early warning systems utilized to monitor for hurricanes and evacuate individuals to lessen the loss of life. The central issue is that technology offers the opportunity for so much more than simply detecting patterns and this opportunity is

one that is not taken advantage of by the whole of emergency and disaster managers. This impact has the potential to be expanded further in emergency and disaster scenarios by utilizing further technology in emergency mitigation, response, and recovery; the research conducted for this paper will demonstrate several different types of technology that have the potential to be applied to emergency and disaster management. Technology has yet to be utilized to its full potential on a uniform basis for emergency and disaster management.

One portion of the research provided in this paper explores the developments within Information Technology that can be tailored to meet several needs within emergency and disaster management operation. The information technology explored in this research varies in nature and purpose, but all of the technologies explored in this research can offer the opportunity for emergency operation centers to create a more efficient environment and the potential to utilize this to create a positive impact within emergency and disaster management. The information technology explored can be applied to a wide range of areas from managing decision making to improving intelligence gathering practices; this provides the support that information technology has the potential to be integrated into several practices within emergency and disaster management. This research is essential to the field for providing vital information to emergency managers on the wide variety of information technologies that can be applied to their operation centers to increase effectiveness and efficiency. The ability to be conscious of the available information technology and understand the information technology that can be applied to emergency and disaster management is only one part of the need; the other portion of this research focuses on factors that influence the determination of whether or not to utilize information technology within operations. The knowledge of these factors provides an

opportunity to understand opportunities for improvement when integrating information technology into the operations of emergency and disaster management

There are several outside factors can influence the decision to determine the utilization of information technology in the various stages of emergency and disaster response; these influential factors can either positively or negatively impact this determination. The following research explores the advancements in cutting edge technology that are available to be applied to the field of emergency and disaster management, but also to discover what limitations and dysfunctions are presently inhibiting the use of technology in emergency and disaster management. There are internal and external factors that aid in the determination of the application of information technology in emergency and disaster management. These factors can vary from social factors to the technology's user interface. Exploring these functions and dysfunctions should allow for the determination of key factors supporting and limiting the expansion of information technology in emergency and disaster management.

This research will first explore a variety of the advances within information technology that have the capability to be applied to emergency and disaster management; gathering this data will lay the foundation for developing an understanding of how these applications can support operations within emergency and disaster management to expand the capabilities of humankind. The research will then focus on the determination of the main factors that influence the potential application of information technology in emergency and disaster management. This research will seek to answer two questions. What are some of the technologies that are available to be applied to emergency and disaster management? What factors are influential in the adoption of information technology into emergency and disaster management? Santos et al. (2011)'s explores how emergency and disaster management practices do not implement information

technology to its fullest ability, sometimes to the detriment of their region. The research sets out to prove that information technology has the ability to create more efficient and effective operation for emergency and disaster manager; this research will demonstrate that cost, ease of use, technological availability, and social influence are influential factors in the application of technology in emergency and disaster management.

### **Literature Review**

Information technology has seen tremendous growth over the years and every year it continues to expand further. Information technology crossing into the boundaries of emergency and disaster management was an inevitable future that has become more of a reality with the continuation of time. Emergency and disaster managers must be willing to adapt and form new realities with these developments or the consequences could be detrimental to those they are meant to protect, which can be seen as the case in Zhou's (2014) research study reviewing the severe detrimental impact a lack of adoption of information technology in emergency and disaster has created for those affected by disaster in China. Zhou (2014) identifies how the use of information technology in understanding emergency logistics has the potential to assist in several areas in emergency and disaster management. Information technology in emergency logistics could be utilized to examine areas of emergency and disaster planning and mitigation that need addressed, such as emergency material supply. Zhou (2014) even examines how emergency logistics has the potential to be utilized to pinpoint the areas of need brought on by disaster in the response and recovery phase. The researcher reflects that a majority of the improvements required within the present system of emergency and disaster management can be met with employing emergency and disaster management logistics technology and this would vastly improve the response during times of disaster, but also the management of resources during

times of non-disaster. This demonstrates the need for technology that could better track and help determine appropriate allocation of resources with emergency and disaster management. The research study highlights the desperate need of technology to help determine essential factors when preparing, responding, or recovering from a disaster.

Renken, Jackman, & Beruvides (2014)'s article reviews how Radio Frequency Identification Technology has the potential to be applied to the different stages of emergency and disaster management. The first portion of the article examines characteristics of emergency and disaster management by reviewing how the formation of FEMA changed the face of emergency and disaster management. According to Renken et al. (2014), the foundation of FEMA formulated four main objectives: to reduce life loss, to minimize property damage, to lessen the impact of disaster on the environment, and to protect the region from all potential hazards and threats. These objectives are carried out during the phases of emergency and disaster response and the article reviews how Radio Frequency Identification Technology has the ability to assist in maintaining these objectives.

Renken et al. (2014) demonstrates how Radio Frequency Identification Technology is comprised of tags with antennas, readers for the tags to send and receive radio signal, the middleware to facilitate data transfer, and finally the applications that are used to have the data transferred can be identified and utilized. The technology is comprised of few parts, so it is more simplistic in nature. Despite its simplistic composition Radio Frequency Identification Technology can be applied to disaster management in several different methods. Renken et al. (2014) explained how Radio Frequency Identification Technology can be utilized in times of disaster response by tagging blood transfusions to ensure informational accuracy and ease of usage in times of need; another example was the use of medical tags to help identify and make

medical information readily available. This application of Radio Frequency Identification Technology is utilized in Texas for the Special Needs Evacuation Tracking System (SNETS) program to help monitor individuals with special needs during times of evacuation and relocation, as well as making their health information readily available. Renken et al. (2014) also demonstrated methods in which Radio Frequency Identification Technology can be applied to preparation and recovery for disaster scenarios by using tags to track the location of essential materials and items for emergency and disaster management. The article also mentions how the tags could be utilized in the recovery process to make structural information on affected structures more readily available to workers.

The usage for Radio Frequency Identification Technology in emergency and disaster management are detailed in this article as one of the many suggestions for the potential that information technology has to offer the field of emergency and disaster management. The article demonstrates a few examples of how this technology has been utilized in real world scenarios and has shown successful outcomes. Radio Frequency Identification Technology has attracted interest over the years and has become an affordable and reliable option for the utilization of technology in emergency and disaster management.

Underwood's (2010) article focuses on another area of information technology that is being developed with the potential to be applied to emergency and disaster response. The article focuses specifically on dual use technologies that are utilized during times of disaster to help understand the situation or ensure this information can be shared with available communication technologies. The article explains how information technology is vital in the processing of data, but a move towards incorporating citizen and first responders has the potential to improve data reception and process timing. Dual-use technology offers the opportunity to allow the everyday

citizen to provide first hand data and knowledge on current emergency and disaster scenarios. Underwood's (2010) article stated, "During peaceful times, dual-use technology, such as mobile phone, operates as an everyday communication device, but during an emergency it transforms into an information sensor and disseminator (p.1)" demonstrates the validity and importance of dual-use technology. One developing technology that is explored in Underwood's (2010) article is Calit2, which is a notification system that utilizes speech recognition to allow citizens to call in to report incidents or citizens can listen about incident information that is pertinent to their inquiries. The content is user regulated and essential information about incidents can be sent directly to users in text or automated calls. Calit2, which is currently being utilized in California, has experienced success in being able to provide data information directly from those affected by emergency and disaster or by those witnessing emergency and disaster without any time delay or red tape. This content has the potential to be utilized further in emergency and disaster management and it has the potential to be easily expanded due to its low cost and ability to be scaled to meet any situation.

Underwood (2010) examined another emergency technology that is being developed in California by a company called ImageCat in partnership with the government; the technology is a virtual disaster viewer. This new technology can gather information remotely using satellite images, from satellites already in existence, to allow users to assess an area after disaster strikes. The system itself is open to the public as well as researchers, which also allows the public to add information to the system. ImageCat has the possibility to be expanded into further uses that could support humanitarian efforts with satellites from other countries that could potentially be utilized, with the proper approval, in times of extreme emergency and disaster.

Underwood (2010) explored another technology that is currently in use for the humanitarian organization UNICEF; this technology, given the name Bee, is a communication system built for field work that employs dual-use technology. This technology is utilized on sites of disasters where the infrastructure that offers support to communications is unstable and unusable. Bee provides access to Wi-Fi for special applications to assist with the work required in the disaster region, as well as telephonic services that allow for swift communication during emergency scenarios that require an immediate response. This is done through Bee's open source telecommunications system and allows for those working in unstable regions to have a form of communication.

