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The Development Of A Human Centered Methodology For The Identification Of Communication Needs And The Assessment Of Hand-held Communication Devices Used To Support Communication Flow In High Consequence Emergency Management

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THE DEVELOPMENT OF A HUMAN CENTERED METHODOLOGY FOR THE IDENTIFICATION OF COMMUNICATION NEEDS AND THE ASSESSMENT OF HAND-HELD COMMUNICATION DEVICES USED TO SUPPORT COMMUNICATION FLOW IN HIGH CONSEQUENCE EMERGENCY MANAGEMENT

by

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ABSTRACT

Communication has been identified as a critical component in the outcome of emergency response. Post-mortems of "what went wrong" in disaster responses often point toward breakdown in communication between first responders, those directing rescue efforts, and the general population as one of the primary impediments to rendering timely aid and communicating adequate safety and weather information. Due to the high resilience, relatively low costs, and advanced features of modern hand-held communication devices, these devices are in a position to drastically improve communication flow during emergency management situations. Due to the lack of official implementation of these devices and the lack of the establishment of standard guidelines for device selection, the use of hand-held communication devices in emergency management is yet to be optimized. Island nations such as the Bahamas, which face unique challenges in regard to emergency management due to geographical, infrastructural, political, and cultural hurdles which are found in the region, can especially benefit from the optimized implementation of hand-held communication devices in emergency management. This study examined current emergency response procedures in The Bahamas, created a baseline for the current use of hand-held communication devices by Bahamian emergency management officials and civilians, identified the communication needs of Bahamian emergency management officials and civilians, and proposed a model for the selection of hand-held communication devices based upon human factors principals and focusing on user priorities.

This study began with a focus group interview which included 14 Bahamian emergency management officials in order to gain an understanding of current Bahamian emergency response

procedures and the communication challenges faced by emergency management officials during high consequence emergencies. A paper based survey was conducted, in which 31 Bahamian emergency management officials answered demographic, skill level, and functionality questions related to the use of hand-held communication devices to support emergency related activities including those directed toward preparation, mitigation, and response. These emergency management officials provided invaluable input based upon their practical experience in high consequence emergency situations. 155 Bahamian civilians participated in a similar survey which was a reduced version of the survey used for emergency management officials. Both surveys included questions in regard to the background information of the participants, previous handheld communication experience, device performance, and what other communication devices were being utilized. The surveys were analyzed using statistical methods of categorical data analysis and correlations were identified. Several communication needs which were categorized as infrastructure, organizational, and equipment needs as well as a hierarchy of device selection factors in regard to the use of hand-held communication devices during emergency management situations were identified. The analytic hierarchy process (AHP) was used in order to determine the priorities of each of the identified device selection factors and a model for the selection of hand-held communication devices used to support communication flow in high consequence emergency management was proposed.

for my son, Amir M. Jeelani

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE:
INTRODUCTION

Hand-held communication devices, particularly cellular phones, have become personal necessities for billions of people around the globe. Wireless technology has revolutionized the way people communicate and perform daily tasks. It is hard for many people to even imagine what life would be like without these gadgets. During high consequence emergencies, communication is one of the keys to limiting casualties. Information exchange is especially critical in developing Island and Caribbean nations such as The Bahamas where unique challenges and communication needs are present and the ideal application of wireless communication in emergency management procedures can drastically improve this information exchange. Although wireless communication has become a standard form of communication in most regions of the world and although these devices are frequently used by emergency management officials while performing task responsibilities, they are still viewed by many as personal possessions. Wireless communication has not been officially implemented in the emergency management policies of many nations and a methodology for assessing these devices specifically when used during emergencies does not exist. Furthermore, the human factors and usability issues associated with utilizing these devices during emergencies have not been considered.

1.1 Emergence of wireless communication use

The use of wireless technology is growing at an exponential rate and has revolutionized communication in the modern day. According to the International Telecommunication Union (2009), Sixty-seven percent of the world's population, or over 4 billion people, are cellular phone user. The number of cellular phone users worldwide has multiplied by over 6 times in the last decade and the number of cellular phone subscriptions today is more than the number of fixed telephone line, fixed broadband, and other internet subscriptions combined. A large part of this growth is due to the rapid growth of cellular phone use in countries with limited infrastructure and resources. Due to satellite technology, communication is no longer as dependent on land based connections and wireless technology is becoming the most emerging form of communication in developing societies.

1.2 Wireless communication in emergency management

Wireless technology is proving to be the most resilient forms of communication during emergency situations (Windle, 2010). Unlike other communication devices, hand-held communication devices operate using multiple different communication methods by utilizing both voice and data networks. Windle (2010) provides an example of a situation when voice networks had very little functionality immediately following the terrorist attack of September 11, 2001 due to overload while BlackBerry messenger and short messaging services remained operable. Due to the resilience of wireless communication, it is clearly the preferred method for communication in emergency management environments and needs to be fully utilized.

Wireless communication can be utilized to locate individuals who are in need of aid as well as to provide civilians with instructions such as where they need to go to receive aid, how they need to treat themselves for injuries, and what precautions need to be taken until relief workers arrive. Wireless technology can also be used to help civilians affected by emergency situations reunite with family members who are also in the affected areas as well as family members abroad. During the aftermath of the massive earthquake in Haiti in January 2010, it was reported that a trapped American aid worker used his iPhone as a survival tool (Levs, 2010). It was also reported that many of the affected civilians in Haiti used social networking services on their mobile devices such as Twitter and Facebook to communicate with family members. During the initial relief efforts, the Thompson Reuters Foundation established the "Emergency Information Service" which allowed Haitian civilians to receive critical information while allowing them to provide feedback to relief workers (Reuters, 2010). In the United States, FEMA has recently set up a mobile website for those in need of information during a disastrous situation (FEMA, 2011).

With the use of wireless technology increasing in developing societies, hand-held communication devices are in a position to play a great role in emergency management. Due to the lack of official implementation of these devices and the lack of the establishment of standard guidelines for device selection, the use of hand-held communication devices in emergency management is yet to be optimized. Island nations such as the Bahamas, which face unique challenges in regard to emergency management due to geographical, infrastructural, political, and cultural hurdles, can especially benefit from the optimized implementation of hand-held communication devices in emergency

management. Being that humans are the end users of these hand-held communication devices and considering that "the psychological, physiological and cognitive states of individuals are increasingly stressed, leading to the introduction of new, unfamiliar and possibly unidentified human factors related stressors" (McCauley-Bell et al., 2008) during high consequence emergencies, it is critical that the human factors issues associated with the use of these devices in such conditions are considered.

1.3 Statement of the problem

This study focused on the opportunity, use and emerging practices for using hand-held wireless technology in high consequence emergency management situations. The objective of this study was to identify the communication needs of Bahamian emergency management officials and civilians as well as to develop a human centered methodology to guide the use and selection of hand-held communication devices, particularly end user technologies such as cellular phones, to support emergency management operations. This study examined current emergency response procedures in The Bahamas, created a baseline for the current use of hand-held communication devices by Bahamian emergency management officials and civilians, identified the communication needs of Bahamian emergency management officials and civilians, and proposed a model for the selection of hand-held communication devices based upon human factors principals and focusing on user priorities.

1.4 Research goals

Given the statement of the problem, the research goals associated with this study are as follow:

1. To determine whether or not specific human factors associated with hand-held communication devices in emergency management exist.
2. To determine whether or not these specific human factors can be identified, qualified, or quantified if it is found that they do exist.
3. To set a baseline for the use of hand-held devices by Bahamian emergency management officials and civilians.
4. To develop a model to holistically represent human factors issues associated with the use of hand-held communication devices in emergency management.

1.4 Research implications

The identification of the communication needs of Bahamian emergency management officials and civilians is valuable to Bahamian emergency management directors and policy makers. By understanding these communication needs, improvements in regard to information exchange are more easily attainable. The proposed human-centered methodology for assessing hand-held communication devices for use in emergency management can be used by Bahamian emergency management officials when assessing potential devices to be purchased for use while performing task responsibilities. In addition, this methodology can be used by device manufacturers when assessing prototypes for devices which will eventually be commercially available. This methodology can even be modified for use in other nations and industries.

CHAPTER TWO:
LITERATURE REVIEW

A review of the literature was performed and the following relevant topics were addressed: communication needs in emergency management including infrastructure, organizational, and equipment needs, civilian considerations, response procedures, information exchange, human factors during emergencies, and usability. Table 1 shows which topics each of the sources addressed and that this study addressed all of these topics. In the following sections, relevant information and findings extracted from the sources are described and organized in the following categories: emergency management in The Bahamas, information exchange during emergencies, human factors issues during emergencies, civilians during emergencies, and device selection and use considerations.

Table 1: Literature review matrix

	Alexander and Klein	Arif	Department of Defense	Natl. Institute of Justice	Ide and Kaneta	Jones	Leventhal and Barnes	Meissner et al.	NEMA	Shankar	Souza and Kuschchu	Villagran et al.	WirelessGuide	Zingale et al.	**Jeelani**
Infrastructure needs								X							X
Organizational needs	X				X	X		X		X	X				X
Equipment needs		X	X	X			X	X					X	X	X
Civilian considerations					X					X	X				X
Response procedures									X						X
Information exchange					X			X				X			X
Human factors	X											X			X
Usability		X	X				X							X	X

2.1 Emergency management in The Bahamas

Jones (2005) states that due to the geographic situation of The Bahamas and the variety of population concentrations and economic conditions among the Bahamian islands, communication between islands is often presented as a challenge. The geographic situation requires that administrative functions for disaster management be duplicated in different parts of the country. Uncertainty of population numbers in certain areas as well as undocumented growth causes difficulties in disaster management efforts. In addition, poor planning of development in coastal areas and floodways increases the risk of damages as a result of natural disasters. Possible improvements including establishing a stronger volunteer network, implementing training programs, and providing trained personnel with communication devices are likely to improve emergency response efforts.

The National Emergency Management Agency (NEMA, 2010), the lead government agency in regard to disaster management in The Bahamas, divides disaster management procedures in the Bahamas into the following phases: 72 hours from impact, 60 hours from impact-hurricane warning phase, 48 hours from impact, 24 hours from impact-alert phase, and post impact which includes rescue, restoration and reconstruction. NEMA's stakeholders are grouped into thirteen Emergency Support Function (ESFs) groups which are made up of representatives from various ministries, departments, agencies, and non-government organizations. Each ESF has an organization delegated as the lead agency along with several supporting agencies. The thirteen ESFs include:

- Transportation
- Communication
- Iublic works and engineering
- International assistance
- Planning and information
- Shelter services
- Relief supplies and distribution
- Health and medical services
- Rescue
- Hazardous materials
- Food, tourism
- Volunteers

In the case of the communication ESF, the Royal Bahamas Police Force is the lead agency and the Department of Civil Aviation, Port Department, Royal Bahamas Defense Force, Bahamas Electricity Corporation, and Bahamas Telecommunication Corporation serve as supporting agencies.

2.2 Information exchange during emergencies

Ide and Kaneta (2004) divide disasters into four phases: initial phase (Phase -1) which includes the time before the disaster occurs, Phase 0 which represents the time period when people must survive alone between 0 and 10 hours after the disaster occurs, Phase 1 which represents when organized rescue measures start between 10 to 100 hours following the incident, Phase 2 which represents the phase when the life and death situation is over between 100 and 1000 hours following the incident, and Phase 3 which represents the recovery period. Providing civilians with the proper information at the proper times is critical to eliminating false information and to maintaining the order of society. The issue of information fluency must be addressed during Phase -1. During Phase 0, emergency management officials must provide civilians with

information related to their safety. In Phase 1, emergency management officials should be in contact with civilians to determine their status. During Phase 2, information critical to supporting the surviving civilians should be provided. During the recovery phase (Phase 3), economic information should finally be released to the general population.

Meissner, Luckenbach, Risse, Kirste, and Kirchner (2002) make a point that in order to efficiently handle natural and man-made disasters, optimal information exchange concerning the situation at hand is a necessity. Considering that disaster management efforts generally involve several different types of emergency services and organizations, both intra- and inter- organizational coordination is needed. This sort of coordination requires information to be communicated between organizations in real time, thus stressing the need for an integrated communication and information system for disaster management. Experts in the disaster management field identified that the following communication and information requirements were not currently successfully met: integration and linkage of information, availability of communication, fast data access, timeliness and updating of information, and standardization of information. In the most critical areas of a post disaster environment, communication should be set up to require personnel in this area to exert as little physical and cognitive effort as possible so they can concentrate on the tasks at hand. There is also the need for devices which are capable of auto-configuration since the conditions in disaster management environments do not give much time for manual configuration.

According to Villagran, Wittenberg-Lyles, and Garza (2006), a challenge for researchers is how information regarding volunteer decision making in disaster management efforts and their experiences can be collected. During disaster management efforts, individuals must make sense of their own experiences while receiving and processing information. During these recovery efforts, uncertainty is generally present resulting from either too little information, too much information, or uncertainty regarding the information which is available. Volunteers in these environments may have trouble integrating communication, cognitive, and emotional responses experienced and integration of information can be problematic in the following forms: divergence; ambiguity; ambivalence; and impossibility. In volunteer decision making, communication is the tool that must be used to help potential volunteers integrate cognitive and emotional responses.

2.3 Human factors issues in high consequence emergency management

Alexander and Klein (2009) discuss that first responders are subject to several disaster stressors including disturbing stimuli and emotional and cognitive experiences. These relief workers are directly in contact with dead bodies, individuals with serious injuries, and distressed families. Several factors exist that either increase or reduce adverse effects and categorizes them into three groups: pre-disaster factors, peri-disaster factors, and post-disaster factors. First responders who are single, older, female, and less educated are more vulnerable in disaster management situations. Better trained relief workers tend to handle disaster stressors better and personality traits also affect how one is affected by the aftermath of a disaster. Good organization,

a clear definition of required duties, individual attention to personal needs, team work, and a sense of appreciation can help to lessen the effects of the previously mentioned factors.

2.4 Civilians during high consequence emergencies

According to Souza and Kuschchu (2005), lack of civilian awareness is a major source of loss as a result of natural disasters. Although governments and private institutions around the world are starting to recognize the importance of mobile disaster management systems, little attention has been generated among the general public of these countries. A few countries are currently utilizing mobile technology in order to promote civilian awareness and in order to better assist civilians during emergency management situations. For example, the i-mode disaster message board in Japan allows subscribers to place and check messages in order to inform family members of their situation, the "Enhanced 911" service which is available in the United States, Australia, and the United Kingdom reports the telephone number and location of individuals making emergency calls on GPS enabled phones, in the UK, SMS alerts are sent to business owners in the event of a possible security threat, and in Hong Kong, SMS alerts were used as a form of mass communication during the SARS outbreak. While the implementation of these services is indeed a step forward, they all currently have drawbacks such as a lack of civilian awareness that these systems exist and the possibility of generating panic due to civilians having too much irrelevant information.

Shankar (2008) states that during disaster management and recovery, civilians play a vital role as the true first respondents to the situation. Community technology

centers, community wireless networks, and end-user social technologies are now becoming more prevalent as tools for communication before and after disasters occur. In recent disasters such as Hurricane Katrina, Hurricane Rita, the train bombings in Mumbai, and the Asian tsunami, civilians have used various forms of social technologies to mobilize civilian led relief efforts, to help reunite people with their families, and to inform people about recovery services. End user technologies are therefore being used more frequently by civilians to connect and communicate during emergency situations, however; questions such as how these technologies should be designed and deployed, the role of these technologies in mobilizing community-based emergency management efforts, and their impact on information policy need to be answered.

2.5 Device selection and use considerations

Zingale, Ahlstrom, and Kudrik (2005) prepared a technical report which provides human factors guidance for the use of handheld, portable, and wearable computing devices. According to this study, understanding the needs and goals of the user is critical when optimizing the selection and use of equipment for a specific job function. For a device to be used with minimal training, major features and functions must be easily accessible and visible. Devices that have good legibility and color contrast are generally easier to learn, more effective, and more readily acceptable by users. A set of criteria must be established in order to determine whether or not a device will be adequate for the user's task performance expectations. Users should be able to hold, transport, or wear their devices for extended periods of time. Devices should be of appropriate physical dimensions which are dependent on the anthropometrics of the existing population of

users. Selecting devices with appropriate human-computer interfaces is essential for meeting user requirements. It is important to consider how well these devices accommodate the environmental conditions under which they are to be used. In addition, it is important to evaluate which aspects of durability are relevant during device selection including resistance to temperature and humidity extremes, resistance to vibration, shock, dust, chemicals, and resistance to damage if the device is dropped. The physical interaction between the device and the user is also important to consider.

The Department of Defense (1995) released a guide for human engineering design considerations and included guidance for hand held test equipment. According to the Department of Defense, handheld equipment should allow the user to attach the device to his or her clothing without interfering with its use. Handheld equipment should have a non-slip surface and should be shaped so that it does not slip out of the user's hand. Handheld equipment should also be small and lightweight. In addition, portable equipment should feature rounded corners and edges.

Low cost cell phones are typically larger, heavier, have fewer features, and cost under $100 (WirelessGuide, 2007). Mid-priced cell phones are smaller and lighter with extended-life batteries and cost $100-$300. High-end cell phones offer the latest features, the smallest designs, and cost over $300. There are currently three standard mobile phone batteries: nickel cadmium (NiCad), nickel metal hydride (NiMH), and lithium ion (Li-ion). NiCad is an older technology and has known problems such as being subject to memory effects, or damage due to charging repeatedly without being fully discharged. NiMH is a newer technology which does not suffer from memory effects like NiCad batteries and holds charge longer. Li-On is a long lasting and light battery type which

does not suffer from memory effects and is the most expensive of the three standard battery types. Talk time and standby time should also be considered when selecting a mobile device. Talk time is the amount of time a battery can power a phone when it is being used to make or receive calls. Standby time is the amount of time a battery can power a phone when it is on but not being used.

