MOBILE COMPUTING:
EMERGENCY MANAGEMENT APPLICATION

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Abstract of Project Presented to the Graduate School
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MOBILE COMPUTING: EMERGENCY MANAGEMENT APPLICATION

By
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May 2012

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Over the past decade, people across the world have witnessed thousands of major emergencies and disasters, such as earthquakes, fires and car accidents. Usually, when these problems occur, the lack of information, the fear, and the nerves decrease the persons' ability to organize ideas and to communicate basic information (e.g. their current position). Since mobile devices, especially Android devices, have been gaining a lot of popularity, this project presents a usable Android application aimed to help people before, during and after an emergency. Mostly, this project focuses on the usability aspects of the application. It was designed and implemented taking into consideration all information related to usability engineering for mobile devices. Once the prototype was developed, a heuristic evaluation was done and improvements to the application were made based on the results of that test. Finally, the application was tested with potential users. The results of the user tests show that the maximum time required by most of the users performing the tasks provided by the application was less than one minute; including people with no previous experience with Android devices. The main conclusion of this project is that even though there are a lot of initiatives from the government aimed to help people in case of an emergency, there is a big group that is not reached by those initiatives, mostly because of the information is not always available or because it is hard to find. A cell phone application is available almost at all time and, if developers take into consideration usability principles, the information could be found very fast, getting assistance from the emergency services could be easier and more lives could be saved.

Resumen de Proyecto Presentado a Escuela Graduada
de la Universidad de Puerto Rico como requisito parcial de los
Requerimientos para el grado de Maestría en Ingeniería

COMPUTACIÓN MÓVIL: APLICACIÓN PARA EL MANEJO DE EMERGENCIAS

Por:
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Mayo 2012

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Durante la última década, las personas a través del mundo han sido testigos de grandes desastres y emergencias, como terremotos, incendios y accidentes de autos. Usualmente, cuando ocurren estos problemas, la falta de información, el miedo y los nervios pueden disminuir la capacidad de las personas de organizar sus ideas y comunicar información básica (por ejemplo, su posición actual). Dado que los dispositivos móviles, especialmente los dispositivos Android, han ganado mucha popularidad en estos años, este proyecto presenta una aplicación para Android destinada a ayudar a las personas antes, durante y después de una emergencia. Sobre todo, este proyecto se enfoca en los aspectos de usabilidad de la aplicación. Fue diseñado e implementado teniendo en cuenta todos los conceptos relacionados a usabilidad para dispositivos móviles. Una vez que el prototipo fue desarrollado, se hizo una evaluación heurística del mismo y se implementaron mejoras a base de estos resultados. Por último, la aplicación se puso a prueba con usuarios(as) potenciales. Los resultados de las pruebas de usuarios(as) muestran que el tiempo máximo requerido por la mayoría de los usuarios(as) para realizar las tareas previstas por la aplicación fue menos de un minuto, incluyendo las personas sin experiencia previa con teléfonos inteligentes. A base de los resultados de este proyecto se concluye que, a pesar de que hay una gran cantidad de iniciativas por parte del gobierno destinadas a ayudar a las personas en caso de una emergencia, hay un gran grupo que no es alcanzado por estas iniciativas, sobre todo debido a que la información no siempre está disponible o porque es la información es difícil de encontrar. Las aplicaciones móviles tienen la ventaja de que están disponibles casi en todo momento y, si los(as) desarrolladores tienen en cuenta los principios de usabilidad, la información se puede encontrar muy rápido, el recibir asistencia podría ser más fácil y se podrían salvar más vidas cuando ocurran emergencias.

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DEDICATION

This project is dedicated first of all to God for giving me the most of precious of all gifts, life. Secondly, I want to dedicate this project to my parents, Neftalí Chaparro and María E. Acevedo and my son Gabriel Miranda-Chaparro, for being there for me during my best days, but also when I needed them the most. This project is also dedicated to the memory of my younger brother Neftalí Chaparro, who died a few years before I began my master studies.

To my advisor, Dr. Kejie Lu, and to the members of my committee Dr. Néstor Rodríguez and Dr. José Borges for their trust. Finally, to my friends in the university who have been there for me always and to my academic counselors Sandra Montalvo, Maritza Figueroa and Damaris Echevarría for their guidance and support.