Emergency and disaster management depends on communication and data to assist in making the immediate and difficult decisions required during times of emergency and disaster; the technology examined in Underwood's (2010) article offered opportunities to allow for quick data gathering and communication/information sharing in regions and times of disaster.

Xu, Zhang, Sugumaran, Choo, Mei, & Zhu's (2016) journal article demonstrates the importance of involving citizens and the information that is readily available through current technology into the field of emergency and disaster management. The article examines how emergency management software systems have the potential to improve through the implementation of modern data processing techniques. Currently emergency and disaster management struggles with efficiently processing all the data that is available and determining what information is pertinent to the scenario Xu et al.'s (2010) article offers the solution in terms of data extraction to discover necessary information that can be applied to emergency and disaster scenarios.

The information sources from which the data extraction would occur are pre-existing, popular social media sites for the region that has been affected. According to Xu et al. (2010) these social media sites offer a large opportunity for information extraction through datamining and this information has the potential to be applied to all four stages of emergency and disaster management. Geospatial application has been widely utilized in the various stages of emergency and disaster management. For example, this information can be utilized by disaster planners to understand areas at risk when planning for mitigation; these systems can even be utilized to exercise plans for response and recovery during times of non-disaster.

During times of disaster social media operates as an information bank that allows individuals to input their data about the disaster and even add images to support this. Xu et al. (2010) examined that studies on emergency and disaster management focus on three main points: the spreading of information on social networks, the subtraction of geographic location information, and semantic analysis. When utilized to the fullest potential datamining can offer information to provide situational awareness in a timely manner and can be utilized to provide data for damage information and requests for assistance.

Xu et al. (2010) found three layers when utilizing social media to perform successful datamining: social layer, crowdsourcing, and spatial information layer. The social layer is utilized to collect data about an emergency event that has occurred. The crowdsourcing layer discovers address and geographic information systems mine the data from social message. The spatial information layer offers the spatial information that has been minded for the emergency event. This is done by using keyword searches within social media; datamining in this fashion allows for researchers to create and understand a timeline of events during the emergency. Media information, like videos and images, can be used to reconstruct the event to determine points of

weakness or to help identify persons of interest. Researchers can also determine things such as risk perception by the volume of social media posts and can help in knowing which locations need various types of assistance. Social media offers a series of opportunities that have yet to be fully tapped by the emergency and disaster community. Social media as a platform for datamining and information sharing could be put to many uses in the field of emergency and disaster management.

Information sharing is a main focus for a portion of the technological advancements focused on improving emergency and disaster management. Marincioni's (2007) research focuses on the topic of utilizing technology for information sharing in emergency and disaster management; he believes that information within emergency and disaster management is improperly disseminated, which stunts potential growth within the field. The research focuses on the information technology that has the capabilities to aid in the dissemination of information around the globe and explores cultural influences on the willingness to utilize technology in emergency and disaster management.

Marincioni's (2007) article introduces a number different technological advancements and the potential these hold for the future of emergency and disaster management. One focus point directed to information technology that offers individuals the opportunity to experience and explain disaster from a distance with virtual reality. The distance education and training opportunities for emergency and disaster management are just one of the advancements the article highlights that technology creates the ability to bring to fruition. These two technological advancements make it possible to offer more detailed and advanced training for emergency and disaster management professionals in times of peace. An added benefit to these two technological advancements is the possibility for information sharing about experiences and

methods with other emergency and disaster professionals. Information sharing is vital to the growth of emergency and disaster management, but the ability to take this knowledge and make split-second decisions during times of peril is another important piece of emergency and disaster management.

Römer, Kersten, Kiefl, Plattner, Mager, & Voigt, (2014) explores the utilization of information technology to gather near-real-time data to support individuals making decisions based off information that is offered at this increased pace. Römer et al. (2014) explores how near-real-time data can be gathered with the utilization of unmanned aerial vehicles to provide support in a variety of situations in both non-disaster and disaster scenarios. To utilize this type of information technology to gather information during times of crisis there will be two portions to the technology: an image processing chain and web applications and services that offer the ability to accept and disseminate the information that has been gathered (Römer et al., 2014). The article explores the ability to utilize this information in traffic for large public events and emergency and disaster scenarios. Römer et al. (2014) stated, “In the VABENE project, an innovative and comprehensive end-to-end-system has been developed, designed to collect and visualize situational and traffic-related information in case of public events and disaster situations (p. 683).” Many of the technologies that are required for running a system like this have been developed further in recent years due to their increased application, especially in Germany where VABENE was created.

Near-real-time data gathered by aerial vehicles offer a unique vision of the emergency and disaster scenario that cannot be attained with satellites. Satellites provided visuals from moments in time, but are not continuously in frame. Information Technology that supplies near-real-time data from aerial vehicles offers the ability to show a continuously flow of information

(not just one frame) to gather a better concept of situational awareness. There are a few systems present within emergency and disaster management that have tapped into near-real-time data using unmanned aerial vehicles; these systems are Geo-Intelligent Collaborative Decision Support System for Real-time Disaster and Emergency Management and NASA's Autonomous Modules Scanner (Römer et al. 2014). According to Römer et al. (2015) the Autonomous Modules Scanner can be utilized to detect wildfires in regions of potential danger.

The issues with utilizing unmanned aerial vehicles to gather near-real-time data are largely due to a lack of exploration of the further application of this type of information technology. Römer et al. (2014) cited other issues for the utilization of this information technology as follows: the unmanned aerial vehicles are highly sensitive to weather, the payload for the unmanned aerial vehicle is limited, and there are limited monitoring systems that capture data continuously for unmanned aerial vehicles. One issue that is unconnected to this is the concerns due to privacy issues in regards to data. If this technology receives further support and exploration in the future many of the technological concerns could be addressed to create an increasingly stable product that could be utilized in emergency and disaster management to gather data at a fast pace for emergency managers.

The Jennings, Arlikatti, & Andrew (2015) article delves into discovering the usage of information technology to aid in decision-making within emergency and disaster management. Emergency Management Decision Support Software allows for emergency and disaster managers to utilize multiple sources of information to gather awareness of a situation. According to Jennings et al. (2015) this ability to gather information from multiple sources increases improved decision-making by reducing the uncertainty that often surrounds emergency and disaster scenarios. There are several products on the market for Emergency Management

Decision Support Software; the two main products mentioned in the article are E-Team and WebEOC (Jennings et al., 2015).

WebEOC and E-Team are Emergency Management Decision Support Software that each maintains their individual characteristics to bring support in decision-making capabilities to emergency and disaster management according to Jennings et al. (2015). The two systems combine data derived from multiple sector organizations and allow for emergency managers to generate situational awareness reports in a timely and accurate manner. E-Team distinguishes itself by identifying as a system that helps facilitate emergency and disaster response by aiding emergency managers with incident management. The article describes how E-Team promotes incident management by providing multiple agencies with a unified idea and frame for the set of operations being undertaken and by also providing resource management support for these teams. WebEOC is distinguished for the safety software the system offers and the application of this software can be utilized to enhance incident management for both public safety agencies and emergency and disaster management by creating a common mission and vision to strive towards. WebEOC also helps facilitate cross-agency resource management support.

Amaye, Neville, & Pope's (2015) research focuses directly on the need for a common language and interoperability for emergency and disaster management; the research acknowledges that while there have been a multitude of developments in the study of the application of information technology to emergency and disaster management, there has been little focus on improving the common language and interoperability of these resources to receive optimal results. Amaye et al. (2015) examines the field of emergency and disaster management as a multidimensional field that has several faucets that require attention and direction to operate at their optimal capacity.

The focus on understanding the different capacities that information technology assist with emergency and disaster management is essential to understanding the developments within the field that promote interoperability and flexibility due to disaster region information flowing in at an accelerated rate than was previously not possible. Amaye et al. (2015) stated, “Extant research highlights distinctive approaches for the use of technology through middleware systems, crisis informatics based on social media platforms, and emergency management information systems (EMIS) that integrate KMS and DSS functions to assist in communication coordination and decision making (p.4).” The different information technology systems can be applied to all of the various stages of emergency and disaster management to ensure that the field is utilizing technology that allows operation at optimal capacity.

Amaye et al. (2015) explores the different components for optimal functioning emergency and disaster management organizations in hopes to better understand the systems and their purposes. The first component explored by Amaye, Neville, & Pope (2015) is that the organization has a firm plan in place and they have the ability to document these functionalities to build a decision model; the decision models three components should be as follows: document processes are being utilized in the correct capacities; capabilities and potential hazards from the local community are being integrated, and applying the previous lessons learn from other sectors and past experiences.