The standard QWERTY keyboard is the fastest of all text entry methods (Arif, 2009). The multi-tap phone keypad is the slowest text entry method. Amongst QWERTY type keyboards, the mini-QWERTY text entry method is the second fastest alternative. The size of keyboard layout does not have a noticeable impact on performance. Soft text entry is faster than text entry using a multi-tap phone keypad, but not as fast as text entry using QWERTY and mini-QWERTY keyboards.

According to the National Institute of Justice "a communication system is made up of devices that employ one of two communication methods (wireless or wired), different types of equipment (portable radios, mobile radios, base/fixed station radios, and repeaters), and various accessories (examples include speaker microphones, battery eliminators, and carrying cases) and/or enhancements (encryption, digital communications, security measures, and interoperability/networking) to meet the user needs." (NIJ, 2002) Shared communication systems such as radios, internet, and telephone can get saturated during emergency situations and that published communication system guidelines must be followed by users in order to maintain a high level of efficiency. A method for selecting communication devices for use in disaster management that considers 14 different selection factors was proposed. These factors were selected by a panel of scientists and engineers who all had extensive experience in

disaster management. These factors are as follows: maximum transmitter output power, secure communications compatibility, programmability, user capability, line of sight, power requirements, battery life, battery locking ability, vehicular adaptor, digital communications compatibility, durability, unit cost, and training requirements. In order to use this proposed device rating method, each factor is given a ranking for each piece of equipment using a symbolic ranking system which uses an empty circle, half full circle, three quarters full circle, and full circle as a rating system in that order. A selection factor key is also presented for each factor. For example, a communication system is given an empty circle if it has restrictive user capability, a half filled circle if it has fixed capability, and a full circle if it has unlimited capability in regard to the user capability factor. The rating rubric for these 14 selection factors can be seen in Figure 1. It should be noted that the rating system proposed by the National Institute of Justice does not provide overall scores for devices and is only used to provide independent ratings for each device selection factor.

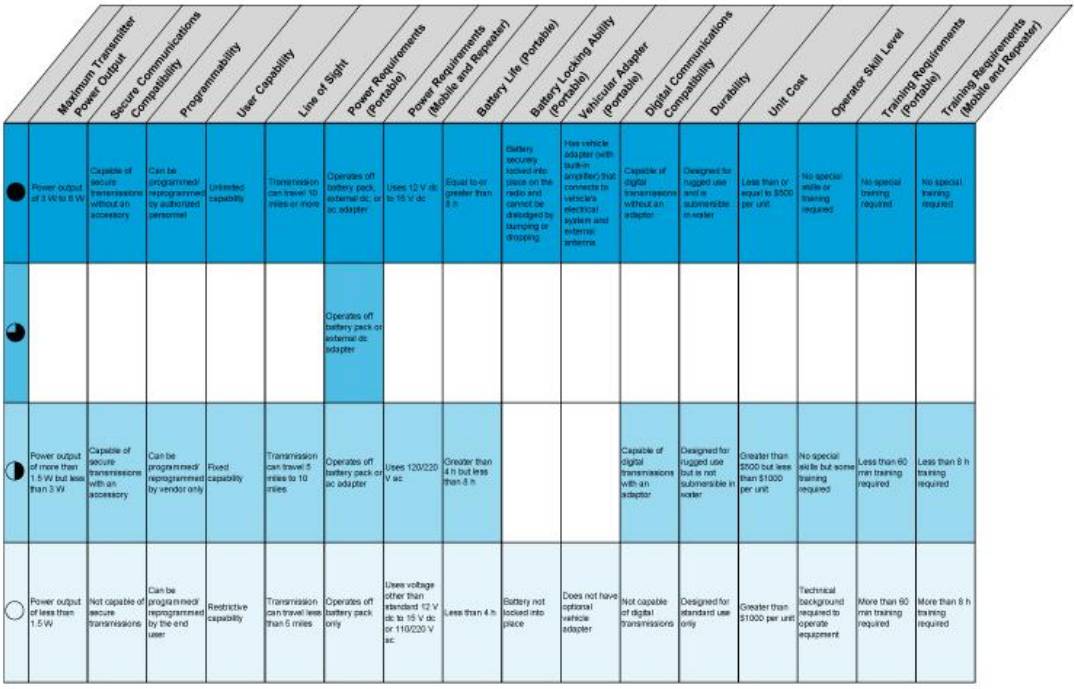


Figure 1: Selection factor key for communication equipment (NIJ, 2002)

In Nielson's model of usability, usability is a component of usefulness (Leventhal and Barnes, 2008). If a system is not useful, then the usability of the system will not matter. Factors aside from usability, such as reliability, can impact whether or not a system is considered useful. Nielson's model specifies that five dimensions are important to usability: easy to learn, efficient to use, easy to remember, few errors, and subjectively pleasing. Nielson does not weight the dimensions in this model since the importance of each dimension is dependent on the project.

CHAPTER THREE:
ASSESSMENT OF COMMUNICATION NEEDS

3.1 Introduction

Information exchange has been identified as a critical component in order to accurately relay important information between affected civilians, aid workers, and officials directing relief efforts (Meissner et al., 2002). With the emergence of wireless technology in disaster management, improving this information exchange is more important than ever. Before making improvements to information exchange, however, it is necessary to first understand the needs of the users of these systems using a human centered approach. The objective of this phase of the study was to utilize knowledge acquisition and data collection techniques in order to determine the communication needs of emergency management officials and civilians residing in the Bahamas, which is identified as a developing island nation facing communication challenges similar to those of other developing nations with limited communication infrastructures. The communication needs were categorized as infrastructure, organizational, and equipment needs. A baseline of what devices are currently used in that country was also established

3.2 Research goals

The research hypotheses associated with the first phase of this study are as follow:

1. To determine whether or not specific human factors associated with hand-held communication devices in emergency management exist.

2. To determine whether or not these specific human factors can be identified, qualified, or quantified if it is found that they do exist.
3. To set a baseline for the use of hand-held devices by Bahamian emergency management officials and civilians.

3.3 Methodology

During this phase of the project, knowledge acquisition and data collection techniques were used in order to determine the communication needs of Bahamian emergency management officials and civilians during emergencies. The knowledge acquisition techniques included examining the sources from the literature review and an interview with a group of subject matter experts. The data collection techniques included performing surveys on Bahamian emergency management officials and civilians. Infrastructure, organizational, and equipment needs were identified by each of these techniques and a comprehensive list of communication needs during high consequence emergencies in The Bahamas was developed. Figure 2 shows the methodology process for the entire study (including both phases) and the steps involved with the methodology for this phase are shaded. It should be noted that since the literature review was an ongoing process throughout much of this project, it is considered a component of both phases.

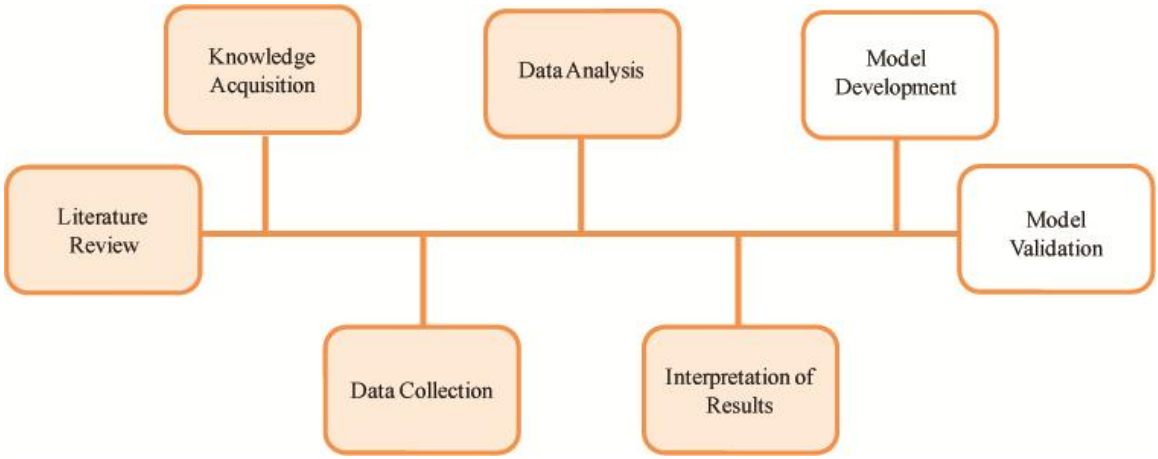


Figure 2: Methodology for the entire study with components of the first phase shaded

3.3.1 Interview with Subject Matter Experts

A focus group interview was held at the National Emergency Management Agency (NEMA) office in Nassau, Bahamas with 14 Subject Matter Experts (SMEs) representing NEMA as well as the various emergency support functions (ESFs) and affiliated organizations including the Department of Broadcasting, the Bahamas Electricity Corporation, the Ministry of Tourism, the Salvation Army, and the Department of Public Health. The purpose of this interview was to learn more about the emergency management operations in The Bahamas and the communication challenges faced by these emergency management officials during emergency management situations.

3.3.1 Survey of the Communication Needs of Emergency Management Officials

A survey was conducted involving 31 Bahamian emergency management officials in order to determine the background information of the participants, their

communication habits, which wireless devices they use, wireless services to which they have access, feedback on the performance and usability factors regarding the devices they use, and which other devices they use during the different phases of emergency management. The 14 emergency management officials who participated in the focus group interview also participated in the survey along with 17 additional emergency management officials in The Bahamas.

Figure 3: Bahamian emergency management officials completing surveys

The paper-based survey (see Appendix B) was used to collect data in order to establish a baseline for current wireless communication use by Bahamian emergency management officials as well as to identify equipment deficiencies experienced by participants. The survey consisted of 28 multiple choice questions as well as 5 free response questions. The questions verified information about the emergency management officials and their personal communication devices. On the survey, questions were grouped under the associated topics of: background, handheld communication experience, device performance, usability, other communication

devices, and suggestions. In the background section, personal questions were asked to acquire information regarding demographics, emergency management position, types of tasks performed by emergency management officials, years of employment, and formal training. Other questions were used to determine the type and service capabilities of the specified handheld communication device; the skill level of the user, frequency of use, and related tasks were also determined in this section. Questions geared toward device speed, reliability, battery life, and durability were used in the device performance section of the survey. In the usability section, civilians rated their devices on their ease of use, size, weight, and accuracy of text entry. Officials were asked if they had problems with their devices slipping out of their hands. The usability section was comprised of questions about the visual clarity, audio clarity, lighting, and interference with device caused by outside factors. In the section of other communication devices, officials were asked to specify any other communication devices to which they have regular access; such devices included satellite phone, landline phone, radio, and personal computers. A series of phase analysis questions was also included in the survey which asked about the types of communication devices utilized by the emergency management officials during the various phases of emergency management; however, that data was not used in this analysis and will be used in a future study. The final section on the survey called for suggestions regarding design improvements for handheld devices and ways the devices can be used to improve their effectiveness during emergency management.

Once all of the surveys were completed and returned, frequency tables, which listed the frequencies and percentages for each possible response, were prepared for each of the questions. The following correlations were examined:

- Age and device owned
- Age and skill level with wireless communication devices
- Problems with devices slipping out of the hands of users and age
- Problems with devices slipping out of the hands of users and device owned
- Education and skill level with wireless communication devices
- Years of experience in emergency management and skill level with wireless communication devices
- Formal training in emergency management and skill level with wireless communication devices
- Speed at which users can perform tasks on their devices and device owned
- Ease of text entry and device owned
- Ease of use and device owned
- Reliability and device owned
- Size of device and device owned
- Weight of device and device owned

3.3.3 Survey of the Communication Needs of Bahamian Civilians

A similar survey (see Appendix B) was conducted involving 155 randomly selected Bahamian civilians living in Nassau, the capital city of The Bahamas which is located on the island of New Providence. The survey used for assessing the communication needs of Bahamian Civilians was a reduced version of the survey used for assessing the communication needs of Bahamian emergency management officials. The survey consisted of 14 multiple choice questions as well as 3 free response questions, which is 15 questions shorter than the survey used for emergency management officials. The questions which were omitted from the survey for civilians included occupation, training, and task related questions which were only relevant to emergency management officials as well as a few detailed questions in regard to device performance and phase

analysis questions. The surveys were manually distributed and administered to ensure a greater level of participation. The distribution took place at high traffic locations (such as a large shopping mall, a few restaurants, and the downtown), as well as smaller local gatherings (such as at church and university classrooms). The different distribution sites allowed for a wide cross section of civilians. It should be noted that many of the approached civilians refused to participate in the survey since they did not have experience with hand-held communication devices.

As with the survey for emergency management officials, frequency tables, which listed the frequencies and percentages for each possible response, were prepared for each of the questions. The following correlations were also examined:

- Age and device owned
- Age and skill level with wireless communication devices
- Problems with devices slipping out of the hands of users and age
- Problems with devices slipping out of the hands of users and device owned
- Education and skill level with wireless communication devices
- Speed at which users can perform tasks on their devices and device owned
- Durability and device owned
- Ease of text entry and device owned
- Ease of use and device owned

3.4 Results

3.4.1 Results from Focus Group Interview

The director of NEMA explained that satellite phones are available for use by all support functions; however, they are only used when other forms of communication are not available. Citizens' Band (C.B) radios are generally used for communication to remote islands. A trunked radio system is utilized by the police force. The main forms of communication between NEMA and the various affiliate organizations are landline

phones, cell phones, and handheld radios which are distributed during critical emergency situations. It was stated that cellular devices were mostly relied on by the local communities during emergencies. It was mentioned during the interview that text messaging was a standard service for all cellular phone customers. Picture/video mail and 3G mobile internet, however, are not available to the general population while these services are available to American tourists since their devices operate off of towers installed by American companies. Several of the emergency management officials indicated that these features would be highly beneficial to emergency management efforts in The Bahamas if they were available.

Several emergency management officials who were present at the focus group interview stated that the main communication problem in The Bahamas in regard to emergency management was the poor communication infrastructure. Many of the emergency management officials expressed concern for the possible loss of cellular service due to natural disasters and that even the most effective devices would become completely useless if service was lost. Some emergency management officials expressed concern for the ability to charge wireless devices if power loss is experienced. A few of the emergency management officials indicated the need for devices that are resistant to severe weather and possess qualities such as being water proof and shock absorbent. Many of the emergency management officials suggested handheld devices feature panic buttons so that geographic information about distressed civilians could be shared with emergency management officials. In addition, it was suggested that devices belonging to local Bahamians should have the ability to receive

connectivity from American towers when local Bahamas Telecommunications Company (BTC) towers are down.

3.4.2 Frequencies of survey responses

The data of response frequencies (see Appendix C) indicate the age brackets of the respondents, the range of wireless hand-held devices surveyed, and the utilization or availability of wireless communication services; they also give indications of battery charge, usability, reliability and the adequacies or inadequacies of device size and weight from the personal perspectives of users.

3.4.2.1 Emergency Management Officials

Figure 4 shows the age distribution of the emergency management officials. It shows that 10% of the survey participants were between 26 and 35, 13% between 36 and 45, 55% between 46 and 55, and 23% were 56 and over. There were no participants who were 25 or under.

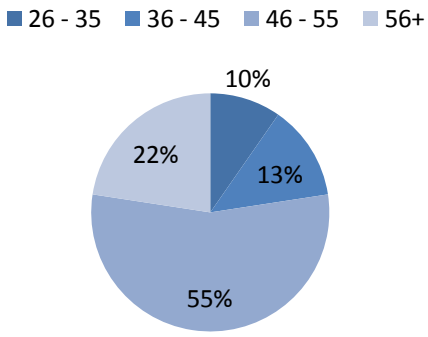


Figure 4: Age distribution of officials

It was also found that 72% of the officials had formal training in emergency management. In addition, 13% of the officials had only a high school diploma, 7% had

an associate's degree, 20% had a bachelor's degree, 37% had a graduate degree, and 23% had some other form of post-high school education or certification. Seventy-seven percent of participating emergency management officials indicated they used their handheld device on a daily basis while performing task responsibilities.

As shown in Figure 5, 71% of the emergency management officials participating in the survey who specified which type of device they used were BlackBerry users, 24% were Nokia users, and 5% were iPhone users. None of the emergency management officials specified that they used any other brands.

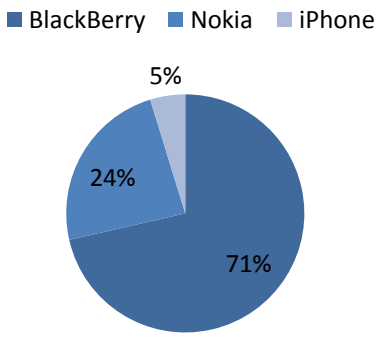


Figure 5: Device use among officials who specified device

Figure 6 shows that 90% of the emergency management officials had access to voice communication on their devices, 87% had access to text messaging, 58% had access to mobile internet, 13% had access to 3G internet, and 6% had other forms of connectivity on their devices.

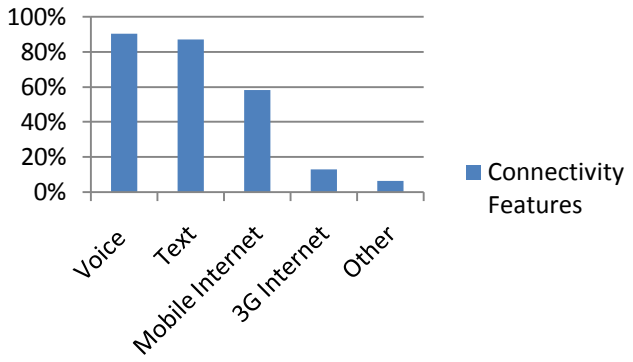


Figure 6: Connectivity services available to officials

As shown in Figure 7, 8% of the officials considered themselves novices regarding skill level with wireless devices, 17% considered themselves advanced beginners, 42% considered themselves as being competent with wireless device use, 25% considered themselves as being proficient, and 8% considered themselves as being experts with wireless devices.