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CHAPTER 1

1 INTRODUCTION

1.1 MOTIVATIONS

During these last few years Android devices have been gaining a lot of popularity. Now these days, people tend to like more Android devices over other smartphones for several reasons:

1. Price: Since Android OS is free, the price of the Android powered devices is less.
2. Hardware supporters: Since Android is a Linux based system; it supports various hardware manufacturers and many different platforms.
3. Carriers: Since there are different manufacturers, there is no mobile carrier dependency.

On the other hand, the amount of tragedies related to accidents or natural disasters are a problem that affects all people. People across the world have witnessed thousands of major emergencies like tsunamis, earthquakes, fires, and car accidents. Even though there are a lot of initiatives from the government to prevent and mitigate the problems associated with certain emergencies, there is evidence that shows that some individuals are not prepared for emergencies. The lack of information is one of the major causes of deaths and injuries.

1.2 CONTRIBUTIONS

The main contributions of this project are:

- A mobile (Android) application was developed. The application includes the following features:
    - Emergency preparedness
        - Preparation of an emergency survival kit

        - Emergency procedures and information about what to do to be better prepared for an emergency
    - Emergency mitigation
        - Steps to follow during an emergency
        - Automatic search of the phone number of different emergency services (ambulance, firefighters and police) based on the user's position.
        - Ability to send the user's position to relatives in case of an emergency.
    - Emergency recovery
        - Steps to follow after an emergency
- Literature review of available emergency management applications.
- Detailed analysis of a heuristic evaluation made to the developed application.
- Detailed analysis of several tests that were done to potential users.

1.3 Document organization

The organization of the rest of the document is as follows: the next chapter explains concepts and other background information that will allow readers to understand the techniques and procedures followed in this study. That information includes a brief introduction to Android, its advantages, and its features. In the same way, a description of usability and its testing methods is presented. Also, that chapter explains the software design model followed in this project. Chapter 3 presents a literature review of available emergency management applications, their approaches, their limitations and the advantages of the proposed solution. Chapter 4 gives readers a deeper description about the design process, the project requirements and its objectives. Chapter 5 describes the heuristic evaluation made to the application; as well the improvements made to the application based on that evaluation. Chapter 6 discusses the test with real users and a deep analysis of the results is presented. Finally, chapter 7 presents some conclusions based on the results and proposes improvements as a future work.

CHAPTER 2

2 BACKGROUND

In this chapter you will find basic information about Android and the development of applications for mobile devices. In the same way, you will find the basics of the usability techniques used in this project to verify its compliance with the established goals. The first section explains what is Android and its advantages over other mobile operating systems. The second section presents basic information about usability: heuristic evaluations and user testing.

2.1 EMERGENCY MANAGEMENT

Emergency management is a four phases process and involves the activities made by the public and private sectors to deal with hazards, risks, and disasters (Baird, 2010). The four phases are emergency mitigation, preparedness, response and recovery. According to Ada City-County Emergency Management Organization, mitigation is defined as *"sustained action that reduces or eliminates long-term risk to people and property from natural hazards and their effects";* preparedness are the plans or procedures designed to save lives and to minimize damage when an emergency occurs; response is how the plans and procedures were put in action to save lives and prevent further damage; and recovery is "*the actions taken to return the community to normal following a disaster*" (Ada City-County Emergency Management Organization, 2012)

Some examples of emergency mitigation could be buying insurance for houses, enforcing building standards, engineering roads and bridges to withstand earthquakes and so forth. Examples for preparedness could be preparing an emergency survival kit, and knowing what to do in case of an emergency. Response activities may include search and rescue victims, sheltering and getting help from emergency officers. Recovery is the last phase and its activities may include repairing buildings, or rebuilding property (Ada City-County Emergency Management Organization, 2012). This project includes features for

emergency preparedness: creating an emergency survival kit and information on what to do before/during an emergency; for emergency response: getting in contact with relatives and emergency centers; and for recovery: providing information about procedures that must be followed after an emergency.

2.2 ANDROID

Android is a software stack for mobile devices that includes an operating system, middleware and key applications (Android Developers, 2011). All the applications developed for Android are written using the Java Programming language and developers can use XML to create the user interfaces. The Android Development Tools (ADT Plugin for Eclipse) are a set of tools designed to give a powerful, integrated environment to build Android applications. Using this software, developers can create and export Android Packages (APKs). These packages are the ones that are installed in the mobile devices.