The next key component that is considered essential is the application of information technology through incident management systems (Amaye et al., 2015). The incident management systems are put in place to assist in making decisions as well as to identify and utilize resources that are available. Amaye et al. (2015) showed the following as elements that incident management systems assist with in disaster: the management is based around the

capabilities that are available, adaptability, the structure of the organization is able to be flexible during times of emergency or disaster, the activities carried out by the organization are functions based of needs in emergency or disaster conditions, and finally the command is ruled with unity.

The next essential component for optimal functioning emergency and disaster management organizations is operational facilities that focus in on the available capabilities that can be offered and understand and value the importance of multi-agency collaboration (Amaye et al. 2015). Multi-agency cooperation requires information sharing and the utilization of information communication technologies to ensure that all agencies are operating with one unified operating picture. Emergency operation centers are responsibility for providing this unified system and coordinating these efforts to ensure the different components of emergency and disaster response are being applied to the correct areas and not duplicating any actions unnecessarily. “The importance of these centers in the EM domain cannot be overstressed as they become the nexus for communication technology, planning, multi-agency response and strategic level decision making serving in all phases”(Amaye et al., 2015, p.17).

The final component to be considered is a functional framework that brings together all of the collaborative technologies (Amaye et. al., 2015). The application of information technology in emergency and disaster management is a useful tool that allows for the expansion of human capabilities far past the traditional possibilities before information technology. Emergency and disaster management agencies that are operating at optimal capacity with the use of information technology should have a framework in place to ensure the various technological components can function and work together to ensure effectiveness in the dynamic content. Emergency and disaster managers are responsible for ensuring there systems can meet the needs of the community they are meant to serve and have the ability to be flexible as required to meet

needs during times of duress. Interoperability is a key component and need to ensure successful emergency and disaster operations.

Interoperability, flexibility, and improvisation are essential to understanding and adapting to a common mission and goal in emergency and disaster management. The conflict of combining efforts from multiple agencies can create communications and operation issues. Mendonca (2007) focuses his article on the examination of Information Communication Technology and the individual to exhibit flexibility and to fulfill the requirements of disaster response. Information Communication Technology, which offers the ability to become adaptable in disaster scenarios, can be tailored to address a variety of disaster scenarios. The ability to successfully stray from the normal routine with a seamless transition is essential when considering the extreme variations in effect and need during a disastrous occurrence. The article argues that the technology utilized for emergency and disaster response would be utilized more effectively if it were made task-free. "Theories of task-technology fit seek to provide prescriptive guidance about which computer technologies are best suited to supporting particular tasks (Mendonca, 2007)." Technology of this nature has the potential to be fitted to the multiple scenarios for a variety of usages to ensure the best use of the technology is taken advantage of during times of peril. These systems are meant to enhance the interoperability of the organizations in their collaborative efforts. Emergency managers and personnel must also be flexible within their roles and responsibilities for facilitating interoperability during the response. The article suggests the employment of functionally diverse equipment to link agencies together during times of disaster for optimal interoperability. These technological advancements offer progressive methods for handling emergency and disaster scenarios, but this does not guarantee the systems will be utilized within the field by emergency managers. The key is to gather an

understanding of the factors that determine the utilization of information technology in emergency and disaster management.

### **Theoretical Framework/Approach**

There are several theories that have been formulated to help examine and explain the adoption of information technology. These theories can be applied in different settings and to different technologies to assist in grasping the social implications of actions and reactions. When examining the field of emergency and disaster management there is no one particular theory that the utilization of technology has been examined under, but there are several theories that can be adjusted from other disciplines and applied to this concept. Researchers have proposed that this lack of a unified theory for the application of information technology in emergency and disaster management is an issue and inhibits the gathering of a full and unified understanding of the issues that emergency and disaster managers experience. The theories reviewed for this research that can be applied to examine the use of technology are, Stress-Strain Theory, the Unified Theory of Acceptance and Use of Technology and the Sociotechnical Theory. These varying theories can be applied to the decision to utilize information technology within emergency and disaster management to help better understand the determining factors.

The theoretical perspective of Stress-Strain focuses on the environment within an organization and the hierarchical systems that require constant bargaining to maintain organizational integrity and development. Stress-Strain can be utilized to understand the sociological reasoning of why some emergency managers choose to adopt information technology. According to Marincioni (2007) the stress-strain theory is a collective conversation with members bargaining with one another to maintain the integrity and growth within emergency and disaster management. Often during bargaining decisions will be made with the

idea of maintaining or adding to the prestige of an organization. This system of bargaining demonstrates the influence a collective voice can have on the potential to adopt or reject the inclusion of information technology within emergency and disaster management.

The Sociotechnical Systems Theory proposes the perspective that to achieve optimal outputs and success, individuals and technology must work in unison to ensure the goal of lessening the loss of life, physical capital, and monetary capital is met during times of emergency and disaster. According to Kim Sharman, Cook-Cottone, Rao, & Upadhyaya (2012) sociotechnical systems are comprised of four main components technology, structure, people, and tasks; each of these components are required to work in unison with each other to create the opportunity for optimal results in effectively responding to an emergency or disaster scenario. Socio-technical Systems Theory views system functions as a twofold process. The first portion is the technical system; this portion of the system examines the process and technology (Kim et al. 2012). The second portion of the system must consider the structure and the individuals to be successful (Kim et al. 2012). These systems require harmonious collaboration to achieve optimal efficiency and outputs; when the systems are no longer in harmony the discord has the potential to create dissention resulting in poor quality operations and outputs. The Sociotechnical Theory works along with the Unified Theory of Acceptance and Use of Technology to ensure that both the social and the technical aspects of the decision to utilize information technology in emergency and disaster management are examined.

The Unified Theory of Acceptance and Use of Technology has been used frequently to explained the use of technology within the private sector, but is not commonly utilized to examine government and non-governmental agencies that provide emergency and disaster management support. This theory supposes that adoption of technology depends upon how well

technology is received and if it has been accepted following the utilization of the technology. Essentially, first the technology must be used and then if this utilization goes well and is well received then organizations are more likely to adopt the technology into their organizational plans. The Unified Theory of Acceptance and Use of Technology can be applied to how emergency managers adopt technology to determine the factors that guide the manager's determination.

Venkatesh, Morris, Davis, & Davis(2003) formulated the Unified Theory of Acceptance and Use of Technology to help fill in the variances and gaps found among other theorist attempting to explain the acceptance and use of technology within modern society. Venkatesh et al. (2003) stated, "we theorize that four constructs will play a significant role as direct determinants of user acceptance and usage behavior: performance expectancy, effort expectancy, social influence, and facilitating conditions (p.477)." There were three factors determined by Venkatesh et al. (2003) to be indirect determinants of the use and acceptance of technology, which were self-efficacy, anxiety, and the thoughts and feelings towards technology.

Performance expectancy revolves around an individual's expectations that the information technology being applied will help them to perform their work more effectively. Venkatesh et al. (2003) stated that age and gender do have an impact on performance expectancy. If an individual perceives the utilization of technology as something that help will help ease and improve their workload there is a greater chance of the individual adopting the technology.

Effort expectancy is the consideration of the complexity of the system and the level of easiness or difficulty of understanding the application and utilization of the system. The

experience of the individual, as well as the age and gender do have the potential to impact the effort expectancy perception (Venkatesh et al. 2003). The easier it is for a system to be incorporated and integrated into a system the more likely the information technology will be adopted.

Social influence represents the relation of the value of which the individual places on their peers' opinions of whether or not the utilization of information technology is received positively or negatively within the organization. Social norms influence decisions within society and when an individual steps outside of these standard social norms there can be a level of discomfort. Venkatesh et al. (2003) stated that one of the central themes of social influence was "the explicit or implicit notion that the individual's behavior is influenced by the way in which they believe others will view them as a result of having used the technology (p.451)." Social influence has the potential to help determine the individual's acceptance of information technology.

Facilitating conditions are determined by the level of support the individual believes the organization has put in place for the utilization of information technology within the technical portion of the infrastructure and also within the organizational infrastructure. Facilitating conditions are essential to creating a positive experience with the employment of information technology within an organization. According to Venkatesh et al. (2003) these facilitating conditions will be affected by age and experience; the facilitating conditions will have a direct impact on the intention to utilize information technology and difficult conditions will create a disinterest in use.