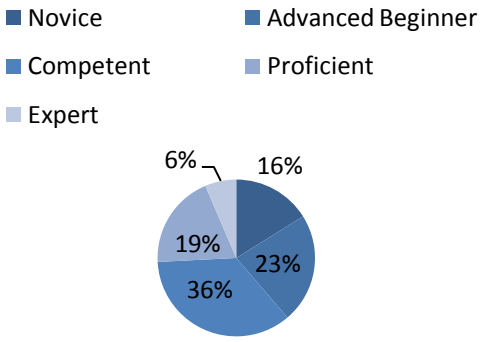


Figure 7: Skill levels of officials with wireless devices

Fifty-five percent of the participating emergency management officials indicated they had experienced problems with gripping their devices. Responses from the other questions in the device performance and usability sections of the survey can be seen in Table 2. Thirteen percent of the survey participants owned devices with battery lives less

than 6 hours, 57% claimed they experienced moderate or slower task performance speeds with their devices, 37% indicated their devices were only fairly durable, fragile, or extremely fragile, 41% claimed their devices were fairly easy or more difficult to use, 45% claimed their device's accommodation to environmental lighting conditions was fairly well or worse, 23% owned devices they felt were big in size, 10% owned devices they felt were heavy or extremely heavy, and 45% of the emergency management officials claimed the ease of text entry on their devices was bearable or worse.

Table 2: Frequencies of device performance and usability responses for officials

	1	2	3	4	5
Battery Life	0-2 hrs.	2^{+}-4 hrs.	4^{+}-6 hrs.	6^{+}-8 hrs.	8^{+} hrs.
	0%	3%	10%	16%	71%
Task Speed	Extremely Slow	Slow	Moderately Fast	Fast	Extremely Fast
	3%	6%	48%	32%	10%
Durability	Extremely Fragile	Fragile	Fairly Durable	Durable	Extremely Durable
	0%	7%	30%	47%	17%
Ease of Use	Extremely Difficult	Difficult	Fairly Easy	Easy	Extremely Easy
	0%	6%	35%	45%	13%
Accommodation. to Environmental Lighting	Extremely Poor	Poor	Fairly Well	Well	Extremely Well
	0%	10%	35%	39%	16%
Size	Extremely Small	Small	Ideal	Big	Extremely Big
	0%	16%	61%	23%	0%
Weight	Extremely Light	Light	Average	Heavy	Extremely Heavy
	13%	23%	55%	10%	0%
Ease of text entry	Highly Unacceptable	Unacceptable	Bearable	Good	Optimum
	0%	6%	39%	52%	3%

Participating emergency management officials were asked what other devices they used in emergency management situations. As shown in Figure 8, 75% of emergency management officials who participated in this survey indicated that they

had satellite phones in emergency management situations, while 88% used landline phones, 83% used radio's, 67% used personal computers, and 8% used other devices.

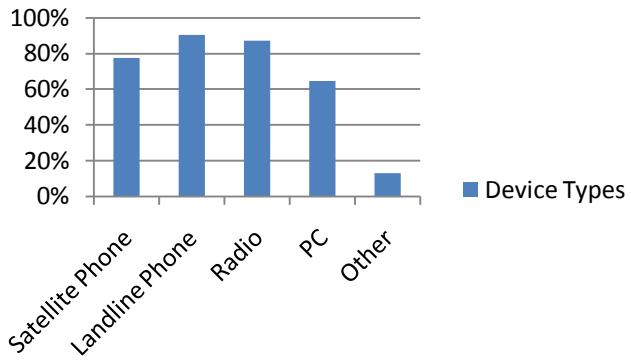


Figure 8: Other devices used by officials in emergency management situations

3.4.2.2 Bahamian Civilians

Figure 9 shows the age distribution of civilian respondents. It shows that 6% of the participating civilians were under the age of 18, 37% were between 18 and 25, 16% between 26 and 35, 21% between 36 and 45, 14% between 46 and 55, and 5% were over 56.

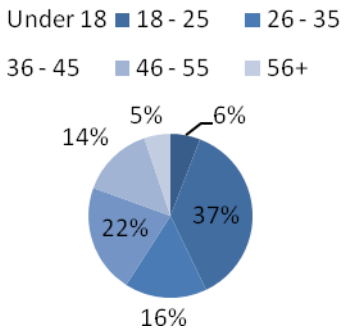


Figure 9: Age distribution of civilians

As shown in Figure 10, 40% of the civilians owned a BlackBerry device, 9% owned an iPhone, 21% owned a Nokia device, 16% owned a Motorola device, and 14% owned a device of some other brand.

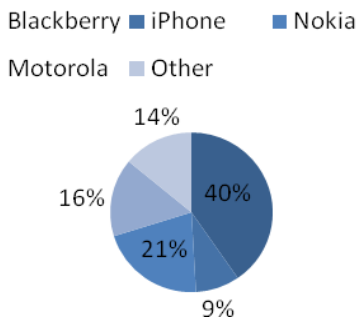


Figure 10: Device use among civilians who specified device

Figure 11 shows that 95% of the survey participants indicated they had access to voice communication on their devices, 94% had access to text messaging, 37% had mobile internet access, 10% had 3G access, and 5% had other forms of connectivity on their devices.

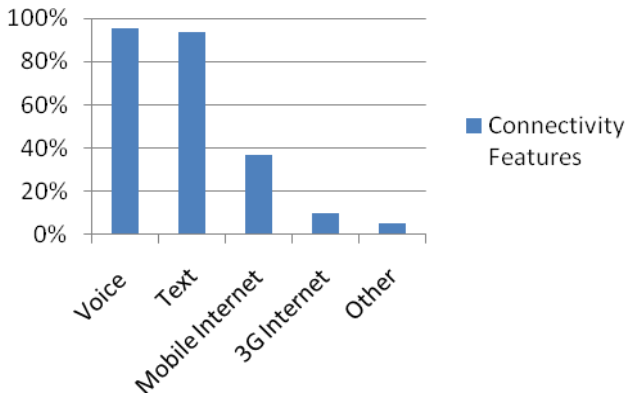


Figure 11: Connectivity features available to civilians

As shown in Figure 12, 10% of the participating civilians considered themselves novices regarding skill level with wireless devices, 11% considered themselves advanced

beginners, 31% considered themselves as being competent with wireless device use, 27% considered themselves as being proficient, and 21% considered themselves as being experts with wireless devices.

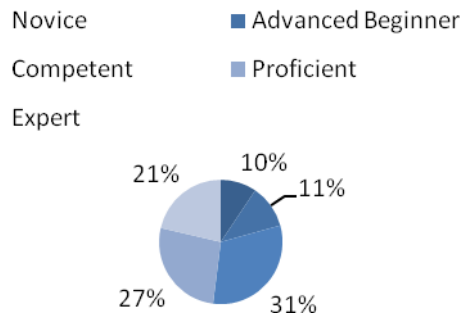


Figure 12: Skill levels of civilians with wireless devices

Additionally, 49% of the civilians indicated they had experienced problems with gripping their devices. Responses from the other questions in the device performance and usability sections of the survey can be seen in Table 3. Twenty percent of the survey civilians owned devices with battery lives less than 6 hours, 49% claimed they experienced moderate or slower task performance speeds with their devices, 36% of indicated that their devices were only fairly durable, fragile, or extremely fragile, 37% claimed that their devices were fairly easy or more difficult to use, 12% owned devices that they felt were big or extremely big, 9% owned devices that they felt were heavy or extremely heavy, and 34% of the participating civilians claimed that the ease of text entry on their devices was bearable or worse.

Table 3: Frequencies of device performance and usability responses for civilians

	1	2	3	4	5
Battery Life	0-2 hrs.	2^{+}-4 hrs.	4^{+}-6 hrs.	6^{+}-8 hrs.	8^{+} hrs.
	0%	4%	16%	29%	51%
Task Speed	Extremely Slow	Slow	Moderately Fast	Fast	Extremely Fast
	1%	7%	41%	34%	18%
Durability	Extremely Fragile	Fragile	Fairly Durable	Durable	Extremely Durable
	3%	8%	25%	46%	18%
Ease of Use	Extremely Difficult	Difficult	Fairly Easy	Easy	Extremely Easy
	1%	9%	27%	45%	19%
Size	Extremely Small	Small	Ideal	Big	Extremely Big
	2%	26%	60%	11%	1%
Weight	Extremely Light	Light	Average	Heavy	Extremely Heavy
	5%	40%	46%	7%	2%
Ease of text entry	Highly Unacceptable	Unacceptable	Bearable	Good	Optimum
	1%	6%	27%	51%	16%

The civilians were also asked what other devices they used in emergency management situations. As shown in Figure 13, 7% of civilians who participated in this survey indicated they had satellite phones in emergency management situations, while 77% used landline phones, 68% used radio's, 70% used personal computers, and 8% used other devices

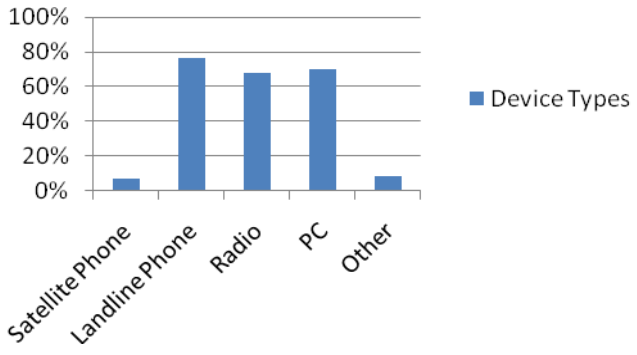


Figure 13: Other devices used by civilians in emergency management situations

3.4.3 Correlations

Correlations were drawn from the survey responses (see Appendix C) that gave rise to the following summary of the user perspectives regarding the performance, usability and other characteristics of their wireless hand-held communication devices. The data tends to indicate that not all phones are equal in the eyes (or hands) of the users and there is considerable variability.

3.4.2.1 Emergency management officials

Since only BlackBerry, Nokia, and iPhone devices were identified as being used by the emergency management officials who participated in the survey and since there were not enough respondents with iPhones to identify any strong correlations, correlations were only examined for BlackBerry and Nokia devices.

A high percentage of emergency management officials who used both devices indicated moderate speeds for completing tasks (Table 4). Additionally, the results indicate officials' perceptions of the Nokia devices as being the most likely of the surveyed device types to give performances that were moderate (50%) or fast (50%). The largest percentage of BlackBerry users (58%) considered that device type to be fast while a large percentage of users (33%) considered that device type to be only moderately fast.

Table 4: Task performance speeds of devices belonging to officials

	Extremely Slow	Slow	Moderate	Fast	Extremely Fast
BlackBerry	0%	0%	33%	58%	8%
Nokia	0%	0%	50%	50%	0%

A significant portion of emergency management officials using both devices indicated the durability of their devices as being fairly durable or less durable (Table 5).

Between both devices, the Nokias were more likely than the others to be considered durable (80%) and the BlackBerry devices more likely to be considered fairly durable (46%) or fragile (21%).

Table 5: Durability of devices belonging to officials

	Extremely Fragile	Fragile	Fairly Durable	Durable	Extremely Durable
BlackBerry	0%	21%	43%	21%	14%
Nokia	0%	0%	20%	80%	0%

User satisfaction of text entry, analyzed in Table 6, shows that 47% of officials using BlackBerry devices indicated their device's text entry is above average (i.e., good) to optimal, while the rest of the Blackberry users found their devices to be either unacceptable or bearable with respect to text entry. Forty percent of Nokia users indicated good text entry, while only 60% indicated it to be bearable or unacceptable.

Table 6: User satisfaction of text entry for devices belonging to officials

	Highly Unacceptable	Unacceptable	Bearable	Good	Optimum
BlackBerry	0%	7%	47%	40%	7%
Nokia	0%	20%	40%	40%	0%

Officials' perspectives on the overall ease of use of their devices are given in Table 7. It is shown that 94% of officials using Blackberry devices indicated their devices were fairly easy, easy, or extremely easy to use. 80% of officials using Nokia devices indicated their devices were either fairly easy or easy to use while the other 20% of Nokia users indicated their devices were difficult to use.

Table 7: Ease of use of devices belonging to officials

	Extremely Difficult	Difficult	Fairly Easy	Easy	Extremely
BlackBerry	0%	7%	47%	40%	7%
Nokia	0%	20%	40%	40%	0%

In terms of reliability, 33% of officials using Blackberry devices deemed the devices to be only fairly reliable, while all Nokia and users of other devices deemed devices to be either reliable or extremely reliable. In regard to accommodation to environmental lighting conditions, all Nokia users indicated their devices accommodate either well or extremely well to environmental lighting conditions (Table 8). Only 40% of BlackBerry users indicated their devices accommodate to operational lighting conditions either well or extremely well.

Table 8: Accommodation to environmental lighting condition of devices belonging to officials

	Extremely Poorly	Poorly	Fairly Well	Well	Extremely Well
BlackBerry	0%	20%	40%	33%	7%
Nokia	0%	0%	0%	80%	20%

The sizes of the devices were also questioned. Twenty percent of officials who were Blackberry users indicated their device as being big. All officials using Nokias indicated the device is either small or ideal. All officials using Nokias and 73% of Blackberry users indicated that the device is either light or average weight.

For the devices taken all together, the results in Table 9 show self-perceptions of high skill levels (competent, proficient, or expert) for all participating officials 18-35 years old; self-perceptions of mixed skill levels for officials age 36-45 and 46-55, however still majority skilled (75% and 64%, respectively, in the combined competent, proficient, or expert category); and self-perceptions of a relatively low skill level

(novice and advanced beginner) by officials 56+ years old (only 29% in the competent category).

Table 9: Skill levels of officials

	Novice	Advanced Beginner	Competent	Proficient	Expert
18-25	0%	0%	25%	18%	14%
26-35	0%	0%	67%	33%	0%
36-45	25%	0%	50%	0%	25%
46-55	18%	18%	29%	29%	6%
56+	14%	57%	29%	0%	0%

Finally, no distinct correlation was found between age and problems with devices slipping from the hands. No distinct correlation was found between skill level and education. No distinct correlation was found between skill level and years of experience in emergency management. No distinct correlation was found between skill level and whether or not formal training in emergency management was received either.

3.4.2.2 Bahamian Civilians

A high percentage of civilians using all devices indicated moderate, slow, or extremely slow speeds for completing tasks (Table 10). Additionally, the results indicate civilians' perceptions of the Nokia devices as being the most likely of the surveyed device types to give performances that were moderate (73%) or extremely fast (27%); the iPhones, they perceived, were most likely to give a fast response (40%) and the Motorolas most likely to function the slowest of all the devices in the survey (11%). The largest percentages of civilians using BlackBerry devices and all other users considered their device types to be only moderately fast (Blackberry 43%, Nokia 73%, Motorola

45%, iPhone 40%, and other devices 50% -- 40% also of iPhone respondents considered their devices to be fast)

Table 10: Task performance speeds of devices belonging to civilians

	Extremely Slow	Slow	Moderate	Fast	Extremely Fast
BlackBerry	0%	9%	43%	26%	22%
Nokia	0%	0%	73%	0%	27%
Motorola	11%	22%	45%	11%	11%
iPhone	0%	0%	40%	40%	20%
Other	0%	0%	50%	25%	25%

A large percentage of civilians using all devices indicated the durability of their devices as being fairly durable, fragile, or extremely fragile (Table 11). Among all the devices, the BlackBerrys were more likely than the others to be considered durable (64%), the Nokia devices more likely to be considered extremely durable (36%), and the Motorolas more likely to be perceived as being fairly durable or fragile (45% and 11%, respectively). Other device types had the highest percentage of the "Extremely Fragile" rating (25%).

Table 11: Durability of devices belonging to civilians

	Extremely Fragile	Fragile	Fairly Durable	Durable	Extremely Durable
BlackBerry	0%	9%	23%	64%	4%
Nokia	0%	0%	18%	46%	36%
Motorola	11%	11%	45%	33%	0%
iPhone	0%	0%	40%	60%	0%
Other	25%	0%	12%	38%	25%

User satisfaction of text entry, analyzed in Table 12, shows that 81% of civilian Blackberry users indicated their device's text entry is above average (i.e., good) to optimal, while the other 19% of civilian Blackberry users found their devices to be either unacceptable or bearable with respect to text entry. Ninety-one percent of civilians using

Nokias indicated good to optimal text entry, while only 9% indicated it to be bearable. Sixty-seven percent of civilian Motorola users indicated unacceptable to bearable text entry, while only 33% indicated that it was good to optimal. All participating civilians who were iPhone users indicated either bearable (25%) or good (75%) text entry for the device, leaving room for improvement. Thus, the Nokia devices were most likely to be considered more ergonomic for text entry.

Table 12: User satisfaction of text entry for devices belonging to civilians

	Highly Unacceptable	Unacceptable	Bearable	Good	Optimum
BlackBerry	0%	5%	14%	48%	33%
Nokia	0%	0%	9%	64%	27%
Motorola	0%	22%	45%	22%	11%
iPhone	0%	0%	25%	75%	0%
Other	0%	25%	13%	63%	0%

Civilian perspectives on the overall ease of use of their devices are given in Table 13. It is shown that 87% of civilians using BlackBerry devices indicated that their devices were fairly easy, easy, or extremely easy to use, while the other 13% found the usage to be either difficult or extremely difficult. All civilian Nokia users indicated that their devices were either fairly easy, easy, or extremely easy to use. There were mixed responses for Motorola, iPhone, and other devices, i.e., around 60% of Motorola, iPhone and other device respondents considered their devices to be either extremely easy or easy to use, while around 40% thought they were either fairly easy or difficult. Only about 33% of civilian Blackberry users and 40% of Nokia users indicated problems with gripping their devices while the majorities (of BlackBerry and of Nokia users) indicated no problems at all. There were split responses on gripping problems from civilians using Motorolas and iPhones.