Android was initially developed by a stand-alone company, founded by Andy Rubin and Chris White and they were developing an open source operating system for digital cameras (Burgelman, Silverman, Wittig, & Hoyt, 2009). In 2005, they sold the company to Google and their mission evolved to delivering a (free and open) Linux-based operating system for cell phones and other mobile devices (Burgelman, Silverman, Wittig, & Hoyt, 2009). Later, in November 2007, Google formally presented Android and created an alliance with other hardware and software developers. This alliance is called Open Handset Alliance (OHA) and its goal is to develop open standards for mobile devices, promote innovation in mobile phones and provide a better experience for consumers at a lower cost (Alliance Members|Open Handset Alliance, 2011). Different companies[1]; such as Texas instruments, Intel, HTC, T-Mobile, Intel, Motorola, Qualcomm and Samsung; were part of this business alliance, thus cheaper phones with a complete operating system were developed. Those Android phones are sold with a software suite that has integration with Google's proprietary applications (Google Maps, Calendar, Gmail, and a full web browser).

[1] The complete list could be found in the OHA webpage

Furthermore, third-party applications can be bought or obtained free via the Android Market.

2.2.1 Android Advantages and Features

Android has several advantages over other operating system. Some of those advantages are described and explained below:

- *Free and open OS*
    - Anybody can develop applications and enhancements to OS. More than just changing and customizing the user interface, developers can even change the core functions with different applications. Also, they can modify the software with their own code or Google's Java libraries and create their own applications.
    - Cellphone carriers are using Android to offer better deals to costumers (they are not paying for the operating system).
    - Since Android is a Linux based system, it supports various hardware manufacturers and many different platforms, therefore there is no mobile carrier dependency.
- *Market Share*
    - According to data released on March 2011 by Nielsen, a market research firm, Android OS is beginning to open up a considerable lead when it comes to recent smartphones adopters. The research shows that half of the consumers who recently acquire a smartphone purchased an Android phone (Oswald, 2011). Comparing Android with the second largest market share, Apple's iOS, we can see that Android's market is two times bigger. The following picture shows the other competitors in the market:

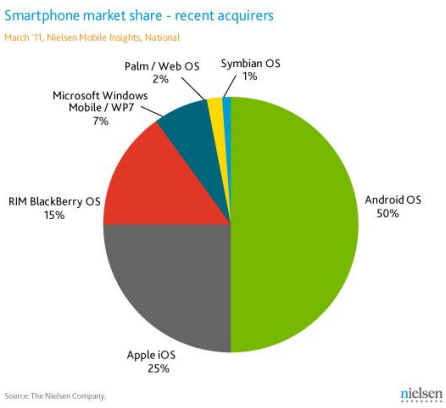

FIGURE 1: MOBILE OPERATING SYSTEMS MARKET SHARE (OSWALD, 2011)

- *Mobility and Portability*
    - Since Android can be used on many different platforms. The open access will help to collect a lot of experience which will make it easier in the future to access other sections.
    - Other operating systems have several applications that are specific to certain hardware platforms and therefore are not portable (i.e. Windows Mobile and iOS).
    - It takes advantage of all the attributes of mobile computing: ubiquity (ability to receive and transmit information anywhere, at any time, in a real-time environment), convenience, instant connectivity (GPRS, Wi-Fi and 3G technologies will give faster access to networks without the need to make a call), personalization and localization of products and services.
- *Development tools*
    - Android offers a variety of free development tools for experienced and un-experienced people. Some of those development tools are: Google's AppInventor, Eclipse SDK, WinDev Mobile, DroidDraw and so forth.
    - If the developers do not have an Android device, then they can use the Android Emulator that comes packaged with the SDK and it can be used to

design debug and test the application in an actual Android run-time environment.

- *Multi-tasking*
    - Android devices can run several applications at the same time, which makes it easier to multitask. The amount of applications that can run at the same time is not limited by the OS because the multitasking capability is provided in the form of services.
- *Features* (Google Labs, 2011) (Google Inc., 2010) (HTC) (Whitson, 2011)
    - Android supports a wide variety of technologies, including Bluetooth, WiFi, GSM/EDGE, CDMA and EV-DO.
    - Android can adapt to traditional smartphone layouts, as well other VGA, 2D, and 3D graphics libraries.
    - Android supports a wide range of audio, video, media, and other format. Also, they provide a Java Virtual Machine that enables users to run applications developed in Java.