Understanding the indirect determinants of the use of information technology listed by Venkatesh et al. (2003) is essential to understanding all the potential factors that can occur. Attitude in relation to technology is an indirect determinant; often this is related to the previously mentioned direct determinants operating as a negative impact on the individual. For instance, when there is not organizational infrastructure to support the utilization of information technology the individual may have a negative attitude towards information technology. Venkatesh et al. (2003) examined self-efficacy and anxiety and found them to be un-related to the behavioral intention of the individual to utilize information technology. The Unified Theory of Acceptance and Use of Technology offers an opportunity to take a detailed look at a variety of potential determinants for utilizing information technology. Understanding factors can help to determine what considerations should be made to encourage the further application of technology in emergency management in the future.

### **Research Design/Methodology**

This study's research will initiate by examining different types of technological advancements that are available to be applied to emergency and disaster management or have been applied to emergency and disaster management in limited settings. This portion of the research will explore the different technological advancements in information technology that have the potential to be applied to different phases of emergency and disaster management. Some of the technologies listed are recent advancements and have not yet been actively applied to emergency and disaster response. Certain technologies that are mentioned are applied on a smaller scale and not utilized as a wide scale opportunity within all emergency and disaster management.

Understanding the available technology is crucial to being able to formulate an understanding for the next portion of the research. The second portion of the research will focus on exploring factors that determine what decisions an emergency manager concludes when presented with the opportunity to utilize information technology in their emergency and disaster management operations. This section of the research will examine a variety of information technologies and will explore the potential factors that could influence an emergency managers decision on the potential utilization of the information technology presented. The focus will be to interrupt and understand in detail how these impacts are created and what these factors in decision-making have the potential to mean for the future of emergency and disaster management with information technology.

The basis of this research was designed during a preliminary assessment of recent natural and man-made disasters and the potential for immense impact on the regions that these incidents occur within. This paper will explore the factors that are influential in determining if emergency and disaster managers utilize information technology in their operations by examining examples of how and when technology is or is not utilized in emergency and disaster response. Research has shown that technology applied to emergency and disaster management has the potential impact to produce lower damage and mortality rates within the case of emergency and disaster response. In spite of these positive results some emergency management professionals are still leery to employ technology in their plans of action during times of disaster. The purpose of this research is to seek out the factors that have an influence on the application of technology within emergency and disaster management.

This study will examine sources that are multidisciplinary in nature and examine both the technical and sociological aspects of these factors in order to give the reader a more holistic

perspective of the events that have occurred within emergency and disaster response that successfully utilized technology, as well as instances where emergency managers did not utilize technology. Understanding times when technology was applied and instances where it was not applied will further the examination of factors that contributed to the determination on the use of technology.

The data for this research is qualitative and was gathered by locating articles and journals by several different authors that focus on the utilization of technology in disaster and emergency response. The tool employed to seek out data material for this research was American Public University System's online library. The online library offered by the American Public University System offers access to thousands of scholarly articles, journals, research projects, and books that have the high quality and accuracy that is essential for conducting research. The material was located by going on American Public University System's databases and searching for articles utilizing key words. The key words and phrases utilized to search for articles were: emergency and disaster management, information technology, disaster management and IT, emergency management and technology. The databases used within the research of this project were multidisciplinary databases for scholarly materials; the two databases that were found to offer the needed comprehensive materials were ProQuest and EBSCOhost. The reasoning behind utilizing these types of databases as the foundation for researching online materials to be employed for this project were due to the multidiscipline nature of the topic, where both emergency and disaster management and information technology are being studied. Online databases also tend to offer more recently published materials for research, which is essential in study the fast paced worlds of emergency and disaster management and information technology. These databases allowed for the opportunity to research articles that contained both of these

phrases (emergency and disaster management and information technology) and discover materials that linked together emergency and disaster management and information technology. Once located the articles were reviewed to determine if they mentioned emergent technologies or theories/factors exploring the adoption of technology within emergency and disaster management. The key phrases that aided within the search for these materials were: emergency management and IT, disaster management and IT, disaster management and technology development.

The boundaries for the research do not include only sociological or technological data, but a combination of articles on emergent discoveries and advancements to form the foundation to further comprehend all the various opportunities for advancement. It is also important to understand how an event occurred to build knowledge of what can be controlled and what cannot be controlled in times of disaster. Research will be assembled from emergency and disaster incident, technology applications, and developments that have occurred within the last twenty years. The incidents that are selected must correlate with one of the following criteria: the incident must either show the use of technology has benefited emergency response, or a gap in response that has created a negative outcome for those impacted, or technological innovations that could be applied to emergency response.

Data gathering is a vital portion of a research study, but data is useless without the proper analysis. This lays the foundation for creating a proper analysis that considers all the factors present within the researched materials. After gathering the data about the scientific and technological impacts of the importance of technology and factors that impact the decision to employ technology in emergency response the analysis and interpretation of data can begin. The analysis will review the various factors that positively and negatively impact the utilization of

technology in emergency and disaster management. The analysis will determine which factors and scenarios create a positive atmosphere for using technology and what factors and scenarios results in resistance of the utilization of technology.

Understanding the dynamics of emergency and disaster response is an important piece of creating opportunities for advancement and the use of technology in emergency and disaster management, but often it is underdeveloped and under researched. This paper will bring to light a greater understanding of the complexities of combining resources to formulate how technological advancements and the pursuit of these discoveries can be achieved and fostered in emergency and disaster management. Furthering the comprehension of the dichotomy that is present within emergency and disaster response currently might allow for understanding how new partnerships and advancement for emergency response technology can be made a staple in the field.

### **Findings/Results/Discussion**

One of the central purposes of this research was to discover the opportunities for advancement present within information technology that had the potential to be applied to the field of emergency and disaster management. Emergency and disaster management has slowly been adopting technology over the years, but the modern world does not progress at a slow pace. The modern world is a constantly shifting and changing environment that leaves no space for slow movement. Information technology moves at an equally aggressive pace and is in a constant stream of development and advancement. The field of emergency and disaster management has fallen behind the times due to the leisurely pace at which the field adopts information technology. When information technology is adopted within the field it is often a step behind the new and emerging technologies. The other crucial purpose of this research was to

discover the factors present that are creating deterrence from the adoption of information technology into emergency and disaster management.

Marcincioni's (2007) article explored factors that determined if emergency managers were willing to include information technology in their emergency and disaster management operations, but also if emergency managers were willing to participate in information sharing. The article examined the process and noted three conditions that must be present for the disaster knowledge exchange to achieve success. The first condition required information technology systems to be viewed as something that could benefit and improve interpersonal interactions. The second condition marked the necessity for emergency managers to be willing to participate by accepting and sharing information. The final condition needed disaster knowledge to be viewed as something that could be shared and transferred among individuals and not simply an individualistic experience that is singular. The article also explored how professional culture deeply impacts that willingness to accept the technology required to create the first condition for successful knowledge sharing.

Emergency managers have the potential to be highly influenced by their desire to gain prestige for their organization, whether this can mean the adoption of information technology or not can be influenced by several factors. One factor to be considered is the experiential and educational background of the emergency manager; individuals with higher education and technical knowledge are generally more comfortable applying information technology to management techniques. The emergency manager's perception and thoughts on what the purpose is of emergency and disaster management, as well as the emergency manager's definition of disaster knowledge had an impact on the willingness to adopt information technology. The article also explained that if the information technology has a focus on enhancing and creating more

meaningful and frequent interactions among individuals the technology has a higher likelihood of success.

Professional culture can be highly influential in an emergency manager's decisions to use information technology. The availability of technology was not found to be influenced by geographical location in Marincioni's (2007) article, but by an organization's mission, vision, and the lead emergency manager's consideration on what influences prestige.

Kim et al. (2012) applied the Socio-technical Systems theoretical perspective to the field of emergency and disaster management to explore the essential elements that were necessary for the adoption and adaptation of information technology into emergency and disaster management practice. Kim et al. (2012) found this research to be vital to the field of emergency and disaster management due to the possibilities that information technology can enhance human capabilities. Socio-technical Systems Theory views system functions as a twofold process. One side comprised of the technical system; the other half is comprised of structures and the individuals (Kim et al. 2012). When applied to Emergency Management Information Systems this theoretical perspective examines the complex system of individuals and technology to fully understand the dimensions in which the system operates and what components are required to operate at optimal capacity. The two systems must cooperate together in synchronization towards a common objective to achieve optimal results. By combining efforts to receive optimal results, the two systems will also achieve optimal operating efficiency. Kim et al. (2012) "views STT as the whole social perspective and two sub sociological and technical systems as organizational perspective (p.1149)." Each of the systems contains their own unique components that create their dynamic environment; the technical is composed of task technology, technology device

communication, and technological information sharing, while the sociological is composed of people, leadership, training, and other social characteristics.