Table 13: Ease of use of devices belonging to civilians

	Extremely Difficult	Difficult	Fairly Easy	Easy	Extremely Easy
BlackBerry	4%	9%	30%	44%	13%
Nokia	0%	0%	17%	58%	25%
Motorola	0%	11%	33%	45%	11%
iPhone	0%	20%	20%	40%	20%
Other	0%	13%	25%	50%	13%

For the devices taken all together, the results in Table 14 show self-perceptions of high skill levels (competent, proficient, or expert) for civilians under 18 and 18-25 years old (100% and 88%, respectively); self-perceptions of mixed skill levels for civilians age 26-35 and 36-45, however still majority skilled (75% and 77%, respectively, in the combined competent, proficient, or expert category); and self-perceptions of a relatively low skill level (novice and advanced beginner) by civilians 46-55 years old and 56+ (only 66% and 50%, respectively, in the combined competent, proficient, or expert category).

Table 14: Skill levels of civilians

	Novice	Advanced Beginner	Competent	Proficient	Expert
Under 18	0%	0%	34%	33%	33%
18-25	9%	3%	30%	33%	25%
26-35	12%	13%	21%	29%	25%
36-45	10%	13%	35%	23%	19%
46-55	5%	29%	43%	14%	9%
56+	25%	25%	25%	12%	13%

Finally, no distinct correlation was found between age and problems with devices slipping from the hands. Also no distinct correlation was found between education and skill level.

3.4.4 Identification of Communication Needs

The communication needs during emergency situations in The Bahamas were analyzed in three categories: infrastructure needs, organizational needs, and equipment needs. Separate lists of communication needs were developed for both of the knowledge acquisition techniques as well as both of the data collection techniques utilized in the methodology of this study (text analysis, interview analysis, survey on emergency management officials, and survey on Bahamian civilians) and a comprehensive list of communication needs was developed.

3.4.4.1 Communication needs based on text analysis

Based on findings from the literature review, a list of the communication needs during emergency situations in terms of infrastructure, organizational, and equipment needs was developed and can be seen in Table 15.

Table 15: Communication needs based on text analysis

Infrastructure needs	
High availability of communication	Fast data access
Organizational needs	
Intra- and inter- organizational coordination	Integrated communication and information system for disaster management
Integration and linkage of information	Timeliness and updating of information
Standardization of information	Phased information release
Utilization of mobile technology in order to promote civilian awareness	
Equipment needs	
Devices that auto-configure	Devices that require little physical and cognitive effort
High visibility of major features and functions	Good legibility and color contrast
Devices that are portable	Appropriate human-computer interface
Devices that are durable	Ergonomic design
Devices with adequate grip	Devices that consider user capability

Devices that are cost effective	Devices that consider usability

3.4.4.2 Communication needs based on interview analysis

As shown in Table 16, a list of communication needs based on the responses during the focus group interview was developed.

Table 16: Communication needs based on interview analysis

Infrastructure needs	
Access to 3G mobile internet	Access to picture and video messaging
Better wireless signals	More reliable service
Organizational needs	
Ability to connect to American towers during emergencies	
Equipment needs	
Weather resistance	Alternative methods for powering devices
Devices enabled with panic buttons	

3.4.4.4 Communication needs based on survey responses from officials

Several infrastructure and equipment deficiencies experienced by Bahamian emergency management officials when using their devices to perform task responsibilities were identified through the use of the survey. Table 17 contains a list of communication needs which were all derived from the deficiencies which were identified through analysis of the surveys on Bahamian emergency management officials.

Table 17: Communication needs based on survey responses from officials

Infrastructure needs	
High availability of connectivity features	Higher reliability of network services
Equipment needs	
Devices with longer battery lives	Devices that allow users to perform tasks more quickly
Devices that are durable	Devices that accommodate to environmental lighting conditions
Smaller devices	Devices with ideal text entry methods
Larger keys	Weather resistance

3.4.4.5 Communication needs based on survey responses from civilians

Several communication deficiencies were also identified through the analysis of the surveys on Bahamian civilians. As with the survey on Bahamian emergency management officials, a list of communication needs which was derived from the identified communication deficiencies was developed and can be seen in Table 18.

Table 18: Communication needs based on analysis of survey responses from civilians

Infrastructure needs	
High availability of connectivity features	Better wireless signals
Organizational needs	
Better technical support from the local cell phone provider	Free minutes during emergencies
Equipment needs	
Devices with longer battery lives	Devices that allow users to perform tasks more quickly
Devices that are durable	Devices that are easy to use
Devices that are portable	Devices with ideal text entry methods
Devices with adequate grip	Voice activation features
Devices enabled with panic buttons	Devices that are reliable
Weather resistance	Tracking features
Alternative methods for powering devices	Larger keys

3.4.4.6 Comprehensive list of communication needs

Finally, a comprehensive list (Table 19) of the communication needs during emergency situations in The Bahamas was developed which incorporates communication needs which were identified through the use of all of the knowledge acquisition techniques. The communication needs which were deemed as being the most relevant and which appeared the most frequently from the lists of communication devices based on the text analysis, interview analysis, survey responses from emergency management officials, and survey responses from civilians were included in the comprehensive list.

Table 19: Comprehensive list of communication needs

Infrastructure needs	
High availability of connectivity features	Fast data access
Access to 3G mobile internet	Access to picture and video messaging
Better wireless signals	More reliable service
Organizational needs	
Intra- and inter- organizational coordination	Integrated communication and information system for disaster management
Integration and linkage of information	Timeliness and updating of information
Standardization of information	Phased information release
Utilization of mobile technology in order to promote civilian awareness	
Equipment needs	
Devices that auto-configure	Devices that require little physical and cognitive effort
High visibility of major features and functions	Good legibility and color contrast
Devices that are portable	Appropriate human-computer interface
Devices that are durable	Ergonomically designed devices
Devices with adequate grip	Devices that consider user capability
Devices that are cost effective	Devices that consider usability
Weather resistance	Alternative methods for powering devices
Devices enabled with panic buttons	Devices with longer battery lives
Devices that allow users to perform tasks more quickly	Smaller devices
Devices with larger keys	Devices that accommodate to environmental lighting conditions
GPS enabled tracking features	Devices with ideal text entry methods
Devices with longer battery lives	Devices that are weather resistance
Devices that are easy to use	Voice activation features

3.5 Discussion

Knowledge acquisition and data collection techniques were utilized in order to determine the communication needs of emergency management officials and civilians residing in the Bahamas. A text analysis was first performed on the existing body of knowledge in order to identify communication needs during emergency situations. A human-centered approach was then used to determine communication needs specific to

emergencies in The Bahamas. The human-centered approach to identifying the communication needs during emergency situations in The Bahamas presented an opportunity for the end-users of wireless hand-held communication devices to offer valuable, real-time experiences and provide data that can be analyzed and used around the globe to improve the universally recognized shortfalls of communication during emergency situations.

Several communication needs specific to emergency management operations in The Bahamas were identified during the focus group interview which involved 15 Bahamian emergency management officials acting as subject matter experts. Several communication deficiencies, mostly in regard to equipment, were identified through the use of surveys on Bahamian emergency management officials and civilians. The results from both surveys were very compatible with one another and all pointed to the same deficiencies proving that Bahamian emergency management officials and civilians shared similar concerns with these hand-held communication devices. Finally, a comprehensive list of communication needs during emergency situations in The Bahamas was compiled. Although communication needs may differ in general from region to region and country to country, the same methodology can be used to identify the communication needs of civilians around the globe.

Based on the results from the knowledge acquisition and data collection techniques which were used to identify communication needs during emergency situations in The Bahamas, it was found that specific human factors associated with the use of hand-held communication devices during high consequence emergencies existed. Due to the context specific conditions and stresses experienced by Bahamian emergency

management officials and civilians along with the performance and usability concerns associated with hand-held communication devices, it is apparent that human factors issues specific to the use of these devices during emergencies do in fact exist. The results from the knowledge acquisition and data collection techniques also proved that that these human factors issues could be identified and quantified or qualified being that these knowledge acquisition and data collection techniques revealed which human factors issues were of concern and to what extent. In addition, the responses from civilians and emergency management officials created a baseline for the current use of hand-held communication devices in The Bahamas.

CHAPTER FOUR:
DEVELOPMENT OF THE DEVICE SELECTION MODEL

4.1 Introduction

The previous phase of this project utilized knowledge acquisition and data collection techniques in order to determine the communication needs in The Bahamas as related to emergency management. The knowledge acquisition tools which were used included a text analysis where the existing body of knowledge was examined, an interview analysis where 14 Bahamian emergency management officials acting as subject matter experts were interviewed, a survey on Bahamian emergency management officials which included the participation of 31 officials, and a survey of Bahamian civilians which included the participation of 155 civilians. A comprehensive list of communication needs was identified from these sources and each need was appropriately classified as an infrastructure need, an organizational need, or an equipment need. The equipment needs which were identified in previous phase include:

- Devices that auto-configure
- Devices that require little physical and cognitive effort
- High visibility of major features and functions
- Legibility and color contrast
- Portable devices
- Devices with appropriate human-computer interfaces
- Devices that are durable
- Ergonomically designed devices
- Devices with adequate grip
- Devices that consider user capability

- Devices that are cost effective
- Devices that consider usability
- Devices that are weather resistant
- Alternative methods for powering devices
- Devices enabled with panic buttons
- Devices with longer battery lives
- Devices that allow users to perform tasks more quickly
- Smaller devices
- Devices with larger keys
- Devices that accommodate to environmental lighting conditions
- Devices with ideal text entry methods
- Devices with longer battery lives
- Devices that are weather resistance
- Devices that are easy to use
- Devices with voice activation features
- Devices with GPS enabled tracking features

Once initial equipment needs were identified, this phase of the project focused on developing a human-centered methodology for the assessment of hand-held communication devices for use in high consequence emergencies, for both officials and civilians. This model, developed only after extensive literature review, incorporated the equipment needs which were identified based upon opinions from Bahamian emergency management officials and civilians, using knowledge acquisition techniques along with text analysis. This model considered the usability factors associated with hand-held communication devices and considered the weighted priority of each selection factor based on input provided by a team of subject matter experts. User experience considerations, user capabilities, user capacities, and usability considerations were considered during the development of this methodology. Including subjective opinions and objective measures in the methodology of the proposed model for device assessment ensured that this model is human-centered. The proposed human-centered methodology

for assessing hand-held communication devices for use in emergencies can be used by Bahamian emergency management officials when assessing potential devices to be purchased for use while performing task responsibilities. In addition, this methodology can be used by device manufacturers when assessing prototypes for devices which will eventually be commercially available. This methodology can even be modified for use in other nations and industries. Civilians can also use this methodology when comparing devices for personal use.

4.2 Research hypotheses

The research goal associated with the second phase of this study is as follows:

1. To develop a model to holistically represent human factors issues associated with the use of hand-held communication devices in emergency management.

4.3 Methodology

During this phase of the project, device selection factors were identified based on further analysis of the equipment needs identified in the previous phase, as well as information found in the ongoing literature review. The identified device selection factors were then prioritized using the analytic hierarchy process (AHP). Rating scales were developed for each of the selection factors and a combination of physical evaluations, objective operator-use measures, and subjective operator opinions were included in these rating scales based upon input from subject matter experts. A human-centered methodology for assessing hand-held communication devices in the context of emergency management, in the form of a mathematical model, was then developed.

Finally, the proposed model was validated by testing the hand-held communication devices most commonly used by Bahamian emergency management officials and civilians against the model.

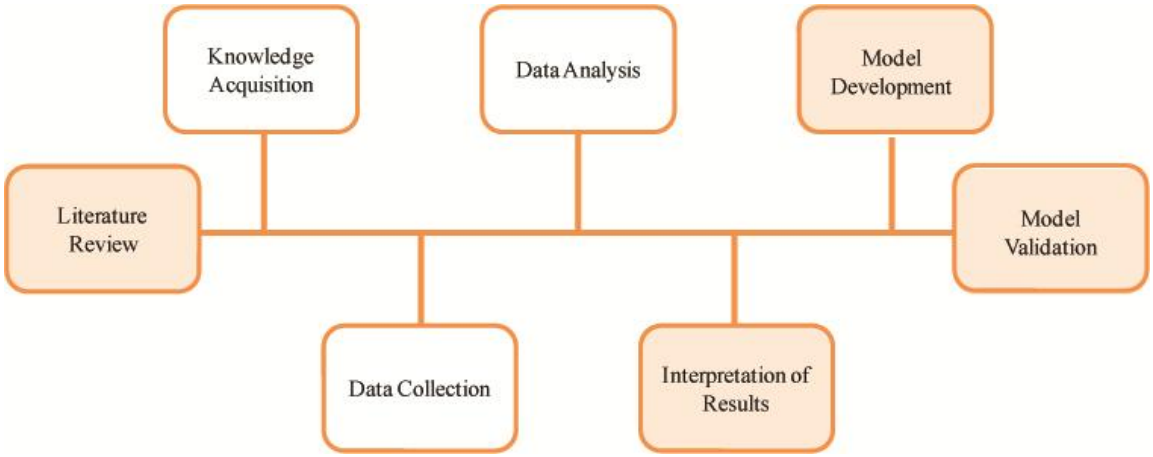


Figure 14: Methodology for the entire study with components of the second phase shaded

4.3.1 Identification of Selection Factors

Device selection factors were selected which addressed the equipment needs that were determined to be the most relevant during emergency management situations. The device selection factors which were selected were chosen with consideration only to features which were publically available on end-user hand-held communication devices at the time this study was conducted. As mobile technology advances and as more innovative features are incorporated in the designs of future devices, this list of device

selection factors can be altered in order to better reflect the latest technological advancements.

4.3.2 Determination of Weighted Priorities of Selection Factors

The analytic hierarchy process (AHP) was used to determine the weighted priority of each device selection factor. Five Bahamian emergency management officials who were identified as being subject matter experts participated in answering a series of pairwise comparison questions which were used to determine the weighted priority of each factor with the use of the Expert Choice 11 software. A pairwise comparison worksheet (see Appendix E) was distributed to each subject matter expert. This worksheet consisted of a series of comparison scales where each expert was asked determine which factor they perceived to be more important for each comparison as well as their perception of how much more important they perceived one factor to be relative to the other. The comparisons included every possible combination of device selection factors and comparisons were also performed for the second level factors. The scale used for all of these comparisons is shown below:

Factor A	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Factor B
	Extreme		Very Strong		Strong		Moderate		Equal		Moderate		Strong		Very Strong		Extreme	

A scale of 1-9 was utilized for the pairwise comparisons. The numerical rating given to the more dominanat factor for any given comparison indicates how many times the expert perceives that factor to be more important than other factors. A rating of 1

(Equal), for example, indicates that both factors are perceived to be equally as important. A rating of 9 (Extreme) on the side of Factor B indicates that Factor B is perceived to be 9 times as important as Factor A. A rating of 3 (Moderate) on the side of Factor A indicates that Factor A is perceived to be 3 times as important as Factor B.

Figure 15: Subject matter experts working on pairwise comparison worksheet for AHP

4.3.3 Development of the device selection model

Rating scales which included ratings ranging from 1-3 were developed for each device selection factor. It was determined that a combination of physical analysis, subjective opinions from potential operators, and objective operator-use measures was necessary in order to fully evaluate the appropriateness of hand-held communication devices for use during emergency situations. A methodology for determining a score for each factor, belonging to one of these three categories, which corresponds to how well a given device ranks in terms of that factor, was prescribed. A device selection model was then developed which considered the ratings and weighted priorities for all of the

selection factors in order to provide an overall score for a given device, indicating its appropriateness during emergency situations in The Bahamas.

4.3.4 Testing of frequently used devices against model

In order to test and validate the proposed model, five of the most commonly used devices among Bahamian emergency management officials and civilians were tested against the proposed model. These devices, which were identified as being the most commonly used devices in The Bahamas from the survey responses collected in the previous phase, included a BlackBerry Torch, a BlackBerry Cure, a Motorola Bravo, a Nokia 2330, and an iPhone 3GS. A physical analysis was performed for each device. A sample size of 17 potential operators was then utilized, in order to determine the subjective and operator-use ratings for the corresponding selection factors for each of the devices being tested in accordance to the proposed model.

4.4 Results

4.4.1 Device Selection Factors

The following 10 device selection factors were identified which addressed the equipment needs and were determined to be the most relevant during emergency management: durability, battery life and type, accommodation to environmental lighting, text entry method, grip, screen size, portability, audio clarity, usability, and unit cost. In addition, second level factors for the more complex factors including battery life and type, portability, and usability were identified. Battery life and type was identified as being a component of battery type, standby time, and talk time. It was determined that

portability was dependent on device weight and volume. Finally, five components of usability were identified based on Nielson's model of usability: ease of learning, efficiency of use, ease of remembering, frequency of errors, and subjective pleasure. The hierarchy of the identified device selection factors can be seen in Figure 3.