2.2.2 Determining Users Location on Android

There are different methods developers can use to obtain the user's location. When developing for Android, developers can utilize its Network Location Provider (using the cell tower and Wi-Fi signals) and/or the device's internal GPS. The device's internal GPS is more precise, but it consumes more battery, only works outdoors and it requires at least 30 seconds to communicate with the available satellites. The Android's Network Location Provider works indoors and outdoors, responds faster and uses less battery power but it could be less accurate (Android Developers, 2011). For this project both methods were implemented, and the user can decide which one they like based on his (her) preferences.

2.3 Software Design

The software design of this project was done following an iterative design model. Several studies (Bury, 1984) (Nielsen, 1993) (Hussain, et al., 2008) demonstrate that the iterative design is the best approach to design user interfaces. In his paper, Jakob Nielsen said: *"even the best usability experts cannot design perfect user interfaces in a single attempt, so a usability engineering lifecycle should be built around the concept of iteration".* This design methodology based on a cyclic process that involves an initial prototype, user testing, results analysis and improvements.

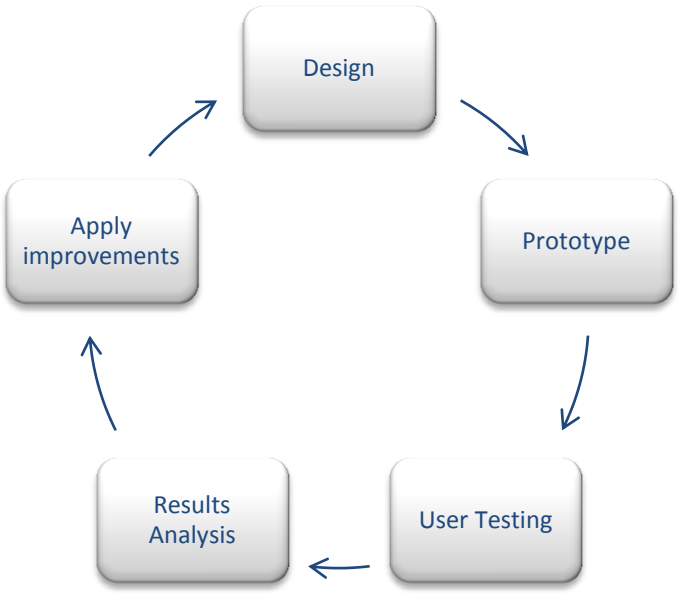

FIGURE 2: ITERATIVE DESIGN MODEL

Following this approach, developers can get feedback from the users and identify major usability issues early in the development cycle; therefore the product quality of the end product is improved.

2.4 Usability

There are many ways of defining usability. The official definition provided by ISO Standard is the extent to which a product can be used by specified users to achieve

specified goals with effectiveness, efficiency and satisfaction in a specified context of use. In other words, it can be defined as a quality term that aims to evaluate five components (Nielsen, 2003):

- *Learnability*: is defined as the "*a measure of the degree to which a user interface can be learned quickly and effectively."* (Usability First, 2012). In other words, learnability is how easy is it for users to accomplish tasks in the application the first time they encounter them.

- *Efficiency*: is the amount of time that a user need to perform the tasks that the application has.

- *Memorability*: is a measure of the degree to which a user can remember the features of the application after a period of not using it.

- *Errors*: Since every person is different, something that is obvious for someone can be misunderstood by others. When these things happen, users could have navigation errors, input errors and so forth. If that happen, the recovery process from the errors should be easy.

- *Satisfaction*: This involves the users' perception of the application. Some aspects that can affect the users' satisfaction are if program is fast, if it meets their expectations, and if it addresses their needs.

In order to verify the compliance of a user interface with these components and with other usability standards, developers can use heuristic evaluations and user's testing. Since heuristic evaluation and user testing each finds usability problems overlooked by the other method, it is recommended that both methods be used. These tools are explained in the following sections.