Socio-technical Systems theory focuses directly on the importance of two systems working together; the functionality of the entire system balances on the system's ability to work the technological and sociological aspects together harmoniously, but when an issue does occur this can create a snowball effect within the systems if not caught quickly enough. Components to consider while applying Socio-technical Systems Theory to emergency and disaster management are as follows: the individuals who are charged with determining complex decisions, the individuals who command the emergency and disaster management process, the individuals who control the emergency and disaster management process, and the individuals who are the first responders to emergency and disaster situations (Kim et al. 2012). It is essential for these individuals to be willing to accept the technological advancements and incorporate the technologies in their operations. When there is a disparity in acceptance and required use this is when the sociological and technological systems lose harmony and cease to work together as one for optimal efficiency.

In Kim et al.'s (2012) research there were several factors that were determined to help influence the willingness of emergency and disaster management personnel to accept information technology. The first was self-efficacy for the ability to make decisions swiftly during times of crisis. The second was the amount of training individuals received. The third is outside support from individuals not at work. The fourth factor was the individual's perspective on information sharing. The fifth factor was if task specific technology was applied. Kim et al. (2012) also found that that all of the following factors must show a positive relationship with effective emergency and disaster management: emergency and disaster management logistics,

leadership in emergency and disaster management, and finally labor in emergency and disaster management. The previous factors are essential when examining the application of information technology to the field of emergency and disaster management under the lens of Socio-Technical Systems Theory to uncover the determinants for the possibility of employing information technology.

Jennings et al. (2015) also examined determinants that influenced the adoption of information technology into emergency and disaster management, but this was achieved by utilizing the Unified Theory of Acceptance and Use of Technology. This Unified Theory of Acceptance and use of Technology was founded in Venkatesh et al.'s (2003) study on the various theoretical perspectives that were available to examine the acceptance and use of information technology. Venkatesh et al. (2003) found these previously conceived theories not inclusive enough and that each theory was missing on an essential determining factor for the use and acceptance of technology, which lead to the creation of their own more inclusive and holistic view on the adoption and utilization of information technology within society. Previous theoretical perspectives held a variety of factors that determined the use of information technology, but while some theories held similar views other theories explored different factors of influence. Noticing these gaps in theoretical perspectives they reviewed all the previous theories and then applied these to several organizations and found seven common determinants (both indirect and direct) for the use of information technology among them (Venkatesh et al. 2003). These results were able to explain over seventy percent of the variances of the intentions to accept and use information technology according to Venkatesh et al. 2003). This study made tremendous strides towards fully grasping and understanding the mind of the individual when examining the intention to utilize technology. Understanding this theory and its importance is

essential to understanding its potential application to information technology within emergency and disaster management.

Venkatesh et al.'s (2003) study did not focus specifically on applying the Unified Theory of Acceptance and Use of Information Technology within emergency and disaster management. Jennings et al. (2015) took the Unified Theory of Acceptance and Use of Technology and applied it to the field of emergency and disaster management. Jennings et al. (2015) utilized this theory to examine and understand the determinants for the utilization and application of technology for emergency managers.

Jennings et al. (2015) examined that while information technology can be widely utilized to aid in guiding coordinated, multiagency efforts and important decision making the adoption of information technology into emergency and disaster management is not always well received. Jennings et al. (2015) interviewed emergency managers and applied the Unified Theory of Acceptance and Use of Technology to understand what factors influenced the emergency managers' determination to utilize information technology in emergency and disaster management. The first factor examined was the possibility of information technology bringing efficiency to the workload. The ease with which the information technology could be adopted and utilized was the second determining factor. The third factor considered was the effect of the thoughts and opinions of the emergency manager's peers. A fourth factor examined was the age of the emergency and disaster manager. Other determining factors were the probability for disaster in the emergency manager's region of responsibility, disaster history, and the amount of intergovernmental collaboration. Jennings et al. (2015) utilized the Unified Theory of Acceptance and Use of Technology to assist in distinguishing the potential road blocks that face the adoption of information technology in emergency and disaster management.

The information compiled within all the research demonstrates the vast potential for the continuation and growth of technological application within emergency and disaster management. The research also provides a comprehensive list of factors that can greatly influence the determination to adopt information technology into operations.

The information gathered from this review will have the ability to aid in furthering the knowledge to what adjustments and consideration must be made in the adoption of the information technology. The application of these theoretical perspectives to the emergent technologies explored within the research offers the opportunity to gain insight on their potential adoption into the field of emergency and disaster management.

Radio Frequency Identification Technology demonstrates one of the potential technologies that could be applied to emergency and disaster management. The technology has the potential to be applied at several of the phases of emergency and disaster management. Radio Frequency Technology is relatively simplistic and only requires three major components to maintain functionality for the user (Renken et al. 2014). The possibilities for what the tags can be attached to are numerous and offer the potential to store, easily access, and gather information at any stage of the process. The tags have the potential to be utilized to store information on any subject matter from buildings to goods, and even individuals. This technology has been researched more over the years as it amasses popularity in the transportation and logistics business realm, which has resulted in the technology becoming more cost efficient and affordable (Renken et al. 2014). Radio Frequency Identification Technology offers tremendous potential to emergency and disaster management, yet this potential has not been seized by emergency management to the fullest.

One reason for potential distrust of Radio Frequency Identification Technology is the ethical concerns when utilized to help track human data due to the sensitive nature of the information. Tags for Radio Frequency Identification Technology come in a variety of forms and the implant chip version of the tag is highly debated issue, especially when it comes to using on humans. Another issue that stem from this is the potential misuse of private information as a cause for concern (Renken et al. 2014). Private information being accessed by non-authorized individuals can create a potential threat to national security in some cases. This bad social stigma associated with Radio Frequency Identification Technology could cause emergency managers to shy away from learning about the additional uses. Social influence has a severe impact on decision-making for the individual.

Due to the lowered cost of Radio Frequency Identification Technology the cost benefit efficiency should be of no concern; the tags can be put to a variety of uses within emergency and disaster management. Radio Frequency Identification Technology devices are generally user friendly and should not create any issues with effort or performance expectancy given their simplistic nature.

Disaster probability and history could be of potential impact for emergency and disaster managers to accept this technology. The higher the potential for disaster and the more history of disaster a region's past contains will result in a further interest in additional resources. An example of this can be seen in the adoption of Radio Frequency Identification Technology in the state of Texas for the Special Needs Evacuation Tracking System (Renken et al. 2014). This successful application of the technology bodes well for the future of Radio Frequency Identification Technology; emergency and disaster management officials are more willing to

accept and adopt technologies that have been successfully tested within a real-world scenario. This type of reasoning is most likely one of the factors behind dual use information technology.

Dual use information technology offers a wealth of opportunities for the field of emergency and disaster management. Dual use technology provides the opportunity to shift the paradigm in information collection and sharing within emergency and disaster management from bureaucratic, slow paced intelligence collection and sharing to a fast paced community based information sharing system. This can be seen with the use of modern technology such as the cellular telephone. Pictures can be taken at the scene of a disaster and can be shared quickly after a disaster to give responders a visual on the impact to a region. Calit2 offers the ability for citizens in California to utilize the system as an emergency and disaster information hotline to keep citizen aware of their surroundings and the potential dangers in the area (Underwood, 2010). This notification system offers low costs because it relies mostly on user technology and regulation. The users collect the information to send in to Calit2 and can pull information that applies to their area.

The technology is relatively new to the market and has not had the opportunity to be widely spread across emergency and disaster management, but Calit2 has many positive factors influencing its continuation of use. This technology has great potential in regards to effort and performance expectancy, as it operates mainly off the common place cellular telephone. The cost-benefit ratio is also not a major issue due to the low running cost of the program using dual use technology. Calit2 has experienced a positive response in California when considering social influence, which could be witnessed during the increased use in times of wildfires (Underwood, 2010). This technology should see an increased continuation as it gets noticed by other emergency and disaster managers.

ImageCat's virtual disaster viewer is another developing information technology that has the potential for further expansion within emergency and disaster management. This virtual disaster viewer has the potential to utilize global satellites to enhance knowledge of disaster by zoning in on regions of concern to give emergency managers a clearer perspective and increase situational awareness to allow for decisive actions to be taken to address the needs of a disaster region. ImageCat is currently partnering with the United Nations to further the utilization of their information technology to provide assistance to regions in hazardous areas or experiencing extreme conditions (Underwood, 2010).