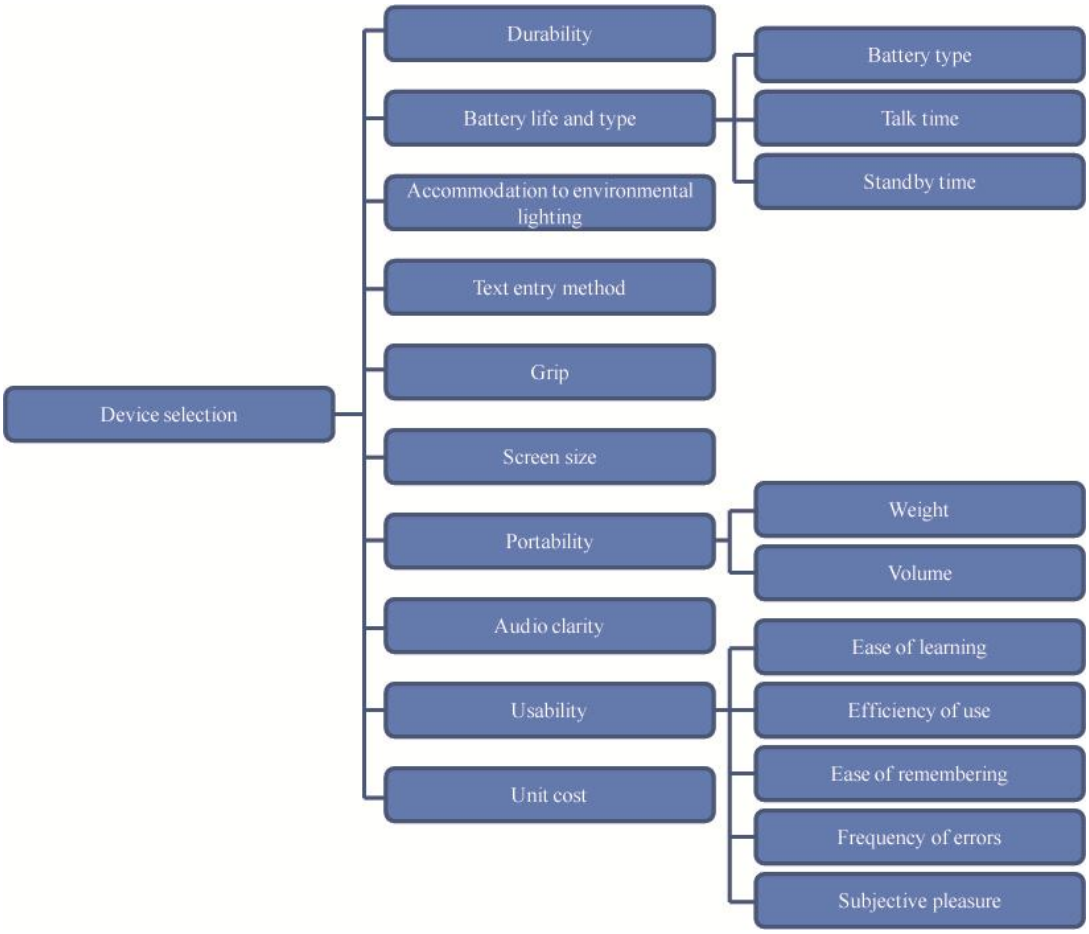


Figure 16: Hierarchy of device selection factors

4.4.2 Weighted Priorities of Device Selection Factors

The weighted priorities of the device selection factors which were calculated using AHP analysis can be seen in Table 20. Weighted priorities for second level selection factors including battery life and type considerations, portability factors, and

usability considerations can be seen in Tables 21-23. Appendix F for the pairwise comparison results for each of the participants as well as the corresponding inconsistency ratios.

Table 20: AHP results for device selection factors

Ranking *(j)*	**Factor**	**Relative Weight** (a_j)
1	Audio clarity	.163
2	Usability	.162
3	Portability	.126
4	Accommodation to environmental lighting	.093
5	Battery life and type	.085
6	Unit cost	.083
7	Text entry method	.081
8	Grip	.072
9	Screen size	.069
10	Durability	.065

Table 21: AHP results for usability considerations

Ranking *(k)*	**Factor**	**Relative Weight** (b_k)
1	Ease of remembering	.306
2	Ease of learning	.202
3	Efficiency of use	.177
4	Frequency of errors	.166
5	Subjective pleasure	.148

Table 22: AHP results for portability factors

Ranking *(l)*	**Factor**	**Relative Weight** (c_l)
1	Weight	.677
2	Volume	.323

Table 23: AHP results for battery life and type considerations

Ranking *(m)*	**Factor**	**Relative Weight** (d_m)

1	Talk time	.514
2	Standby time	.325
3	Battery type	.161

4.4.2 Rating methodology for device selection factors

The rating methodology in Table 25 is to be used in order to rate each of the device selection factors and second level factors on a scale of 1-3. A combination of physical measures (green), subjective opinions from potential users (blue), and objective operator-use measures (pink) are incorporated in this methodology.

Table 24: Rating scales for selection factors

	3	2	1
Durability	Designed for rugged use and is submersible in water	Designed for rugged use, but is not submersible in water	Designed for standard use only
Battery life and type			
Talk time	Equal to or greater than 8h	Greater than 4h but less than 8h	Less than 4h
Standby time	400h+	200h-400h	Less than 200h
Battery type	Li-Ion	NiMH	NiCad
Accommodation to environmental lighting	Extremely well	Well	Poorly
Text Entry	Mini-Qwerty physical text entry with large buttons	Mini-Qwerty physical text entry with small buttons	Mini-Qwerty soft text entry or limited key physical text entry
Grip	Highly Adequate	Adequate	Inadequate
Screen size	320x480 or larger	176x220 to 320x480	176x220 or smaller
Portability			
Weight	Under 3.0 oz	3.0-6.0 oz	Over 6.0 oz
Volume	Under 5.0 in^3	5.0-6.0 in^3	Over 6.0 in^3
Audio clarity	Extremely clear	Clear	Unclear
Usability			
Ease of learning	Extremely easy	Easy	Difficult
Efficiency of use	Under ($\bar{x}$-.5s) task time	($\bar{x}$-.5s)- ($\bar{x}$+.5s) task time	Over ($\bar{x}$+.5s) task time

Ease of remembering	Extremely easy	Easy	Difficult
Frequency of errors	Less than ($\bar{x}$-.5s)	($\bar{x}$-.5s)- ($\bar{x}$+.5s)	More than ($\bar{x}$+.5s)
Subjective pleasure	High	Medium	Low
Unit Cost	Over $300	$100-$300	Under $100

The rating of the physical specification involves analyzing the manufacturer's specification for each device. In order to rate the subjective measures (marked in blue on Table 24), a survey should be employed which instructs potential operators to perform a series of tasks using each device followed by a series of questions. In order to rate the objective measures (marked in pink on Table 24), measures in regard to efficiency of use and frequency of errors must be taken on participants during the device testing session.

4.4.2.1 Subjective measures

During the device testing session, participants should be asked their opinions on each of the subjective factors. Prior to answering these questions, the participants should be instructed to familiarize themselves with each device and to test each device's features. The subjective factors should be rated on a scale of 1-3 based on the rating categories described in Table 24.

4.4.2.2 Objective measures

In order to provide ratings for the operator-use measures of efficiency and frequency of errors, quantifiable measures must be taken during the device testing session. For efficiency, the measures include mean task time for the following tasks: placing a call to a contact named "emergency" in the phone book, taking a picture, and composing the following text message: "Help I'm trapped at 1800 University Dr., Apt.

32B!" without making corrections. The task times for each of the three tasks are to be calculated and the frequencies of errors experienced while composing the text message are to be counted. Each of these tasks should start from the home screen of each device. Once all of the data is collected, the sample mean ($\bar{x}$) and sample standard deviation (s) for each task (combining the results from all of the devices) are to be calculated. The entries for all of the measures (task times and frequencies of errors) should then be converted to the 1-3 scale. For any entry less than ($\bar{x}$-.5s), a rating of 3 is given for that entry. For any entry between ($\bar{x}$-.5s) and ($\bar{x}$+.5s), a rating of 2 is given for that entry. For any entry greater than ($\bar{x}$+.5s), a rating of 1 is given. The mean of the ratings for each task for each device are then taken. Finally, the mean of the mean task ratings for each device are taken which yields the overall rating of efficiency for each device. The mean rating for frequency of errors for each device yields the overall rating for frequency of errors for each device.

4.4.3 Proposed Device Selection Model

A human-centered device selection model was proposed which allows for the calculation of a score for a given hand-held communication device which indicates how appropriate it is for use during emergency situations in the Bahamas. This model is truly human-centered, given that the identification of device selection factors evolved from user input, the model incorporates Nielson's model of usability, and subjective opinions and operator-use measures are integrated into the methodology. While several models of usability exist, it should be noted that Nielson's model of usability was selected since the

dimensions that it includes were the most measurable. A graphical version of this model can be seen in Table 6. The mathematical version of this model can be seen below:

$$Z=f_1a_1+f_2a_2+f_3a_3+f_4a_4+f_5a_5+f_6a_6+f_7a_7+f_8a_8+f_9a_9+f_{10}a_{10}\ (1)$$

The following equations can be used to determine the values of f_2, f_3, and f_5, which are dependent on second level factors:

$$f_2 = g_1b_1+g_2b_2+g_3b_3+g_4b_4+g_5b_5\ (2)$$

$$f_3 = h_1c_1+h_2c_2\ (3)$$

$$f_5 = i_1d_1+i_2d_2+i_3d_3\ (4)$$

where

1) Z = overall score
2) F_n = rating for each device selection factor
3) a_j = weighted priority for each factor
4) g_o = rating for each usability factor
5) b_k = weighted priority for each usability factor
6) h_p = rating for each portability factor
7) c_l = weighted priority for each portability factor
8) i_q = rating for each battery life and type consideration
9) d_m = weighted priority for each battery life and type consideration

The following equation is a comprehensive equation which integrates the five equations listed above:

$$Z=f_1a_1+f_2(g_1b_1+g_2b_2+g_3b_3+g_4b_4+g_5b_5)+f_3(h_1c_1+h_2c_2)+f_4a_4+f_5(i_1d_1+i_2d_2+i_3d_3)+f_6a_6+f_7a_7+f_8a_8+f_9a_9+f_{10}a_{10}\ (5)$$

Table 25: Device selection model

	Audio clarity	Ease of remembering	Ease of Learning	Efficiency of use	Frequency of Errors	Subjective Pleasure	Usability	Weight	Volume	Portability	Accommodation to environmental lighting	Battery Life (talk)	Battery Life (standby)	Battery Type	Battery	Unit Cost	Text entry method	Grip	Screen Size	Durability	Weighted Score
	.163	.306	.202	.177	.166	.148	.162	.677	.323	.126	.093	.514	.325	.161	.085	.083	.081	.072	.069	.065	1.00
Device 1																					
Device 2																					
Device 3																					
Device 4																					
Device 5																					

4.4.4 Ratings of Currently Used Devices

The physical measures for each device were taken by referring to the specifications provided by the manufacturers. A sample size of *17* participants was used to collect data in regard to the subjective and objective measures for each device. Based on the collected data, the ratings for each of the subjective and objective ratings were determined in accordance with the proposed guidelines. Table 26 shows the ratings for each of the five devices. It should be noted that this example was only used to test and validate the proposed model as well as to illustrate how it is to be used in order to rate devices. In a real-world application of this model, a statistically significant sample size should be utilized which reflects the profile of users likely to use the devices.

In this example, it was found that the iPhone 3GS was the most appropriate device for use during emergencies in the Bahamas compared to the other devices tested, followed respectively by the BlackBerry Torch, the Motorola Bravo, the Nokia 2330, and the BlackBerry Curve. Based upon this evaluation, it was found that the BlackBerry Torch and the iPhone 3GS accommodated best to environmental lighting followed by the Motorola Bravo, BlackBerry Curve, and Nokia 2330. The iPhone 3GS had the best grip followed by the BlackBerry Torch, the Motorola Bravo, the BlackBerry Curve, and the Nokia 2330. The Nokia 2330 was determined to be the most ideal in terms of portability followed by the BlackBerry Curve, Motorola Bravo, and the iPhone 3GS with the BlackBerry Torch being the least portable. In terms of usability, the Motorola Bravo and the iPhone 3GS scored the highest followed by the BlackBerry Torch, the Nokia 2330, and the BlackBerry Curve.

While the weighted scores for the devices revealed differences in the appropriateness of each device during emergencies in The Bahamas, the variation in the scores was minimal. Had

this had been an actual application of the model involving a statistically significant number of Bahamian emergency management officials, these results could be interpreted to prove that the differences between the devices is negligible thus eliminating the need to invest in more appropriate devices. While this model can be used to assist with selecting devices for use during emergencies, it can also be used when deciding whether or not purchasing of more appropriate devices is necessary.

Table 26: Ratings of currently used devices

	Audio clarity	Ease of remembering	Ease of Learning	Efficiency of use	Frequency of Errors	Subjective Pleasure	Usability	Weight	Volume	Portability	Accommodation to environmental lighting	Battery Life (talk)	Battery Life (standby)	Battery Type	Battery	Unit Cost	Text entry method	Grip	Screen Size	Durability	Weighted Score
	.163	.306	.202	.177	.166	.148	.162	.677	.323	.126	.093	.514	.325	.161	.085	.083	.081	.072	.069	.065	1.00
BlackBerry Torch	2.3	2.1	2.2	1.9	2.2	2.0	2.1	2.0	1.0	1.7	2.7	2.0	2.0	3.0	2.2	1.0	2.0	2.3	3	1.0	2.05
BlackBerry Curve	2.0	1.9	1.4	1.6	1.9	1.5	1.7	2.0	2.0	2.0	2.0	2.0	2.0	3.0	2.2	1.0	2.0	2.1	3	1.0	1.88
Motorola Bravo	2.2	2.5	2.4	2.3	2.0	2.0	2.3	2.0	2.0	2.0	2.5	2.0	2.0	3.0	2.2	1.0	1.0	2.3	3	1.0	2.00
Nokia 2330	2.1	2.1	1.8	1.9	1.8	1.2	1.8	3.0	3.0	3.0	1.8	1.0	2.0	3.0	1.7	3.0	1.0	1.9	1	1.0	1.92
iPhone 3GS	2.5	2.5	2.3	2.2	2.2	2.2	2.3	2.0	2.0	2.0	2.7	2.0	2.0	3.0	2.2	2.0	1.0	2.4	3	1.0	2.16

4.5 Discussion

A human-centered methodology for the assessment of hand-held communication devices for use in emergency management allows for the rating of hand-held communication devices in terms of appropriateness in emergency management situations in the Bahamas, with the needs of users as a main priority. A hierarchy of device selection factors was developed based on results from the knowledge acquisition techniques as well as information retrieved from the literature review of on device selection factors. AHP was used in order to determine the weighted priority of each device selection factor. This process incorporates physical analysis, subjective opinions from potential users, and operator-use measures in order to rate devices. Considering that user needs were considered during the identification of device selection factors for this model in addition to incorporating usability considerations, subjective measures, and objective measures, this model is a completely human-centered solution for assessing hand-held communication devices in terms of Bahamian emergency management. By developing and testing the proposed methodology, the goal to develop a mathematical model to holistically represent human factors issues associated with the use of hand-held communication devices in emergency management was achieved.

CHAPTER FIVE:
CONCLUSION

Hand-held communication devices are in a position to improve communication flow during high consequence emergency due to the high resilience of these devices, relatively low costs, and advanced features. These devices have not been officially implemented in emergency management operations in many nations and no guidelines for the selection of hand-held communication devices using a human-centered approach currently exists. The optimized use of these devices can be especially beneficial to Island nations such as the Bahamas, where improvements in communication can be used to overcome regional hurdles which are common among Caribbean nations.

In this study, knowledge acquisition techniques including text analysis, interview analysis, and surveys on Bahamian emergency management officials and civilians were used in order to develop a baseline for current emergency management operations and device use in The Bahamas as well as to identify the communication needs in this country during emergency situations. Device selection factors which are relevant to emergency management were identified based on the identified equipment needs and information found during the literature review. AHP analysis was used to determine the weighted priority of each selection factor and a mathematical model for the selection of hand-held communication devices based upon human factors principals and focusing on user priorities was proposed.

The knowledge acquisition and data collection techniques which were used to identify the communication needs of Bahamian emergency management officials and civilians revealed the

existence and extent of several human factors issues and device deficiencies associated with utilizing hand-held communication devices during emergencies thus achieving the research goals for this project that specific human factors issues associated with hand-held communication devices in emergency management existed and could be identified and qualified or quantified to be correct. Through the use of the data collection techniques, the research goal to establish a baseline for the current use of hand-held communication devices in The Bahamas was achieved. Finally, the development and validation of the human-centered methodology for assessing hand-held communication devices in the context of high consequence emergencies achieved the research goal that a mathematical model can be developed to holistically represent human factors issues associated with the use of hand-held communication devices in emergency management.

5.1 Future areas of research

Future areas of research include performing a similar study examining the communication needs during high consequence emergency management situations in other nations. AHP analysis can be performed on subject matter experts from other countries in order to develop similar methodologies applicable to other specific geographical, infrastructure, and political considerations. In addition, the proposed methodology can be altered in order to be suitable in industries other than emergency management. A future study could also consider needs during emergency situations other than communication using a human-centered approach.

APPENDIX A:
IRB APPROVAL LETTER

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Pamela McCauley Bush**

Date: **April 11, 2011**

Dear Researcher:

On 4/11/2011, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	IRB Initial Review Submission Form
Project Title:	The development of a human centered methodology for the assessment of wireless computing devices used to support communication flow in high consequence emergency management: A U.S.-Caribbean collaborative research project
Investigator:	Pamela McCauley Bush
IRB Number:	SBE-11-07613
Funding Agency:	National Science Foundation
Grant Title:	NSF EAGER Grant # 1048171
Research ID:	1050953

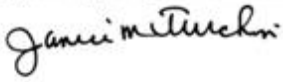
***NOTE: This study may not commence until written approval from the** National Emergency Management Agency Headquarters (Bahamas) **has been obtained. Please forward a copy of the approval to the IRB when it becomes available.**

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Kendra Dimond Campbell, MA, JD, UCF IRB Interim Chair, this letter is signed by:

Signature applied by Janice Turchin on 04/11/2011 04:04:07 PM EDT



IRB Coordinator

THE NATIONAL EMERGENCY MANAGEMENT AGENCY [NEMA]
Cabinet Office P.O. Box N-7147 Tel: 242-322-6081/5 Fax: 242-326-5456
Email: nema@bahamas.gov.bs

Our Ref: NEMA /100

University of Central Florida
Office of Research and Commercialization
12201 Research Parkway, Suite 501
Orlando, FL 32826

Date: 14th April, 2011.

To Whom It May Concern:

RE: COLLECTION OF SURVEY DATA

This letter is to confirm that permission was granted to the University of Central Florida and the College of The Bahamas collaborative research team to collect survey data at the National Emergency Management Agency (NEMA) headquarters in Nassau, The Bahamas.