2.4.1 HEURISTIC EVALUATIONS

The goal of the heuristic evaluations is to find the usability problems in a general user interface (GUI). The results of the evaluations help designers to identify and judge the

compliance of the GUI with recognized usability principles. These principles were created by Jakob Nielsen and are explained below (Nielsen, 2003):

- *Simple and Natural Dialogue*
    - Dialogues should not contain irrelevant or rarely used information. All the irrelevant information units compete with the relevant units of information and diminish their relative visibility. The information should appear in a natural and logical order.
- *Speak the User's Language*
    - The terms used as labels in the applications should be clear, and expressed in words familiar to the user rather than in system-oriented terms.
- *Minimize the User's Memory Load*
    - The instructions should be simple. They data that the users have to store in their short-term memory should be very limited or none.
- *Be Consistent*
    - If users repeat an action, they should obtain the same results. The similar icons, labels and groups should be related.
- *Provide Feedback*
    - The system should keep users informed about what is happening with the application. For every process that takes more than a minute to finish, the appropriate feedback should be shown.
- *Provide Clearly Marked Exits*
    - If the users made a mistake, the application should be prepared to allow them to "escape" from that unwanted state easily.
- *Provide Shortcuts*
    - The system should be developed taking into consideration novice and expert users. The features that make an application easy to learn can delay experienced users. For this reason, tools and shortcuts to speed up the interaction of experienced users should be provided.
- *Provide Good Error Messages*
    - The error messages should be clear and present the exact cause of the problem. They must never criticize the users or their abilities and they should provide meaningful suggestions to the user about the options to recover from that error.
- *Error Prevention*
    - Even better than good error messages is a careful design that prevents a problem from occurring in the first place.

- *Help and Documentation*
    - If the documentation is necessary, that data should be easy to search, precise, concise and focused on the users' tasks.

The level of compliance or severity of the problems is based on a combination of three factors: the frequency, the impact and the persistence. This severity rating is very important when defining the urgency of actions related to a problem.

After the test results are provided to designers, they should analyze the results and make changes if they are necessary.

2.4.2 USER TESTING

The user testing is probably the most useful method for usability testing. It gives the opportunity to see possible clients interacting with the application and to observe the problems that they are having and the questions that they had. In this way, the developer can get invaluable elements to make the interface easier to use. According to Nielsen, the usability experts should set three main components (Nielsen, 2000):

- Get representative users, usually five users are enough to identify major usability problems. Nielsen said: "Testing with a greater number of users increase the cost of the test, not the relevance of the results."
- Set representative tasks and ask users to perform them.
- Observe the users behavior quietly, the moderator should collect the data on the user's success, speed of performance, and satisfaction. All these data, quantitative and qualitative, shall be used to create a test report.

CHAPTER 3

3 RELATED WORK AND MARKET OVERVIEW

There are several applications in the market for disaster management. This section will reveal the positive and negative points of each solution developed and how the proposed solution will address all those issues.

3.1 THE I-MODE® DISASTER MESSAGE BOARD SERVICE.

In a report created by NTT DoCoMo in August 2003 says: "under the present network system, there may be instances in the case of a major disaster where the flow of both voice calls and data packet transmissions would have to be controlled. This would be necessary to prevent degradation in network performance due to congestion from the anticipated flood of calls". (NTT DoCoMo, 2003). Based on this, the company created a disaster management application to its i-mode[2] users. The application allows users within the disaster area to place and check messages in order to inform relatives and associates of their current situation. The system has three major limitations (Souza & Kushchu, 2005):

- The application is limited to a specific population (DoCoMo's users with the i-mode service).
- Users are limited to send a maximum of 10 messages SMS with a less than 200 alphanumeric characters and each message is saved for up to 72 hours.
- The system is only activated in the event of a major calamity, there is no pre-disaster management

3.2 ENHANCED 911

The wireless Enhanced-911 or E911 is a program divided in two phases. Phase I requires carriers, upon appropriate request by a local Public Safety Answering Point (PSAP), to report the telephone number of a wireless 911 caller and the location of the antenna that received the call. Phase II requires wireless carriers to provide far more

[2] i-mode is a mobile Internet service that has caused a revolution in both business and private lifestyles in Japan

precise location information, within 50 to 300 meters in most cases (Turban & Volonino, 2009). In other words, the application connects public emergency services with citizens in need by tracking down the citizen's position (*GPS-enabled phones users required*). This saves time since users do not need to explain where they are, but what kind of assistance they need. According to the FCC, his system is not fully implemented and the deployment of E911 requires the development of new technologies and upgrades to local 911 PSAPs, as well as coordination among public safety agencies, wireless carriers, technology vendors, equipment manufacturers, and local wire-line carriers (Federal Communications Commission, 2011). The system has the following limitations (Souza & Kushchu, 2005):

- Only works with GPS-enabled phones.
- Most local call centers do not have the technology that is needed to get the caller's location come from their wireless phones and it does not provide a standardized way of sending the users position or emergency message.
- The project is not fully implemented, and the set-up costs involved were cited as a constraint to be solved by the US operators (i.e. Sprint, AT&T, T-Mobile) regarding further phases of the system.