The virtual disaster viewer's use of previously existing technology further demonstrates the potential of dual use technology in emergency and disaster management. The virtual disaster viewer can be run effectively by utilizing currently active global satellites can be run in a cost efficient manner according to Underwood (2010). The data provided within the virtual disaster viewer should provide a clear picture for understanding conditions needed to perform the job of an emergency manager, thus contributing to job efficiency for the emergency disaster manager. The data offered by the virtual disaster viewer has the potential to be utilized to facilitate the formation of a common operating picture when utilized in interagency collaborations. This information technology has received positive reviews where it has been introduced within society and has the potential to see further growth in the coming years, as evident by the possible partnership with the United Nations.

Emergency and disaster management is also seeing an increasing focus on the improvement of communication technology. UNICEF has developed a technology to improve the communication pathways available to field workers in areas where little to no infrastructure is in place to allow information technology to operate; this technology is called Bee

(Underwood, 2010). This allows for field workers operating in regions of extreme infrastructure collapse or lack of required resources to create a functioning infrastructure to access technologies to increase efficiency and functionality within their jobs. Bee also offers the opportunity to be utilized with pre-existing technology, such as cellular telephones to create a system that able to be applied and use with ease by workers.

Bee is being deployed in areas that have experience past disaster or crises for workers to be able to operate and communicate with a rapid ability and efficiency not previously possible. These areas have a history of instability or higher disaster probability. Bee utilizes dual use information technology, which creates affordability in employing the technology within the field, thus offering increased cost efficiency. The technology should receive positive social reception due to the ease of use the information technology applied offers. Individuals of all ages and genders utilize cellular technology all over the globe; Bee utilizing this technology offers the possibility for the application of information technology in emergency and disaster management to not be greatly affected or influenced by age and gender. Dual use technology offers the potential for expansion into utilizing social media during times of disaster in addition to the use of cellular technology as mentioned above.

Social media has been widely adopted around the globe by individuals of all ages and genders; this social media presence offers the opportunity for the information contained within the popular social media outlets to be utilized in emergency and disaster management, but this possibility has yet to be fully explored by professionals. The use of social media would be another type of dual use technology that has the potential to greatly benefit emergency and disaster management in many ways.

Xu et al.'s (2010) research explores the application of social media to emergency and disaster management. The technological boom over the last decade has left opportunities open for improving several emergency and disaster systems; the researcher believes a main area to focus on improvement is current data processing techniques. The central focus of the Xu et al.'s (2010) research is on information datamining from social media websites and applying the information that is gathered from this datamining to emergency and disaster response. Information offered in a timely manner required to make decisions for the action items to all four stages (mitigation, preparedness, response, and recovery) of emergency and disaster management.

Xu et al. (2010) refers to web users who utilize social media as a network to share and interact with other media users about their environment are social sensors. Datamining offers the opportunity to gather this information in a time efficient manner to apply to emergency and disaster response. Emergency managers then utilize the data to understand where the regions of need are located and what resources are needed in various locations. Xu et al. (2010) utilizes three major points (social layer, crowdsourcing, and spatial information layer) for datamining to extrapolate data to be applied to the different stages of emergency and disaster management.

Datamining can assist in managing performance expectation at all stages of emergency and disaster management. This information technology offers an immense potential for information provided to emergency managers; the more information about a potential or occurring emergency and disaster scenario the more decisively an emergency manager can determine what actions must be taken. These decisions are also made to offer more accurate prevention and response.

The information technology applied within datamining is fairly simplistic in nature and only uses a data collection system and popular social media sites. The system allows emergency managers to employ key words to search within popular social media site to discover the specific words or phrases that would aid in gathering information that is essential to the emergency manager's cause. The public would only need to continue to utilize the social media sites that were already being used. This technology should not create issues in regards to effort expectancy due to the ease of use that it offers both emergency managers and the public. The facilitating conditions and support for this are clearly present with the high use of social media in today's world. This information has the potential to be applied to every phases of emergency and disaster management, so it should be highly supported by emergency managers and their agencies.

Social influence is vital for the support of the adoption of information technology in emergency and disaster management. Datamining utilizes the popular social media sites, so the data extracted should provide visual and written information in a timely manner that was not previously available. These types of results have the potential to receive positive social recognition within the emergency and disaster community. One concern for utilizing this information technology is that the data provided is not always accurate, but the information gathered from the data still can provide a greater situational awareness that assists with the quick decision making that is required of emergency managers. The public has already begun to see a use of social media during times of emergency and disaster. This can be seen with local fire and police departments creating Twitter and Facebook accounts or when Facebook offers the ability for individuals to check in as safe during times of crises and disaster. The potential for utilizing social media during times of emergency and disaster has a limitless potential for growth that will

continue to develop as the years progress and the public continues the increasing focus on social media within society.

The requirement for quick decision making is an aspect of emergency and disaster management that is constantly being mentioned due to the great importance each of these decisions and their resulting actions hold. Emergency Management Decisions Support Software aids emergency managers in examining the data collected to be analyzed for emergency and disaster management assistance to make fast paced decisions that can lessen the social and economic impact of a crisis scenario. Emergency Management Decision Support Software creating situational awareness allows for emergency managers to continuously update the decisions made. The ability to make adjustments as needed due to the constant flow of information providing updates creates an assurance that services and supplies will be directed to the regions of need with as much accuracy as possible.

As previously mentioned two available Emergency Management Decision Support Software systems that exist and are popular are WebEOC and E-Teams. While each software system holds its own special features and functionalities that assist with emergency and disaster management, the software systems are both of equal importance to the field of emergency and disaster management. "These programs allow emergency managers to generate timely and accurate situational reports, fuse data from multi-sector organizations, and help manage the response demands (p.605)." These software systems offer the ability to aid emergency managers in making quick decisions and consistently show positive results when applied to the field. This is done by reducing the uncertainty emergency managers are faced with when making difficult decisions responding to emergency and disaster scenarios, thus creating and fostering the ability to form a sense of situational awareness. Despite these positive results that can be demonstrated

upon application of the technology, the Emergency Management Decisions Support Software systems have not been universally applied and accepted among the entirety of emergency and disaster management. Technology that aids in supporting decision making creates the potential for further growth for emergency and disaster management.

Emergency Management Decision Support Software requires that emergency managers develop a familiarization with the information technology required to apply the system to their current operations. The willingness of an emergency manager to apply this system to their operations was found to be dependent on what their estimation was on the level of ease for learning and utilizing the Emergency Management Decision Support Software (Jennings et al. 2015). If emergency managers had an expectation that the system would be difficult to learn and apply to their operations they were less likely to adopt the system. This puts a requirement on the software developer to put together an easy to use customer interface, so that application of the technology can be done without drawn out, extensive training. The age of the emergency manager was not found to directly impact the decision on whether or not to utilize Emergency Management Decision Support Software but the education and experiential past of the individual were found to be of influence. The higher the degree of education and the more experience an emergency manager had with information technology the more accepting they were of applying the Emergency Management Decision Support Software to the center of operations (Jennings et al., 2015). The more user friendly the interface for the customer the more likely they are to bring this in to their organization.

Facilitating conditions were another factor that helped to determine if emergency and disaster managers would be willing to apply Emergency Management Decision Support Software to their current operations. Facilitating conditions consider the infrastructure of an

organization and their potential to apply the systems to their current set of operations. Support systems, training, and the availability of technical support to assist with systems issues all played a factor in the determination to utilize the information technology systems offered by Emergency Management Decision Support Software.

Decisions on emergency response must be made quickly within emergency and disaster management to stem the flow of devastation and destruction. Emergency Management Decision Support Software offers the ability to assist emergency managers in reviewing the data available during an emergency and disaster scenario in a comprehensive manner, which provides the ability for emergency managers to make quick decisions for emergency and disaster management operations. If an emergency manager feels that a system developed can assist in making them more efficient and effective at their position they are more likely to adopt the Emergency Management Decision Support Software to apply to their emergency and disaster operations. Emergency Management Decision Support Software typically creates a positive impact on emergency operations and is therefore likely to receive positive feedback in regards to effort expectancy (Jennings et al. 2015).

The software is currently not widely known to the public outside of emergency and disaster management professionals, so the social influence portion of determining an emergency manager's decision to utilize Emergency Management Decision Support Software will be influenced directly by professional culture. Professional culture deeply impacts the decisions that are made within an organization; this type of social influence can deeply impact how an organization's operations are determined and constructed. Emergency managers hypothesized how their peers would agree with or respect the decision to apply Emergency Management Decision Support Software to their operations before determining if the software would be put to

use. Emergency managers who receive positive feedback from their peers on the application of the software to emergency and disaster management operations will be more likely to utilize the information technology in this regard.