Sincerely,

Captain Stephen M. Russell
Director
NEMA

APPENDIX B:
SURVEYS

EMERGENCY MANAGEMENT COMMUNICATION SURVEY - OFFICIALS

Background

1. What is your age?

☐ 18-25 ☐ 26-35 ☐ 36-45 ☐ 46-55 ☐ 56+

2. What is your position in emergency management? _____

3. What types of tasks do you perform in your position? _____

_____

4. How many years have you been involved with emergency management?

☐ 1-5 ☐ 6-10 ☐ 11-15 ☐ 16-20 ☐ 21^{+}

5. Do you have formal training in emergency management? ☐ Yes ☐ No

6. What is your highest level of education?

☐ High School ☐ Associates ☐ Bachelors ☐ Graduate Studies ☐ Other_____

Handheld communication experience

7. Do you own a personal handheld communication device? (i.e. iPhone, Droid) ☐ Yes ☐ No

8. If so, what type of handheld device do you own? _____

9. Which services do you have access to on your device? (check all that apply)

☐ Voice ☐ Text ☐ Mobile Internet ☐ 3G Internet ☐ Other _____

10. How would you rate your skill level with handheld communication devices?

☐ Novice ☐ Advanced Beginner ☐ Competent ☐ Proficient ☐ Expert

11. How often do you use your handheld device to perform your task responsibilities?

☐ Never ☐ Hardly Ever ☐ Monthly ☐ Weekly ☐ Daily

12. When utilizing your handheld device while performing your task responsibilities, what types of tasks will you be simultaneously performing? (check all that apply)

☐ Driving ☐ Walking ☐ Writing/Typing ☐ Hands on work ☐ Other_____

Device performance

13. When utilizing your handheld device while performing your task responsibilities, how would you rate the reliability of your device?

☐ Highly unreliable ☐ Unreliable ☐ Fairly reliable ☐ Reliable ☐ Highly reliable

14. What is the battery life of your device during regular daily use?

☐ 0-2 hrs ☐ 2^{+}-4 hrs ☐ 4^{+}-6 hrs ☐ 6^{+}-8 hrs ☐ 8^{+} hrs

15. How would you rate the speed at which you can perform tasks on your device?

☐ Extremely slow ☐ Slow ☐ Moderate ☐ Fast ☐ Extremely fast

16. How would you rate the durability of your device in regard to how you use it on a regular basis to perform your task responsibilities?

☐ Extremely fragile ☐ Fragile ☐ Fairly durable ☐ Durable ☐ Extremely durable

Usability

17. How would you rate the ease of use of your device?

☐ Extremely difficult ☐ Difficult ☐ Fairly easy ☐ Easy ☐ Extremely easy

18. How would you rate the consistency of the user interface of your device?

☐ Extremely fragile ☐ Fragile ☐ Fairly durable ☐ Durable ☐ Extremely durable

19. How would you rate the visual clarity of information displayed on the screen of your device when using it to perform your task responsibilities?

☐ Extremely unclear ☐ Unclear ☐ Fairly clear ☐ Clear ☐ Extremely clear

20. How would you rate the audio clarity of information you hear when using it to perform your task responsibilities?

☐ Extremely unclear ☐ Unclear ☐ Fairly clear ☐ Clear ☐ Extremely clear

21. How well does your device accommodate the operational lighting conditions while you are performing your task responsibilities? (ex. extreme sunlight)

☐ Extremely poorly ☐ Poorly ☐ Fairly well ☐ Well ☐ Extremely well

22. How would you rate the size of your device?

☐ Extremely small ☐ Small ☐ Ideal ☐ Big ☐ Extremely big

23. How would you rate the weight of your device?

☐ Extremely light ☐ Light ☐ Average ☐ Heavy ☐ Extremely heavy

24. How would you rate the ease of text entry on your device?

☐ Highly unacceptable ☐ Unacceptable ☐ Bearable ☐ Good ☐ Optimum

25. Does your device provide a means for attaching it to your body or clothing without interfering with other tasks you may be performing? ☐ Yes ☐ No

26. Do you ever have problems with your device slipping out of your hand? ☐ Yes ☐ No

27. Please list any other usability or human factors issues with you handheld device

_____

_____

Other communication devices

28. What other devices do you use in emergency management situations? (check all that apply)

☐ Satellite Phone ☐ Landline Phone ☐ Radio ☐ PC ☐ Other_____

For questions 28-31,

- *Phase -1 refers to the pre-disaster phase*
- *Phase 0 refers to the time from when the disaster occurs to 10 hours afterwards*
- *Phase 1 refers to when rescue measures start between 10 to 100 hours after the disaster*
- *Phase 2 refers to when the life and death threat from the disaster is over between 100 to 1000 hours after the disaster*
- *Phase 3 refers to the long term recovery period that begins after 1000 hours following the disaster.*
- *Check all phases which apply and do not check anything if the device is not used.*

29. During what phases of emergency management do you use satellite phones?

☐ Phase -1 ☐ Phase 0 ☐ Phase 1 ☐ Phase 2 ☐ Phase 3

30. During what phases of emergency management do you use laptop computers?

☐ Phase -1 ☐ Phase 0 ☐ Phase 1 ☐ Phase 2 ☐ Phase 3

31. During what phases of emergency management do you use desktop computers?

☐ Phase -1 ☐ Phase 0 ☐ Phase 1 ☐ Phase 2 ☐ Phase 3

32. During what phases of emergency management do you use radio communication?

☐ Phase -1 ☐ Phase 0 ☐ Phase 1 ☐ Phase 2 ☐ Phase 3

Suggestions?

33. In addition, do you have any suggestion regarding design improvements that can be incorporated into handheld devices and the way they are used in order to improve their effectiveness during emergency management?

_____

_____

EMERGENCY MANAGEMENT COMMUNICATION SURVEY - CIVILIANS

Background

2. What is your age?

☐ Under 18 ☐ 18-25 ☐ 26-35 ☐ 36-45 ☐ 46-55 ☐ 56+

2. What is your occupation? _____

3. What is your highest level of education?

☐ High School ☐ Associates ☐ Bachelors ☐ Graduate Studies ☐ Other_____

Handheld communication experience

4. Do you own a personal handheld communication device? ☐ Yes ☐ No

5. If so, what type of handheld device do you own? _____

6. Which services do you have access to on your device? (check all that apply)

☐ Voice ☐ Text ☐ Mobile Internet ☐ 3G Internet ☐ Other_____

7. How would you rate your skill level with handheld communication devices?

☐ Novice ☐ Advanced Beginner ☐ Competent ☐ Proficient ☐ Expert

Device performance

8. What is the battery life of your device during regular daily use?

☐ 0-2 hrs ☐ 2^{+}-4 hrs ☐ 4^{+}-6 hrs ☐ 6^{+}-8 hrs ☐ 8^{+} hrs

9. How would you rate the speed at which you can perform tasks on your device?

☐ Extremely Slow ☐ Slow ☐ Moderate ☐ Fast ☐ Extremely fast

10. How would you rate the durability of your device in regard to how you use it on a regular basis to perform your task responsibilities?

☐ Extremely fragile ☐ Fragile ☐ Fairly durable ☐ Durable ☐ Extremely durable

Usability

11. How would you rate the ease of use of your device?

☐ Extremely difficult ☐ Difficult ☐ Fairly easy ☐ Easy ☐ Extremely easy

12. How would you rate the size of your device?

☐ Extremely small ☐ Small ☐ Average ☐ Big ☐ Extremely big

13. How would you rate the weight of your device?

☐ Extremely light ☐ Light ☐ Ideal ☐ Heavy ☐ Extremely heavy

14. How would you rate the ease and accuracy of text entry on your device?

☐ Highly unacceptable ☐ Unacceptable ☐ Bearable ☐ Good ☐ Optimum

15. Do you ever have problems with your device slipping out of your hand? ☐ Yes ☐ No

Other communication devices

16. What other devices do you have regular access to? (check all that apply)

☐ Satellite Phone ☐ Landline Phone ☐ Radio ☐ PC ☐ Other_____

Suggestions?

17. In addition, do you have any suggestion regarding design improvements that can be incorporated into handheld devices and the way they are used in order to improve their effectiveness during emergency management?

_____

_____

APPENDIX C:
SURVEY RESPONSES

SURVEY RESPONSES – OFFICIALS

Sample size: 31

Q1: What is your age?

Code	Item	Frequency	Percent
1	18 - 25	0	0%
2	26 - 35	3	10%
3	36 - 45	4	13%
4	46 - 55	17	55%
5	56+	7	23%

Q2: What is your position in emergency management?

Public Information Officer
Finance officer
NEMA director
Sr. Manager Logistics - NEMA, report for BTC
Sr. Deputy Director of Meteorology
Disaster Coordinator
Disaster management coordinator at Department of Public Health
Disaster Manager
Technical-Liaison
Liaison
Relief Coordinator
Disaster manager
Tourism rep
Ministry of Public Works representative at NEMA
Director of National E.M.S.
Disaster coordinator
Disaster Manager, PMH
Security
Assistant Emergency Centre Manager
Psychiatrist
Chairperson
Shelter Manager
Assistant Administrator
District Coordinator
Chairman of disaster management
Incident Commander
Disaster preparedness coordinator
Driver
Ministry of Public Works representative at NEMA

Q3: What types of tasks do you perform in your position?

Disseminate information, draft press releases, arrange press conferences
Finance, EOC manager, and Certified Disaster Trainer
Coordinate NEMA activities
Contract administration, property loss control, security, emergency management
Hurricane warnings, tsunami alerts, earthquake alerts
Coordinate disaster preparation activities, update mitigation manual
Coordination of all aspects of disaster management as it pertains to Public Health Services and rep. at NEMA
Ensure the company has relevant items in stock and people on call
Broadcaster, Television and Radio Communication
Communication / information dissemination, logistics coordination, reporting
Ensure completion of disaster preparation, coordinate relief activities
EOC management reports, training coordination, program management
Liaison with the Ministry of Tourism and NEMA
Report to the Director of Public Works
Responsibility for the administration and operations of the National E.M.S.
Direct and co-ordinate disaster activities
Program Planning and Execution
All security matters, assist with movement of casualties
Resource dispatch and management
Post disaster mental health services
Plan, Coordinate, and communicate for greater efficiency.
Ensuring the shelter is up and sunning and all the items that are needed are in stock and ready to be shipped out or delivered by drivers
Assist with operation of command center
Organizing preparation, response, and coordinating logistics
Organizer/coordinator
Responsible for overall incident activities
Coordinate disaster preparation with all stakeholders and act on behalf of the director of NEMA
First Responder
Management of Public Works and Engineering

Q4: How many years have you been involved with emergency management?

Code	Item	Frequency	Percent
1	1 - 5	7	23%
2	6 - 10	6	19%
3	10 - 15	7	23%
4	16 - 20	9	29%
5	21+	2	6%

Q5: Do you have formal training in emergency management?

Code	Item	Frequency	Percent
1	Yes	21	72%
2	No	8	28%

Q6: What is your highest level of education?

Code	Item	Frequency	Percent
1	High School	4	13%
2	Associates	2	7%
3	Bachelors	6	20%
4	Graduate Studies	11	37%
5	Other	7	23%

Q7: Do you own a personal handheld communication device?

Code	Item	Frequency	Percent
1	Yes	30	97%
2	No	1	3%

Q8: If so, what type of handheld device do you own?

Nokia E71
BlackBerry
BlackBerry Bold
BlackBerry Bold
BlackBerry
iPhone 3G
BlackBerry Curve
Nokia
BlackBerry
BlackBerry Bold
Nokia
Nokia
BlackBerry Curve
8150
BlackBerry
BlackBerry Pearl
BlackBerry
BlackBerry
BlackBerry
BlackBerry
BlackBerry

Nokia

Q9: Which services do you have access to on your device?

Code	Item	Frequency	Percent
1	Voice	28	90%
2	Text	27	87%
3	Mobile Internet	18	58%
4	3G Internet	4	13%
5	Other	2	6%

Q10: How would you rate your skill level with handheld communication devices?

Code	Item	Frequency	Percent
1	Novice	5	16%
	Advanced		
2	Beginner	7	23%
3	Competent	11	35%
4	Proficient	6	19%
5	Expert	2	6%

Q11: How often do you use your handheld device to perform your task responsibilities?

Code	Item	Frequency	Percent
1	Never	0	0%
2	Hardly Ever	5	16%
3	Monthly	2	6%
4	Weekly	0	0%
5	Daily	24	77%

Q12: When utilizing your handheld device while performing your task responsibilities, what types of tasks will you be simultaneously performing?

Code	Item	Frequency	Percent
1	Driving	19	61%
2	Walking	20	65%
3	Writing/Typing	20	65%
4	Hands on work	15	48%
5	Other	1	3%

Q13: When utilizing your handheld device while performing your task responsibilities, how would you rate the reliability of your device?

Code	Item	Frequency	Percent
1	Highly Unreliable	0	0%
2	Unreliable	0	0%
3	Fairly Reliable	7	23%
4	Reliable	15	48%
5	Extremely Reliable	9	29%

Q14: What is the battery life of your device during regular daily use?

Code	Item	Frequency	Percent
1	0 - 2	0	0%
2	2^{+}- 4	1	3%
3	4^{+}- 6	3	10%
4	6^{+}- 8	5	16%
5	8^{+}	22	71%

Q15: How would you rate the speed at which you can perform tasks on your device?

Code	Item	Frequency	Percent
1	Extremely Slow	1	3%
2	Slow	2	6%
3	Moderate	15	48%
4	Fast	10	32%
5	Extremely Fast	3	10%

Q16: How would you rate the durability of your device?

Code	Item	Frequency	Percent
1	Extremely Fragile	0	0%
2	Fragile	2	7%
3	Fairly Durable	9	30%
4	Durable	14	47%
5	Extremely Durable	5	17%

Q17: How would you rate the ease of use of your device?

Code	Item	Frequency	Percent
1	Extremely Difficult	0	0%
2	Difficult	2	6%
3	Fairly Easy	11	35%
4	Easy	14	45%
5	Extremely Easy	4	13%

Q18: How would you rate the consistency of the user interface of your device?

Code	Item	Frequency	Percent
1	Extremely Inconsistent	0	0%
2	Inconsistent	0	0%
3	Fairly Consistent	7	23%
4	Consistent	21	68%
5	Extremely Consistent	3	10%

Q19: How would you rate the visual clarity of the information displayed on the screen of you device?

Code	Item	Frequency	Percent
1	Extremely Unclear	1	3%
2	Unclear	0	0%
3	Fairly Clear	4	13%
4	Clear	19	61%
5	Extremely Clear	7	23%

Q20: How would you rate the audio clarity of the information you hear on your device?

Code	Item	Frequency	Percent
1	Extremely Unclear	1	3%
2	Unclear	0	0%
3	Fairly Clear	7	23%
4	Clear	14	47%
5	Extremely Clear	8	27%

Q21: How well does your device accommodate the operational lighting conditions while you are performing your task responsibilities?

Code	Item	Frequency	Percent
1	Extremely Poorly	0	0%
2	Poorly	3	10%
3	Fairly Well	11	35%
4	Well	12	39%
5	Extremely Well	5	16%

Q22: How would you rate the size of your device?

Code	Item	Frequency	Percent
1	Extremely Small	0	0%
2	Small	5	16%
3	Ideal	19	61%
4	Big	7	23%
5	Extremely Big	0	0%

Q23: How would you rate the weight of your device?

Code	Item	Frequency	Percent
1	Extremely Light	4	13%
2	Light	7	23%
3	Average	17	55%
4	Heavy	3	10%
5	Extremely Heavy	0	0%

Q24 How would you rate the ease of text entry on your device?

Code	Item	Frequency	Percent
1	Highly Unacceptable	0	0%
2	Unacceptable	2	6%
3	Bearable	12	39%
4	Good	16	52%
5	Optimum	1	3%

Q25: Does your device provide a means for attaching it to your body or clothing without interfering with other tasks?

Code	Item	Frequency	Percent
1	Yes	20	67%
2	No	10	33%

Q26: Do you ever have problems with your device slipping out of your hand?

Code	Item	Frequency	Percent
1	Yes	17	55%
2	No	14	45%

Q27: Please list any other usability or human factors issues with your handheld device

Text input can be difficult because of small keys

Availability of network infrastructure

Two way radio feature on cell phones would limit the number of devices an individual would have to carry

Resistance to severe weather, water proofing, shock absorption, camera/media transfer ability

Reliability of network services

Q28: What other devices do you use in emergency management situations?

Code	Item	Frequency	Percent
1	Satellite Phone	24	77%
2	Landline Phone	28	90%
3	Radio	27	87%
4	PC	20	65%
5	Other	4	13%

Q29: During what phases of emergency management do you use satellite phones?

Code	Item	Frequency	Percent
1	Phase -1	9	29%
2	Phase 0	18	58%
3	Phase 1	15	48%
4	Phase 2	9	29%
5	Phase 3	5	16%

Q30: During what phases of emergency management do you use laptop computers? (check all that apply)

Code	Item	Frequency	Percent
1	Phase -1	19	61%
2	Phase 0	11	35%
3	Phase 1	13	42%
4	Phase 2	13	42%
5	Phase 3	11	35%

Q31: During what phases of emergency management do you use desktop computers?

Code	Item	Frequency	Percent
1	Phase -1	21	68%
2	Phase 0	16	52%
3	Phase 1	14	45%
4	Phase 2	14	45%
5	Phase 3	17	55%

Q32: During what phases of emergency management do you use radio communication? (check all that apply)

Code	Item	Frequency	Percent
1	Phase -1	19	61%
2	Phase 0	23	74%
3	Phase 1	22	71%
4	Phase 2	19	61%
5	Phase 3	12	39%

Q33: Do you have any other suggestions?