3.3 SMS DISASTER ALERTS

This is a Government to Citizens (G2C) system to give real time information about hazardously locations in order to avoid the population to go to those places along with controlling the possible mass hysteria caused by rumors. Right now it is only working in Hong Kong. Some of the issues with this system are the following:

- The messages are one way and they are not customizable; this generates problems in terms of anxiety and may not fit the necessities of certain groups of population (e.g. people with disabilities, elder population, etc.). Since the messages do not take into consideration the user's position, the system could generates a lot of information that is not relevant to all the users. For example, if a user is located in

the north side of the country, he/she could receive a message that is relevant to the users in the south.

- People will receive a SMS, not video or voice data. Also, they cannot communicate with their relatives in case of an emergency.
- It does not provide a service to allow citizens to report problems or emergencies.

3.4 ADVANTAGES OF THE DEVELOPED APPLICATION

The previously mentioned products have some similarities with the developed application. However, these products have some serious limitations, including parts that have not been developed, restrictions to the citizens, and some of them work only with GPS-enabled phones. Furthermore, there is no evidence that these systems are considering none of the quality measures in terms of usability or human factors. In addition, no studies were found about the amount of time spent by user performing the tasks provided by the application. The developed application takes into consideration all the usability principles, and all the tasks provided by the application can be found two clicks away (or less) from the main screen.

CHAPTER 4

4 APPLICATION DEVELOPMENT

4.1 Objectives

The design of this project involved a usable mobile application aimed to help people before, during and after an emergency. To accomplish this task, two main objectives were developed. The important design decisions were made taking into consideration those objectives and they are explained below:

- *Design an Android application to determine users' location and send information to emergency centers or relatives before, during or after an emergency.* This objective involves:
    - Clear understanding of the Android environment and the integrated development environment.
    - Research and selection of a technology to determine an accurate user's location taking advantage of mobile devices features.
    - Identify ways for accessing the application features easily
    - Determine the more feasible ways of communication if an emergency is occurring or has occurred.
- *Design a table with information about different emergency centers in Puerto Rico and its phone numbers.* This objective involves:
    - Research for databases that contain the phone numbers of all the police, firefighters and ambulances of the island.
    - If the previously described database does not exist, then this information will be gathered from different electronic sources.
- *Examine the user interface and judge its compliance with recognized usability principles.* This objective involves:
    - Create and run heuristic evaluations of the application
    - Document all the process and identify opportunities for improvement.

- Documented conformity to industry standards, established usability principles, and known human limitations
- Run usability tests with novice and expert users to evaluate the behavior of possible stakeholders, their needs and concerns with the interface.
- Prioritize changes and upgrades to the system based on user generated data (rather than guesses about what customers want and need).

4.2 Project Impact

This project has a positive social impact since it provides information about emergency management to its users, thus they will be better informed and/or prepared if they faced a situation like the ones described in the application. Furthermore, the application has an effective way of getting in contact with the nearest emergency service, thus users can save time when they have an emergency.

As an environmental impact, this project is going to be used on electronic devices, thus all the data presented is displayed electronically. This fact reduces the paper usage and keeps the application environmental friendly.

4.3 Integrated Development Environment (IDE) Setup

There are a several set of tools that are needed to program android projects. The development tools used in this project are the following:

- Eclipse
  - Java Development Kit 6 (JDK 6)
  - Eclipse 3.5 (Galileo)
- Android SDK
- Android Development Tools plugin (ADT Plugin for Eclipse)
  - These tools are designed to extends the capabilities of Eclipse and to quickly set up new Android projects, create the applications user interface, debug the applications using the Android SDK tools, and even export android packages (APK).

4.4 Design and Implementation

4.4.1 Use Cases[3]

The following diagram shows all the interactions that the user can have with the application.