Emergency Management Decision Support Software systems can be applied to the different stages of emergency and disaster response to help increase the ability of the emergency operations center. The importance of this type of information technology is clearly visible given the completed research out the positive outcomes of its application (Jennings et al., 2015). This technology allows for effective management and has the potential to be something that is adopted by emergency and disaster management on a larger scale, because the ability to manage data and resource application in an effective manner is essential to emergency and disaster management.

This perspective is what makes the ability to collect near-real-time data for emergency and disaster management an opportunity of such great importance. Data that emergency managers receive is often delayed due to the different methods of data and resource collection. This delay can create result in an increase of time before resources and supplies reach those in desperate need. Römer et al. (2014) recognized this disparity for both emergency and disaster management and public event management and gathered information to research the application of near-real-time data to critical events. Near real-time-data offers several capabilities that have not been present previously in emergency and disaster management and the potential for this has yet to be fully explored for application in the field.

Near-real-time data coupled with unmanned aerial vehicles presents an interesting opportunity for the field of emergency and disaster management. This offers the ability to gather data without personnel or reporting individuals present at the scene of the crisis by utilizing the

unmanned aerial vehicles with the ability to stream data to the emergency operations center. This would provide detailed, accurate, visual information into the scene of the disaster and would demonstrate the magnitude of the impact on the region. According to Römer et al. (2015) “Information on the current occupancy of assembly areas provides situational awareness and can improve response time and effectiveness in emergency rescue operations in the case of public events and natural disasters (p.683).” This information can also be collected in regions where there is little accessibility and visibility in the aftermath of disaster. There are current systems in place that employ unmanned aerial vehicles to collect real-time-data for emergency and disaster management systems; these systems are the Geo-Intelligent Collaborative Decision Support System for Real-time Disaster and Emergency Management and NASA’s Autonomous Modules Scanner (Römer et al. 2014). These systems can be utilized to improve the field of emergency and disaster management in regards to preparation and response with providing highly detailed data in real-time.

Real-time-data utilizing unmanned aerial vehicles has not been widely applied to the field of emergency and disaster management, but is beginning to gather attention as the potential for utilization becomes more apparent. The cost efficiency for utilizing unmanned aerial vehicles should be considered when exploring the application of this technology into emergency and disaster management practices. Unmanned aerial vehicles that produce real-time-data are lower in cost and safer than sending personnel directly into disaster regions.

The ability to gather this information without sending personnel into emergency and disaster regions allows for emergency managers to gather data more quickly and complete their tasks with greater efficiency. This positive impact for performance expectation for emergency managers could potentially support the adoption of this information technology into emergency

and disaster management. The potential for the utilization of unmanned aerial vehicle technology is limited by certain factors. The technology is highly sensitive to weather conditions and cannot be relied upon when certain conditions are present; an example of this would be high winds or intense rains (Römer et al. 2014). This lack of reliability might be one of the factors that are preventing the widespread use of unmanned aerial vehicles for emergency and disaster response.

The ethics behind the utilization of unmanned aerial vehicles has been a highly debated subject. The social acceptance of this varies by group and individual, which might affect an emergency manager's decision to make this technology an addition to their operations. Unmanned aerial vehicles could potentially be expanded for further utilization in emergency and disaster management, but their current application shortcomings and ethically questionable applications have the potential to halt their adoption.

The findings of this research indicate that it is not a lack of available technology that affects emergency and disaster management, but rather a lack of adoption and unity in regards to the application of information technology in emergency and disaster management. There are a number of technological advancements available to be applied within the field of emergency and disaster management; a number of these advancements have the potential to offer the opportunity to enhance emergency and disaster management centers' organizational capacities.

One essential function within emergency and disaster management is the capability to communicate with other emergency and disaster organizations. A number of the technologies presented within this research offer the ability to expand communications within the field. One type of technology that offers this capability is the Information Communication Technology. This widened flow of communication creates an opportunity for emergency and disaster management officials to share information about their experience and knowledge within

emergency and disaster management. Information technology that focuses on information communication creates the possible for quick and frequent transfer of information between individuals and organizations. Information sharing between emergency and disaster management officials offers an opportunity for growth and development within emergency and disaster centers. The opportunity for this growth potential is derived from ensuring organizational efficiency by emergency officials sharing best practices.

Another benefit of information technology explored within the research was the ability to extract and obtain data at an increased pace offering emergency managers the ability to create a vivid, picture of the emergency and disaster scenario at a faster rate than previously possible. This can be attributed to the advance of the age of information technology, which has created a place for citizens to share information with just the click of a button. Social media provides limitless potential for emergency and disaster managers to gather data in real time about emergency and disaster occurrences from individuals who are witnessing the scenario firsthand. Datamining offers an opportunity for emergency and disaster managers to enhance information gathering techniques to increase situational awareness and heighten awareness of resource allocation needs for the affected regions (Xu et al., 2010)

Information technology offers flexibility and can be combined to create an environment of efficiency within emergency and disaster management; this can be seen when datamining from social media is combined with the advances in Information Communication Technology. Applying these communication technologies to emergency and disaster management allows for increased communication capabilities between emergency and disaster managers and field workers; this will allow for effective incremental decisions to be made in field based off the information communicated to the field workers (Mendonca, 2007). One problem for emergency

and disaster management in the past has been the inability to know where resources are most needed directly after disaster; information technology offers a chance to change the ability to respond to disaster. The ability to produce plans of action that directly align with the current needs of regions and individuals impacted by disaster demonstrates the impact that can be made when combining Information Communication Technology and near-real-time data.

A technology type explored within the research that offers the ability to aid emergency and disaster managers with the ability to process data and make a determination on difficult decisions in times of disaster are Emergency Management Decision Support Software. Data is essential to understanding the needs generated by an emergency and disaster scenario, but sifting through all of this data can be a cumbersome process. Depending on the amount of data this has the potential to delay an emergency manager's decision making. Emergency Decision Support Software is a type of information technology that offers a potential solution for this scenario. Jennings et al.'s (2015) research detailed how Emergency Management Decision Support Software aids emergency managers in processing data from multiple sources and then utilizing this data to make swift decisions in regards to emergency and disaster response.

Emergency Management Decision Support Software technology could be applied to help support interagency cooperation during times of disaster (Jennings et al., 2015). At times, interagency operations within emergency and disaster management can lead to further chaos and confusion; this can be seen with Hurricane Katrina (Hutchins et al., 2008). The struggle to bring together all of the response organizations under a singular operating picture can allow for a misuse of the resources available during times of emergency and disaster. The technology creates an opportunity for flexibility within roles and operations to provide a common operating picture for all of the organizations; this collaboration has the potential to create the ability to further

focus on the needs of the victims. Non-governmental organizations have assumed a permanent place in emergency and disaster response, so the ability for emergency operation centers to collaborate with other organizations has become a necessity. Increased efficiency in creating smooth collaboration offers the opportunity for emergency and disaster response to operate with a decrease in error and the potential to further protect and save lives through the utilization of Emergency Management Decisions Support Software.

Emergency and Disaster Management's integration with information technology offers the opportunity to expand the capabilities for emergency and disaster response. Yet, the information technology reviewed in this research has not been widely adopted and integrated into operations to the fullest extent by emergency and disaster managers. The information technology researched in this paper has been adopted by some emergency operation centers, but has not been uniformly applied to all of emergency and disaster management despite the possibilities and opportunities it has to offer. This occurs because the determination for the application of information technology to emergency and disaster management is influenced by outside factors as previously shown; understanding these outside factors offers the opportunity for growth and development.

The exploration of information technology for this study revealed a variety of the potential information technologies for application into emergency and disaster management. These explorations lead to the discovery of key determinants that shape the decisions on the application of information technology in emergency and disaster management. Originally the study projected the key determinants would be cost factor, technological availability, ease of use, and social influence. Cost factor and social influence were found to be essential to the determination of information technology being adopted in emergency and disaster management,

but there was little research to be found of technological availability as a determinant. Jennings et al. (2015) stated that technological availability was found to be related more to the purpose of the agency versus the region. There were key determinants that were not previously considered that have influential impact on emergency and disaster management, which are performance and effort expectancy.