Install a panic button on wireless handheld device in order to track an injured responder
When local BTC towers are down after a disaster, other networks such as AT&T and Sprint should be able to take over. Durability of device.
Increased durability and two way radio application
Ability to transfer internet services from mobile to laptop when local internet is not operable
Ensure that handheld devices can be used as a medium to send data If other services are down
Consideration should be given to the durability of the device considering the environmental conditions.
Ability to transfer internet services from mobile to laptop when local internet is not operable
Consideration should be given to the durability of the device considering the environmental conditions.
Make them lighter

Training for use of satellite phones.
Combine both satellite phones and radios into one mobile phone for emergency teams at a very reasonable rate to reduce the amount of communication devices that a team member carries on them.
Reduction of size of satellite phones
Difficulty with visibility during high sun exposure
Better ability of devices to attach to body, multiple channels to avoid overload
Incorporate GPS technology, utilize solar power, place disaster manuals on devices in PDF format

SURVEY RESPONSES – CIVILIANS

Sample size: 155

Q1: What is your age?

Code	Item	Frequency	Percent
1	Under 18	9	6%
2	18 - 25	57	37%
3	26 - 35	25	16%
4	36 - 45	33	21%
5	46 - 55	22	14%
6	56+	8	5%

Q2: What is your occupation?

Salesman/DJ
Fashion Designer
Student
Sales Assistant
Student
Sales Associate
Administrative Director
Student
Sales Associate
Student
Helper
Atlantis
Businessman
Supervisor
Sales Associate
Shopkeeper
Sales Rep
Prison Officer
Tailor
Retail
Cashier
Prison Officer
Technician
Sales Person
Project Manager
Sales Associate
Electrician

Vendor
Cashier/ Sales Clerk
Waiter
Mechanic
Waiter
Operator
Prison Officer
Prison Officer
Prison Officer
Fisherman
Tile Layer
Student
Personal Assistant
H.M.P.
Prison Officer
Police Officer
Prison Officer
Fisherman
Attorney
Waitress
Carpenter
Supervisor
Receptionist
Banker
Carpenter
Finance Officer
Retail
Butcher
Student
Accountant
Beautician
Student
Student
Banker
Student
Office Manager
Teacher
Student
Social Worker
Retired
Cashier
Banker
Banker
Student
Student

Student
Retired
Nurse
Blood Bank
Road Traffic Officer
Delivery Manager
Student
Student Advisor
Student Councilor
Teacher
Assistant Manager -
Reservations
Domestic Worker
Chef
Unemployed
Engineer
Student
Student
Seamstress
Executive Secretary
Computer Technician
Immigration Officer
Marketing Intern
Chef
Secretary
Police Officer
Civil Servant
Nail Technician
Computer Tech
Certified Financial Analyst
Student
Electrical Engineer
Student
Guest Service Host
Unemployed
Contractor
Police Officer
Store Clerk
Civil Servant
Bank Teller
Prisoner
House Wife
House Wife
Bank Teller
Manager

Lawyer
Student
Student
Student
Student
Student
Bank Teller
Cashier
Architect
Drafting Technician
Student
Technician
Student
Student
Student
Student
Student
Student
Bank Teller
Student
Student
Student
Student
Bank Teller
Trust Officer
Accountant
Accountant
Trust Officer
Trust Officer
Computer Tech
Banker
Trust Administrator

Q3: What is your highest level of education?

Code	Item	Frequency	Percent
1	High School	79	51%
2	Associates	30	19%
3	Bachelors	28	18%
4	Graduate Studies	10	6%
5	Other	8	5%

Q4 Do you own a handheld personal communication device?

Code	Item	Frequency	Percent
1	Yes	152	98%
2	No	3	2%

Q5 If so, what type of handheld device do you own?

Blackberry 8520
(Gemini)
LG Cookie
Blackberry Curve
Blackberry Curve
Blackberry Bold
Razor
Siemen
Nokia 7500 Prism
Samsung
Nokia 2610
Nokia Pebel
Nokia 6103b
Motorola
Blackberry Curve
Motorola Kodak
Military Phone
Razor (Motorola)
Nokia
BlackBerry Pearl
BlackBerry Storm
Motorola V3
Blackberry
Blackberry 8110
Nokia
Blackberry
Blackberry
Nokia
Blackberry Curve
Motorola
HTC Diamond
Blackberry Bold
9700
Samsung
Blackberry
Motorola Slvr

Blackberry
Nokia
Blackberry
Blackberry
iPhone
Blackberry Bold
9700
Blackberry 8320
Nokia
Iphone
Nokia
Iphone 3G
Motorola Razor
HTC
Iphone
Blackberry
Motorola V3
Nokia
Blackberry Storm
Blackberry
Iphone
Blackberry

Q6: Which services do you have access to on your device?

Code	Item	Frequency	Percent
1	Voice	148	95%
2	Text	145	94%
3	Mobile Internet	57	37%
4	3g Internet	15	10%
5	Other	8	5%

Q7: How would you rate your skill level with handheld communication devices?

Code	Item	Frequency	Percent
1	Novice Advanced	14	9%
2	Beginner	17	11%
3	Competent	47	31%
4	Proficient	40	27%
5	Expert	32	21%

Q8: What is the battery life of your device during regular daily use?

Code	Item	Frequency	Percent
1	0-2	0	0%
2	2^{+}-4	6	4%
3	4-6	24	16%
4	6-8	44	29%
5	8^{+}	78	51%

Q9: How would you rate the speed at which you can perform tasks on your device?

Code	Item	Frequency	Percent
1	Extremely Slow	2	1%
2	Slow	10	7%
3	Moderate	62	41%
4	Fast	52	34%
5	Extremely Fast	27	18%

Q10: How would you rate the durability of your device?

Code	Item	Frequency	Percent
1	Extremely Fragile	4	3%
2	Fragile	12	8%
3	Fairly Durable	39	25%
4	Durable	70	46%
5	Extremely Durable	28	18%

Q11: How would you rate the ease of use of your device?

Code	Item	Frequency	Percent
1	Extremely Difficult	1	1%
2	Difficult	14	9%
3	Fairly Easy	41	27%
4	Easy	69	45%
5	Extremely Easy	29	19%

Q12: How would you rate the size of your device?

Code	Item	Frequency	Percent
1	Extremely Small	3	2%
2	Small	40	26%
3	Ideal	92	60%
4	Big	17	11%
5	Extremely Big	1	1%

Q13: How would you rate the weight of your device?

Code	Item	Frequency	Percent
1	Extremely Light	8	5%
2	Light	61	40%
3	Average	71	46%
4	Heavy	11	7%
5	Extremely Heavy	3	2%

Q14: How would you rate the ease of text entry on your device?

Code	Item	Frequency	Percent
1	Highly Unacceptable	1	1%
2	Unacceptable	9	6%
3	Bearable	39	27%
4	Good	74	51%
5	Optimum	23	16%

Q15: Do you ever have problems with your device slipping out of your hand?

Code	Item	Frequency	Percent
1	Yes	68	49%
2	No	72	51%

Q16: Do you have any other suggestions?

The lack of technological support from our service provider
Add a voice activation feature. A locator/ pager (to make them quicker to find when time is of the essence)
In case of emergency it would be a nice feature to have a SOS feature to alert emergency services.
More grip

Voice Activated and Controlled
Needs to upgrade their system
increase the depth of water proofing to 12 ft
They can improvement by investing in new company like T mobile
Free minutes during emergencies
Tracking feature
Communication systems need to upgrade and stop crashing
Make devices water resistant
Water and shock proof
More competitive market, better rates, and more programs
Emergency call button even if service is unavailable
Solar panel charging built into phone
Voice activation and voice to text conversion
Once touch emergency dialing
Phones should broadcast location in case of emergency
Added grip to keep phone from slipping
More user friendly
That they be made waterproof
Better Reception and Signal
Satellite capabilities
Better Reception
Better signal and waterproof
Better Signal
Extremely versatile device
Better Signal. Multitask Capability; More Features
Better Signal, nationwide internet, relocation of volume buttons for less interference
Change in ring type options
Include a wristband with the phone to improve durability factors
Better internet access
Personal voice calibration
Better touch screen features
Medium size keys
Touch screens for emergency contacts
More user friendly
More compact and less bulky
Incorporate GPS
Voice Activator

APPENDIX D:
CORRELATION TABLES

CORRELATIONS – OFFICIALS

Table 27: Strengths of association for ages and device use for officials

	BlackBerry	Nokia	iPhone
18-25 (2)	0	0	0
26-35 (3)	0.2	0	0
36-45 (4)	0.2	0	0
46-55 (5)	0.4	1	1
56+ (6)	0.2	0	0

Table 28: Strengths of association for skill levels and ages for officials

	26-35	36-45	46-55	56+
Novice	0	0.25	0.176471	0.14285714
Advanced Beginner	0	0	0.176471	0.57142857
Competent	0.66666667	0.5	0.294118	0.28571429
Proficient	0.33333333	0	0.294118	0
Expert	0	0.25	0.058824	0

Table 29: Strengths of association for ages and gripping problems for officials

	Yes	No
18-25	0	0
26-35	0.17647059	0
36-45	0.11764706	0.14285714
46-55	0.52941176	0.57142857
56+	0.17647059	0.28571429

Table 30: Strengths of association for education levels and skill levels of officials

	Novice	Advanced Beginner	Competent	Proficient	Expert
High School	0	0.14285714	0	0.333333	0.5
Associates	0.25	0	0	0.166667	0
Bachelors	0.25	0.14285714	0.2727273	0.166667	0
Graduate	0.5	0.57142857	0.2727273	0.166667	0.5
Other	0	0.14285714	0.4545455	0.166667	0

Table 31: Strengths of association for skill levels and years of experience for officials

	1-5	6-10	10-15	16-20	21+
Novice	0.14285714	0.16666667	0.1428571	0.222222	0
Advanced Beginner	0	0.5	0	0.333333	0.5
Competent	0.57142857	0.16666667	0.5714286	0.222222	0
Proficient	0.28571429	0.16666667	0.1428571	0.222222	0
Expert	0	0	0.1428571	0	0.5

Table 32: Strengths of association for skill levels and years of experience for officials

	Yes	No
Novice	0.19047619	0
Advanced Beginner	0.23809524	0.25
Competent	0.33333333	0.5
Proficient	0.14285714	0.25
Expert	0.0952381	0

Table 33: Strengths of association for task performance speed and device use for officials

	BlackBerry	Nokia	iPhone
Extremely Slow	0	0	0
Slow	0	0	0
Moderate	0.33333333	0.5	0
Fast	0.58333333	0.5	1
Extremely Fast	0.08333333	0	0

Table 34: Strengths of association for durability and device use for officials

	BlackBerry	Nokia	iPhone
Extremely Fragile	0	0	0
Fragile	0.21428571	0	0
Fairly Durable	0.42857143	0.2	0
Durable	0.21428571	0.8	0
Extremely Durable	0.14285714	0	1

Table 35: Strengths of association for text entry and device use for officials

	BlackBerry	Nokia	iPhone
Highly Unacceptable	0	0	0
Unacceptable	0.06666667	0.2	0
Bearable	0.46666667	0.4	0
Good	0.4	0.4	1
Optimum	0.06666667	0	0

Table 36: Strengths of association for ease of use and device use for officials

	BlackBerry	Nokia	iPhone
Extremely Difficult	0	0	0
Difficult	0	0.4	0
Fairly Easy	0.53333333	0.2	0
Easy	0.46666667	0.4	0
Extremely Easy	0	0	1
TOTAL	15	5	1

Table 37: Strengths of association for reliability and device use for officials

	BlackBerry	Nokia	iPhone
Highly Unreliable	0	0	0
Unreliable	0	0	0
Fairly Reliable	0.33333333	0	0
Reliable	0.46666667	0.6	0
Extremely Reliable	0.2	0.4	1

Table 38: Strengths of association for size and device use for officials

	BlackBerry	Nokia	iPhone
Extremely Small	0	0	0
Small	0.13333333	0.2	0
Ideal	0.6	0.8	1
Big	0.26666667	0	0
Extremely Big	0	0	0

Table 39: Strengths of association for weight and device use for officials

	BlackBerry	Nokia	iPhone
Extremely Light	0	0	0
Light	0.2	0.4	0
Average	0.73333333	0.6	1
Heavy	0.06666667	0	0
Extremely Heavy	0	0	0

CORRELATIONS – CIVILIANS

Table 40: Strengths of association for ages and device use for civilians

	BlackBerry	Nokia	Motorola	iPhone	Other
Under 18	0	0	0.111111	0.2	0
18-25	0.39130435	0.36363636	0.333333	0.4	0.57143
26-35	0.17391304	0.09090909	0	0.4	0.14286
36-45	0.2173913	0.18181818	0.111111	0	0.14286
46-55	0.13043478	0.36363636	0.444444	0	0.14286
56+	0.08695652	0	0	0	0

Table 41: Strengths of association for skill levels and ages for civilians

	Novice	Advanced Beginner	Competent	Proficient	Expert
Under 18	0	0	0.06383	0.075	0.09375
18-25	0.35714286	0.11764706	0.361702	0.475	0.4375
26-35	0.21428571	0.17647059	0.106383	0.175	0.1875
36-45	0.21428571	0.23529412	0.234043	0.175	0.1875
46-55	0.07142857	0.35294118	0.191489	0.075	0.0625
56+	0.14285714	0.11764706	0.042553	0.025	0.03125

Table 42: Strengths of association for ages and gripping problems for civilians

	Yes	No
Under 18	0.05970149	0.02777778
18-25	0.35820896	0.40277778
26-35	0.20895522	0.13888889
36-45	0.2238806	0.23611111
46-55	0.11940299	0.16666667
56+	0.02985075	0.02777778

Table 43: Strengths of association for education levels and skill levels of civilians

	Novice	Advanced Beginner	Competent	Proficient	Expert
High School	0.46153846	0.72222222	0.478261	0.45	0.5625
Associates	0.30769231	0.11111111	0.173913	0.25	0.1875
Bachelors	0.07692308	0.05555556	0.23913	0.225	0.15625
Graduate	0.07692308	0.11111111	0.108696	0.05	0.03125
Other	0.07692308	0	0	0.025	0.0625

Table 44: Strengths of association for task performance speed and device use for civilians

	BlackBerry	Nokia	Motorola	iPhone	Other
Extremely Slow	0	0	0.111111	0	0
Slow	0.08695652	0	0.222222	0	0
Moderate	0.43478261	0.72727273	0.444444	0.4	0.5
Fast	0.26086957	0	0.111111	0.4	0.25
Extremely Fast	0.2173913	0.27272727	0.111111	0.2	0.25

Table 45: Strengths of association for durability and device use for civilians

	BlackBerry	Nokia	Motorola	iPhone	Other
Extremely Fragile	0	0	0.111111	0	0.25
Fragile	0.09090909	0	0.111111	0	0
Fairly Durable	0.22727273	0.18181818	0.444444	0.4	0.125
Durable	0.63636364	0.45454545	0.333333	0.6	0.375
Extremely Durable	0.04545455	0.36363636	0	0	0.25

Table 46: Strengths of association for text entry and device use for civilians

	BlackBerry	Nokia	Motorola	iPhone	Other
Highly Unacceptable	0	0	0	0	0
Unacceptable	0.04761905	0	0.222222	0	0.25
Bearable	0.14285714	0.09090909	0.444444	0.25	0.125
Good	0.47619048	0.63636364	0.222222	0.75	0.625
Optimum	0.33333333	0.27272727	0.111111	0	0

Table 47: Strengths of association for ease of use and device use for civilians

	BlackBerry	Nokia	Motorola	iPhone	Other
Extremely Difficult	0.04347826	0	0	0	0
Difficult	0.08695652	0	0.111111	0.2	0.125
Fairly Easy	0.30434783	0.16666667	0.333333	0.2	0.25
Easy	0.43478261	0.58333333	0.444444	0.4	0.5
Extremely Easy	0.13043478	0.25	0.111111	0.2	0.125

Table 48: Strengths of association for gripping problems and device use for civilians

	BlackBerry	Nokia	Motorola	iPhone	Other
Yes	0.33333333	0.4	0.5	0.5	0.25
No	0.66666667	0.6	0.5	0.5	0.75

APPENDIX E:
PAIRWISE COMPARISON WORKSHEET

DEVICE SELECTION PAIRWISE COMPARISON WORKSHEET

The scale below will be used to capture your opinions on the importance of device selection factors in regard to the use of wireless communication devices in emergency management situations:

Factor A	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Factor B
	Extreme		Very Strong		Strong		Moderate		Equal		Moderate		Strong		Very Strong		Extreme	

A rating of 1 (Equal) indicates that you perceive both factors to be equally as important. A rating of 9 (Extreme) on the side of Factor B indicates that you perceive Factor B to be 9 times as important as Factor A. A rating of 3 (Moderate) on the side of Factor A indicates that you perceive Factor A to be 3 times as important as Factor B.

Please indicate (by circling) your perceived level of importance for each of the following comparisons:

Comparison 1: Device Selection Factors

Important terms:

- Durability: the ruggedness of the equipment
- Accommodation to environmental lighting: how well the visibility of content displayed on the device is under extreme (both excessive and minimal) lighting conditions
- Text entry: the text entry method utilized by the device (i.e. touch screen, physical keyboard, etc.)
- Grip: how adequate the gripping surface of the device is in terms of both texture and shape
- Screen size: the size of the device's display
- Portability: how easily the device can be transported
- Audio clarity: how well audio communication can be heard using the device
- Usability: the extent to which the device can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use
- Unit cost: the cost of the equipment including all support equipment and consumables

	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Durability	Extreme		Very Strong		Strong		Moderate		Equal		Moderate		Strong		Very Strong		Extreme	Battery life and type
Durability	Extreme		Very Strong		Strong		Moderate		Equal		Moderate		Strong		Very Strong		Extreme	Accom. to environmental lighting
Durability	Extreme		Very Strong		Strong		Moderate		Equal		Moderate		Strong		Very Strong		Extreme	Text entry method

Durability	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Grip
Durability	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Screen size
Durability	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Portability
Durability	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Audio Clarity
Durability	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Usability
Durability	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Unit Cost
Battery life and type	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Accom. to environmental lighting
Battery life and type	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Text entry method
Battery life and type	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Grip
Battery life and type	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Screen size
Battery life and type	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Portability
Battery life and type	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Audio Clarity
Battery life and type	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Usability
Battery life and type	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Unit Cost
Accom. to environmental lighting	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Text entry method

Accom. to environmental lighting	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Grip
Accom. to environmental lighting	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Screen size
Accom. to environmental lighting	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Portability
Accom. to environmental lighting	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Audio Clarity
Accom. to environmental lighting	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Usability
Accom. to environmental lighting	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Unit Cost
Text entry method	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Grip
Text entry method	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Screen size
Text entry method	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Portability
Text entry method	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Audio Clarity
Text entry method	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Usability
Text entry method	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Unit Cost
Grip	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Screen size
Grip	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Portability
Grip	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Audio Clarity

Grip	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Usability
Grip	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Unit Cost
Screen Size	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Portability
Screen Size	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Audio Clarity
Screen Size	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Usability
Screen Size	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Unit Cost
Portability	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Audio Clarity
Portability	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Usability
Portability	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Unit Cost
Audio Clarity	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Usability
Audio Clarity	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Unit Cost
Usability	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Unit Cost

Comparison 2: Portability factors

Important terms:

- Weight: how much the device weighs in ounces
- Volume: the physical size of the device

Weight	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Volume

Comparison 3: Battery life and type considerations

Important terms:

- Battery type: the type of battery utilized by the device (NiCad, NiMH, or Li-Ion)
- Talk time: how long the battery will power the device when it is used to make or receive calls
- Standby time: how long the battery will power the device when it is not being used

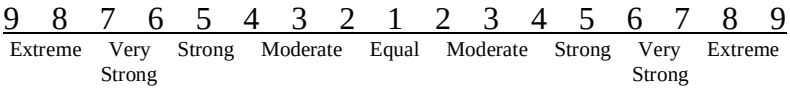
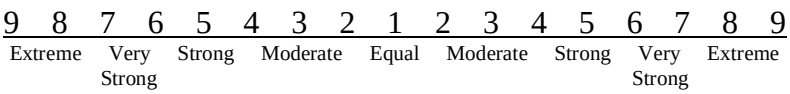
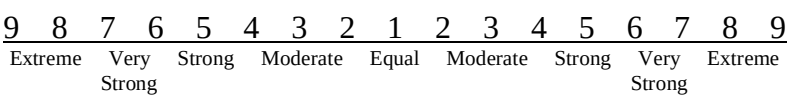
Battery Type	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Talk time
Battery Type	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Standby time
Talk time	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Standby time

Comparison 4: Usability factors

Important terms:

- Ease of learning: how fast a user can learn how to perform major functions with the device)
- Efficiency of use: the number of steps required to perform tasks using the device
- Ease of remembering: how easily a user can remember how to operate the device
- Frequency of errors: how many errors users commit when using the device
- Subjective pleasure: the level of pleasure experienced by users when using the device

Ease of Learning	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Efficiency of use
Ease of Learning	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Ease of remembering
Ease of Learning	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Frequency of errors
Ease of Learning	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Subjective pleasure
Efficiency of use	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Ease of remembering
Efficiency of use	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Frequency of errors
Efficiency of use	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 Extreme Very Strong Strong Moderate Equal Moderate Strong Very Strong Extreme	Subjective pleasure

Ease of remembering		Frequency of errors
Ease of remembering		Subjective pleasure
Frequency of errors		Subjective pleasure

APPENDIX F:
PAIRWISE COMPARISON RESULTS

PARTICIPANT 1

Table 49: Device selection factors pairwise comparison results for P1

	Durability	Battery Life	Accomodat	Text Entry I	Grip	Screen Size	Portability	Audio Clari	Usability	Unit Cost
Durability		(5.0)	1.0	(5.0)	(2.0)	(5.0)	(8.0)	(8.0)	(8.0)	1.0
Battery Life and			2.0	1.0	(2.0)	(2.0)	1.0	1.0	1.0	1.0
Accomodation t				(2.0)	(4.0)	(4.0)	(4.0)	(2.0)	(4.0)	3.0
Text Entry Meth					1.0	1.0	1.0	1.0	1.0	1.0
Grip						1.0	1.0	1.0	(3.0)	2.0
Screen Size							3.0	2.0	2.0	1.0
Portability								1.0	1.0	1.0
Audio Clarity									1.0	1.0
Usability										1.0
Unit Cost	Incon: 0.09									

Table 50: Battery life and type consideration pairwise comparison results for P1

	Battery Typ	Talk Time	Standby Tir
Battery Type		1.0	1.0
Talk Time			1.0
Standby Time	Incon: 0.00		

Table 51: Portability factors pairwise comparison results for P1

	Weight	Volume
Weight		1.0
Volume	Incon: 0.00	

Table 52: Usability factors pairwise comparison results for P1

	Ease of Lea	Efficiency c	Ease of Rer	Frequency	Subjective I
Ease of Learning		(4.0)	(4.0)	4.0	1.0
Efficiency of Use			1.0	4.0	4.0
Ease of Remembering				4.0	1.0
Frequency of Errors					(3.0)
Subjective Pleasure	Incon: 0.08				

PARTICIPANT 2

Table 53: Device selection factors pairwise comparison results for P2

	Durability	Battery Life	Accomodat	Text Entry I	Grip	Screen Size	Portability	Audio Clari	Usability	Unit Cost
Durability		1.0	(2.0)	(3.0)	(4.0)	1.0	(6.0)	(9.0)	(9.0)	1.0
Battery Life and			(2.0)	(6.0)	(5.0)	1.0	(5.0)	(6.0)	(9.0)	1.0
Accomodation t				1.0	(3.0)	4.0	(3.0)	(3.0)	(2.0)	1.0
Text Entry Meth					3.0	4.0	(3.0)	(3.0)	(4.0)	1.0
Grip						4.0	2.0	(4.0)	(5.0)	1.0
Screen Size							(2.0)	(2.0)	(6.0)	1.0
Portability								1.0	(3.0)	1.0
Audio Clarity									1.0	1.0
Usability										3.0
Unit Cost	Incon: 0.10									

Table 54: Battery life and type consideration pairwise comparison results for P2

	Battery Typ	Talk Time	Standby Tir
Battery Type		(5.0)	(2.0)
Talk Time			1.0
Standby Time	Incon: 0.09		

Table 55: Portability factors pairwise comparison results for P2

	Weight	Volume
Weight		5.0
Volume	Incon: 0.00	

Table 56: Battery usability factors pairwise comparison results for P2

	Ease of Lea	Efficiency c	Ease of Rer	Frequency	Subjective I
Ease of Learning		5.0	(4.0)	(5.0)	(5.0)
Efficiency of Use			(4.0)	(4.0)	(4.0)
Ease of Remembering				1.0	1.0
Frequency of Errors					1.0
Subjective Pleasure	Incon: 0.09				

PARTICIPANT 3

Table 57: Device selection factors pairwise comparison results for P3

	Durability	Battery Life	Accomodat	Text Entry I	Grip	Screen Size	Portability	Audio Clari	Usability	Unit Cost
Durability		4.0	(2.0)	8.0	7.0	5.0	4.0	2.0	2.0	2.0
Battery Life and			1.0	7.0	4.0	7.0	4.0	3.0	3.0	6.0
Accomodation t				5.0	4.0	5.0	3.0	1.0	2.0	3.0
Text Entry Meth					(2.0)	1.0	(5.0)	(6.0)	(2.0)	(3.0)
Grip						3.0	(2.0)	(5.0)	(5.0)	(5.0)
Screen Size							(7.0)	(8.0)	(5.0)	(6.0)
Portability								(3.0)	(4.0)	2.0
Audio Clarity									2.0	4.0
Usability										3.0
Unit Cost	Incon: 0.09									

Table 58: Battery life and type consideration pairwise comparison results for P3

	Battery Typ	Talk Time	Standby Tir
Battery Type		(9.0)	(5.0)
Talk Time			4.0
Standby Time	Incon: 0.07		

Table 59: Portability factors pairwise comparison results for P3

	Weight	Volume
Weight		8.0
Volume	Incon: 0.00	

Table 60: Usability factors pairwise comparison results for P3

	Ease of Lea	Efficiency o	Ease of Rer	Frequency	Subjective I
Ease of Learning		4.0	1.0	2.0	5.0
Efficiency of Use			(4.0)	(2.0)	2.0
Ease of Remembering				4.0	4.0
Frequency of Errors					8.0
Subjective Pleasure	Incon: 0.08				

PARTICIPANT 4

Table 61: Device selection factors pairwise comparison results for P4

	Durability	Battery Life	Accomodat	Text Entry I	Grip	Screen Size	Portability	Audio Clari	Usability	Unit Cost
Durability		1.0	1.0	1.0	1.0	(5.0)	(5.0)	(3.0)	1.0	1.0
Battery Life and			1.0	1.0	1.0	(3.0)	(3.0)	(4.0)	(7.0)	1.0
Accomodation t				2.0	1.0	(3.0)	(3.0)	1.0	1.0	1.0
Text Entry Meth					2.0	2.0	1.0	1.0	1.0	1.0
Grip						1.0	1.0	1.0	(3.0)	1.0
Screen Size							(3.0)	1.0	1.0	1.0
Portability								1.0	2.0	1.0
Audio Clarity									1.0	1.0
Usability										1.0
Unit Cost	Incon: 0.09									

Table 62: Battery life and type consideration pairwise comparison results for P4

	Battery Typ	Talk Time	Standby Tir
Battery Type		(2.0)	(2.0)
Talk Time			1.0
Standby Time	Incon: 0.00		

Table 63: Device selection factors pairwise comparison results for P4

	Weight	Volume
Weight		1.0
Volume	Incon: 0.00	

Table 64: Device selection factors pairwise comparison results for P4

	Ease of Lea	Efficiency c	Ease of Rer	Frequency	Subjective I
Ease of Learning		1.0	1.0	1.0	3.0
Efficiency of Use			1.0	1.0	3.0
Ease of Remembering				1.0	3.0
Frequency of Errors					3.0
Subjective Pleasure	Incon: 0.00				

PARTICIPANT 5

Table 65: Device selection factors pairwise comparison results for P5

	Durability	Battery Life	Accomodat	Text Entry I	Grip	Screen Size	Portability	Audio Clari	Usability	Unit Cost
Durability		3.0	(2.0)	1.0	2.0	(3.0)	(2.0)	(4.0)	(4.0)	1.0
Battery Life and			(2.0)	2.0	3.0	1.0	1.0	(3.0)	(2.0)	3.0
Accomodation t				2.0	3.0	2.0	(2.0)	(3.0)	(2.0)	(2.0)
Text Entry Meth					2.0	2.0	(2.0)	(2.0)	1.0	2.0
Grip						(2.0)	(2.0)	(4.0)	(3.0)	(2.0)
Screen Size							(2.0)	(3.0)	(3.0)	(2.0)
Portability								(2.0)	1.0	2.0
Audio Clarity									1.0	2.0
Usability										2.0
Unit Cost	Incon: 0.08									

Table 66: Battery life and type consideration pairwise comparison results for P5

	Battery Typ	Talk Time	Standby Tir
Battery Type		(3.0)	(2.0)
Talk Time			3.0
Standby Time	Incon: 0.05		

Table 67: Device selection factors pairwise comparison results for P5

	Weight	Volume
Weight		1.0
Volume	Incon: 0.00	

Table 68: Device selection factors pairwise comparison results for P5

	Ease of Lea	Efficiency o	Ease of Rer	Frequency	Subjective
Ease of Learning		1.0	1.0	2.0	1.0
Efficiency of Use			1.0	3.0	1.0
Ease of Remembering				2.0	1.0
Frequency of Errors					(2.0)
Subjective Pleasure	Incon: 0.00				

COMBINED

Table 69: Device selection factors combined pairwise comparison results

	Durability	Battery Life	Accomodat	Text Entry I	Grip	Screen Size	Portability	Audio Clari	Usability	Unit Cost
Durability		1.19136	(1.51572)	(1.13397)	1.11843	(1.71877)	(2.60517)	(3.36587)	(2.70192)	1.1487
Battery Life			(1.1487)	1.18466	1.03714	1.03131	(1.30259)	(1.88817)	(2.11179)	1.7826
Accomodat				1.58489	1.0	1.27226	(1.88817)	(1.7826)	(1.51572)	1.35096
Text Entry I					1.43097	1.7411	(1.97435)	(2.04767)	(1.51572)	(1.08447)
Grip						1.43097	(1.1487)	(2.40225)	(3.68011)	(1.37973)
Screen Size							(1.94729)	(1.88817)	(2.14113)	(1.64375)
Portability								(1.43097)	(1.43097)	1.31951
Audio Clari									1.1487	1.51572
Usability										1.7826
Unit Cost	Incon: 0.02									

Table 70: Battery life and type consideration combined pairwise comparison

	Battery Typ	Talk Time	Standby Tir
Battery Type		(3.06389)	(2.09128)
Talk Time			1.64375
Standby Time	Incon: 0.00		

Table 71: Device selection factors combined pairwise comparison results

	Weight	Volume
Weight		2.09128
Volume	Incon: 0.00	

Table 72: Device selection factors combined pairwise comparison results

	Ease of Lea	Efficiency o	Ease of Rer	Frequency	Subjective I
Ease of Learning		1.37973	(1.7411)	1.26191	1.24573
Efficiency of Use			(1.7411)	1.08447	1.43097
Ease of Remembering				2.0	1.64375
Frequency of Errors					1.31951
Subjective Pleasure	Incon: 0.01				

REFERENCES

Alexander, David and Klein, Susan. (2009). *First Responders after Disasters: A Review of Stress Reactions, At-Risk, Vulnerability, and Resilience Factors.* Prehospital and Disaster Medicine 2009, 24920: 87-94.

Arif, Ahmed S., Wolfgang, Stuerzlinger.(2009). *Analysis of Text Entry Performance Metrics.* 2009 IEEE Toronto International Conference-Symposium on Biomedical Engineering.

Department of Defense. (1995). *Human engineering design guidelines.* (MIL-HDBK-759C). Philadelphia, Pa: Navy Publishing and Printing Office.

Director of NEMA. "The Bahamas Disaster Preparedness and Response Policy Review."*FEMA: Mobile*. Federal Emergency Management Agency. Web. 29 Apr. 2010. Retrieved from http://m.fema.gov/.

Ide, Akira and Naoki Kaneta.(2004) *"A Study on Disaster Management about the Protection of Spreading Rumors on the Network." IEEE Xplore*.

International Telecommunication Union. (2009) *ITU Corporate Annual Report 2008*. Rep. Geneva. Retrieved from http://www.itu.int/osg/csd/stratplan/AR2008_web.pdf.

International Telecommunication Union. (2009*) "The World in 2009: ITC Facts and Figures."* http://www.itu.int/ITU-D/ict/material/Telecom09_flyer.pdf.

International University of Japan. Retrieved on July 18, 2010 from http://www.m4life.org/proceedings/2005/PDF/47_R134FS.pdf.

Jones, E. (2005) *The Bahamas National Hurricane Response: 2004 Report on Findings.* Prepared for United Nations Development Program. April 2005.

Leventhal, L., & Barnes, J. (2008). *Usability Engineering*. Upper Saddle River: Pearson/Prentice Hall.

Levs, Josh. *Trapped Father Survives with Help of Phone App. CNN World*. Turner Broadcasting System, Inc., 24 Jan. 2010. Web. 29 Apr. 2010. Retrieved from http://www.cnn.com/2010/WORLD/americas/01/24/haiti.survivor.phone.app/index.html

Meissner, A, Luckenbach, T., Risse, T., Kirste, T., and Kirchner, H. (2002). *Design Challenges for an Integrated Disaster Management Communication and Information System.* The First IEEE Workshop on Disaster Recovery Networks (DIREN 2002).

McCauley-Bell, Pamela R., Samiullah K. Durrani, Mark Jacobsen, Annette Hemphill, and Shelby Vaughn. (2008) *Human Factors and Ergonomic Issues in Large Scale Disaster Management.*

National Emergency Management Agency. (2010). *The Bahamas Disaster Preparedness and Response Policy Review.*

Perry, Ronald and Michael Lindell. (1978) *The Psychological Consequences of Natural Disaster:A Review of Research on American Communities.* Mass Emergencies Vol. 3 (pp. 105-115).

Reuters AlertNet - Emergency Information Service Helps Thousands in Haiti. Reuters AlertNet. Homepage. Web. 05 May 2010. http://www.alertnet.org/thenews/newsdesk/126400923428.htm.

Shankar, K. (2008). *Wind, Water, and Wi-Fi: New Trends in Community Informatics and Disaster Management*. Information Society. Vol 24, Issue 2, pp. 116-120.

Smith, Patrick and David Simpson. (2009) *Technology and Communications in an Urban Crisis.* Journal of Urban Technology. April 2009.

Souza, F. Kushchu, I. (2005). *Mobile Disaster Management System Applications-Current Overview and Future Potential.*

U.S. Department of Justice. (2002). *Guide for the Selection of Communication Equipment for First Responders* (NIJ Guide 104-00). National Institute of Justice Publication. Vol. I, February 2002.

Villagran, Melinda, Elaine Wittenberg-Lyles, and Raymond Garza. (2001) *A Problematic Integration Approach to Capturing the Cognitive, Cultural, and Communication Experiences of Hurricane Katrina Volunteers.* Analyses of Social Issues and Public Policy, Vol. 6, No. 1, 2001, pp. 87-97.

Windle, Dale. (2002). *The Role of Wireless Technology in Disaster Recovery.* Issue brief. Binomial International. Retrieved from www.binomial.com/resources/**wireless**_in_dr.pdf.

Wireless Guide. (2007). *How To Choose Your Cell Phone. Web.* http://www.wirelessguide.org/phone/choosing-phones.htm

Zingale,Carolina.*(2005). Human Factors Guidance for the Use of Handheld, Portable, and Wearable Computing Device. NTIS.* Nov.2005.