The determination that cost was an influential factor for the utilization of information technology in emergency and disaster management can be supported by several of the technologies researched in this study. Underwood (2010) emphasizes the importance that Calit2 utilizes preexisting information technology for operation and information dissemination, which keeps operating cost low when integrating the technology for emergency and disaster response. Underwood (2010) explains the success that Calit2 has experienced where it is available in California can be attributed to this lack of cost that comes with the utilization of the technology and the wide social acceptance this technology has received from the public. Renken et al. (2014) mentions the low cost of Radio Frequency Identification Technology several times within the research; demonstrating that the increased development of the technology resulting in lower cost increases the potential for this technology to be applied more widely within emergency and disaster management. Römer et al. (2014) emphasized the lower cost of unmanned aerial vehicles gathering data versus transporting emergency and disaster personnel to gather information within the field. The research demonstrates the vast importance of cost efficiency when developing and applying information technology to the field of emergency and disaster management.

Ease of use or effort expectancy was a factor found to be highly influential in the determination of the application of information technology to emergency and disaster

management. Underwood (2010) explored the possibility of utilizing preexisting information technology to gather information and improve communication within emergency and disaster management; information technology systems that operate utilizing preexisting structures, systems such as Calit2, ImageCat, and Bee, offer the user the ability to employ systems that have been in existence for some time and might already be familiar. Familiarity with systems offers an ease in the adoption and application that requires less effort than if the system were foreign to the users. Systems that lack familiarity have the potential to create further work when initially adopted due to the extensive training that would be required to apply and operate a new system in an emergency operations center. Dual use technologies offer the potential capability to be easier for field workers to apply within their practices without additional extensive training; this can be seen with UNICEF's Bee technology (Underwood, 2010).

The importance information technology offering a user friendly interfaced which promotes ease of use is supported during Xu et al. (2016) article emphasizing the possibility of dual use technology in emergency and disaster management. Social media offers familiar platform that is easy to adopt because the technology is widely utilized by the general population all over the globe. This dual use technology offers a user friendly interface that has the capability to be easily expanded to meet the needs and requirements of emergency and disaster response officials. This flexibility and ease of use has provided an opportunity for emergency and disaster organizations to utilize this tool to both communicate with the general public and to gather information from the general public in regards to emergency and disaster scenarios. There are several information technologies available (Underwood, 2010) that offer the opportunity to extract data and create an operation picture for emergency managers (Xu et al., 2016). The research from the above studies demonstrates a connection between ease of use and likelihood of

adoption. The more ease with which a technology can be utilized the more likely the information technology is to be adopted.

Social influence was found to be one of the most influential determinants for the application of technology in emergency and disaster management. If technology was ill thought of the less likely the potential adoption of the technology was. Venkatesh et al.'s (2003) research found social influence to be an influential factor when examining if an organization has adopted information technology into their operations. Renken et al. (2014) examined how the thoughts of an emergency manager's peers on the adoption and application of Radio Frequency Identification Technology had an influential impact on the emergency manager's decision. Marincioni (2007) explored how profession cultural (the thoughts and feelings of peers within the organization) deeply impacts an emergency manager's own thoughts and feelings of the adoption of information technology within the organization. The research demonstrates that an emergency manager's perception of the positive and negative aspects of the application of information technology are generally determined by what they define as an acceptable social norm; if technology is viewed as a dysfunction or outside of the norms than the emergency manager is more likely to reject the adoption of information technology.

While there have been several technological advancements that offer emergency and disaster management the possibility to expanding an emergency operations center's capabilities, there have been several factors that influence the determination of whether or not to adopt information technology into operations. The central determining factors found within the research were social influence, cost, and ease of use. The ability to gather an understanding of the factors that influence the adoption and application of information technology in emergency and disaster management offers the opportunity for emergency management organizations to

adjust and adapt to the challenges organizations face when undergoing this integration. This understanding creates the opportunity to develop knowledge of the potential roadblocks that can halt the adoption of information technology by creating organizational shifts and better preparing employees for changes of this nature. This also offers information technology organizations the potential to further understand the requirements for the application of information technology to emergency and disaster management.

The research demonstrated a lack of informational availability on technological availability being a potential determinate of the application of information technology in emergency and disaster management. This subject could provide benefit to the field of emergency and disaster management if studied further. If this was determined to be an influential factor there is a potential to increase disaster preparedness and decrease the loss of property and human capital during times of emergency and disaster. There was also little research to be found on a unified approach to the application of information technology in emergency and disaster management. Creating a shared language and knowledge among individuals in the field of emergency and disaster management would benefit and provide additional ease in understanding the functions and dysfunctions present.

The research completed demonstrated that social influence had the potential to create a positive impact for the application of information technology, this social influence could be utilized by the federal government to push for further development of information technologies. Integrating information technology that allow for increased information communication into emergency and disaster centers would create the potential for interagency collaboration and sharing of effective best practices. If the federal government were to require further adoption of information technology in emergency and disaster management the field could experience a new

potential for growth and development. Intergovernmental collaboration with trainings and information sharing sessions to help facilitate these new requirements could have the potential to expose emergency managers to new horizons and create a system that encourages technology adoption. Information technology is an integral piece of the future of the world; emergency and disaster management is an essential discipline to ensure the future of society. The combination of these two disciplines working together to create effective, efficient emergency and disaster management operations provides a bright outlook for an improved future.

## Reference List

- Amaye, A., Neville, K., & Pope, A. (2015). Collaborative disciplines, collaborative technologies: A primer for emergency management information systems. Paper presented at the 11-20. Retrieved from <http://search.proquest.com/docview/1776778040?accountid=8289>
- Hutchins, H. M., Annulis, H., & Gaudet, C. (2008). Crisis planning: survey results from hurricane katrina and implications for performance improvement professionals. *Performance Improvement Quarterly*, 20(3), 27-51. Retrieved from <http://search.proquest.com/docview/218561073?accountid=8289>
- Jennings, E., Arlikatti, S., & Andrew, S. (2015). Determinants of emergency management decision support software technology: an empirical analysis of social influence in technology adoption. *Journal Of Homeland Security & Emergency Management*, 12(3), 603-626. doi:10.1515/jhsem-2014-0079
- Kim, M., Sharman, R., Cook-Cottone, C. P., Rao, H. R., & Upadhyaya, S. J. (2012). Assessing roles of people, technology and structure in emergency management systems: a public sector perspective. *Behaviour & Information Technology*, 31(12), 1147-1160. doi:10.1080/0144929X.2010.510209
- Marincioni, F. (2007). Information technologies and the sharing of disaster knowledge: the critical role of professional culture. *Disasters*, 31(4), 459-476. doi:10.1111/j.1467-7717.2007.01019.
- Mendonça, D., Jefferson, T., & Harrald, J. (2007). Collaborative adhocracies and mix-and-match technologies in emergency management. *Communications Of The ACM*, 50(3), 45-49.

- Renken, K., M.Eng, Jackman, A. M., PhD., & Beruvides, Mario,PhD., P.E. (2014). An analysis of the potential and actual utilization of the technology in emergency management. Paper presented at the 1-6. Retrieved from <http://search.proquest.com/docview/1705171361?accountid=8289>
- Rodriguez, H., Wachtendorf, T., James, K., & Trainor, J. (2006). A snapshot of the 2004 indian ocean tsunami: Societal impacts and consequences. *Disaster Prevention and Management*, 15(1), 163-177. Retrieved from <http://search.proquest.com/docview/214384052?accountid=8289>
- Römer, H., Kersten, J., Kiefl, R., Plattner, S., Mager, A., & Voigt, S. (2014). Airborne near-real-time monitoring of assembly and parking areas in case of large-scale public events and natural disasters. *International Journal Of Geographical Information Science*, 28(4), 682-699. doi:10.1080/13658816.2013.866240
- Santos, R. S., Borges, M. R., S., Canós, J.,H., & Gomes, J. O. (2011). The assessment of information technology maturity in emergency response organizations. *Group Decision and Negotiation*, 20(5), 593-613. doi:<http://dx.doi.org/10.1007/s10726-011-9232-z>
- Xu, Z., Zhang, H., Sugumaran, V., Choo, K., Mei, L., & Zhu, Y. (2016). Participatory sensing-based semantic and spatial analysis of urban emergency events using mobile social media. *EURASIP Journal On Wireless Communications & Networking*, 2016(1), 1-9. doi:10.1186/s13638-016-0553-0
- Underwood, S. (2010). Improving disaster management. *Communications Of The ACM*, 53(2), 18-20. doi:10.1145/1646353.1646362

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: toward a unified view. *MIS Quarterly*, 27(3), 425-478.

Zhou, X. L. (2014). Research on management of emergency material based on information technology. *Applied Mechanics and Materials*, 644-650, 6178-6180.

doi:<http://dx.doi.org/10.4028/www.scientific.net/AMM.644-650.6178>