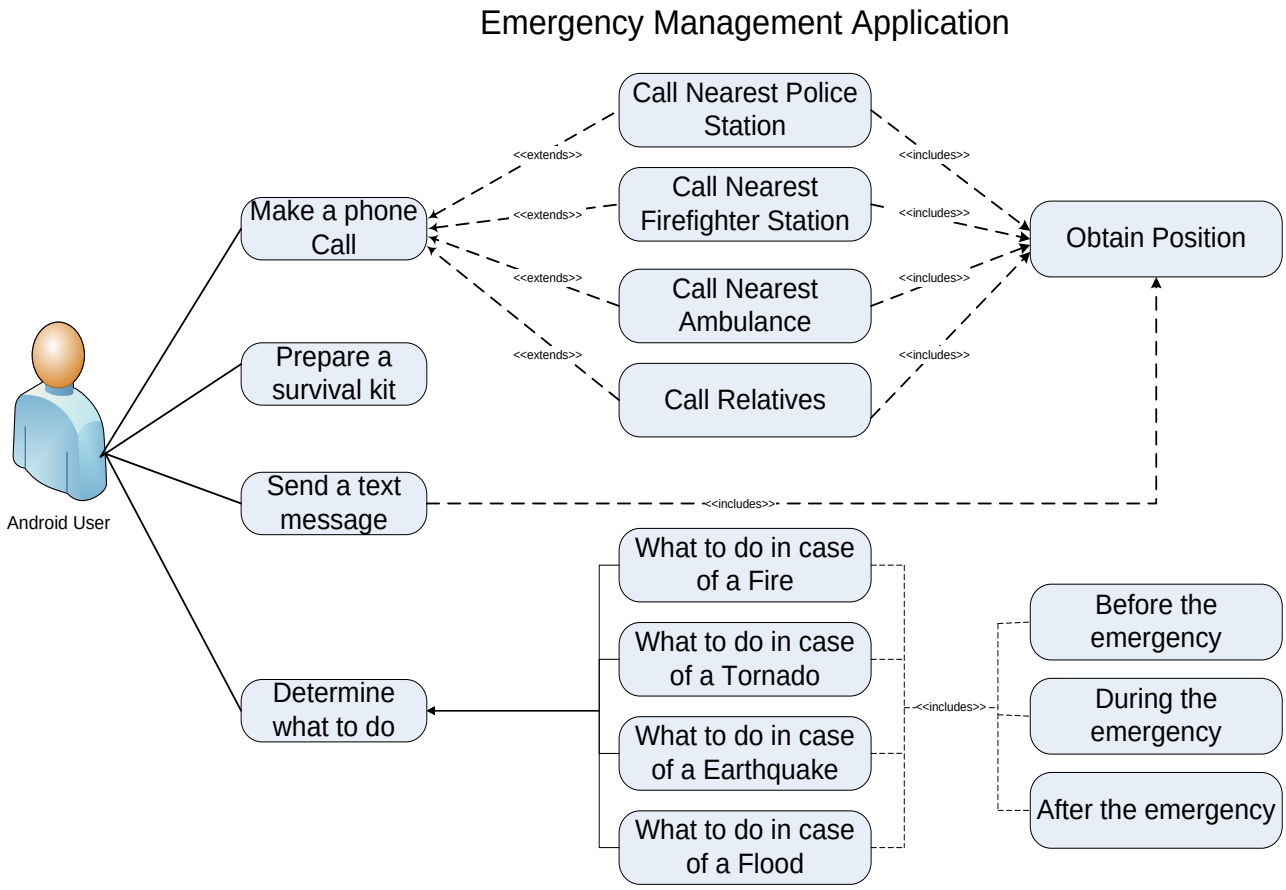

FIGURE 3: USE CASE DIAGRAM

[3] All the emergency procedures available in the application were taken mostly from the Federal Emergency Management Agency (FEMA) website, from ready.gov and from the Puerto Rico Emergency Management Agency (Agencia Estatal para el Manejo de Emergencias de Puerto Rico -PREMA).

As shown in the previous diagram, the user can:

- Make a phone call
    - The user can make a phone call to the nearest police, ambulance, or firefighter. Also, they can make a phone call to their relatives. Before making the phone calls, the application searches and displays the users position
- Prepare an emergency kit
- Send a text message
    - The text message includes information about the user's position
- Determine what to do
    - The users can determine the emergency procedures that they must follow in case of a certain emergency. It will display information about what to do before, during and after the emergency.

4.4.2 Interface Options

The interface of the application was made in a way that all tasks could be reached with a maximum of two clicks. As shown in the following diagram, once the users open the application, they will have direct access to five tabs (Get Help, What to do, Emergency Kit, Edit Contacts and Information). Those tabs hold the main functionalities of the application.

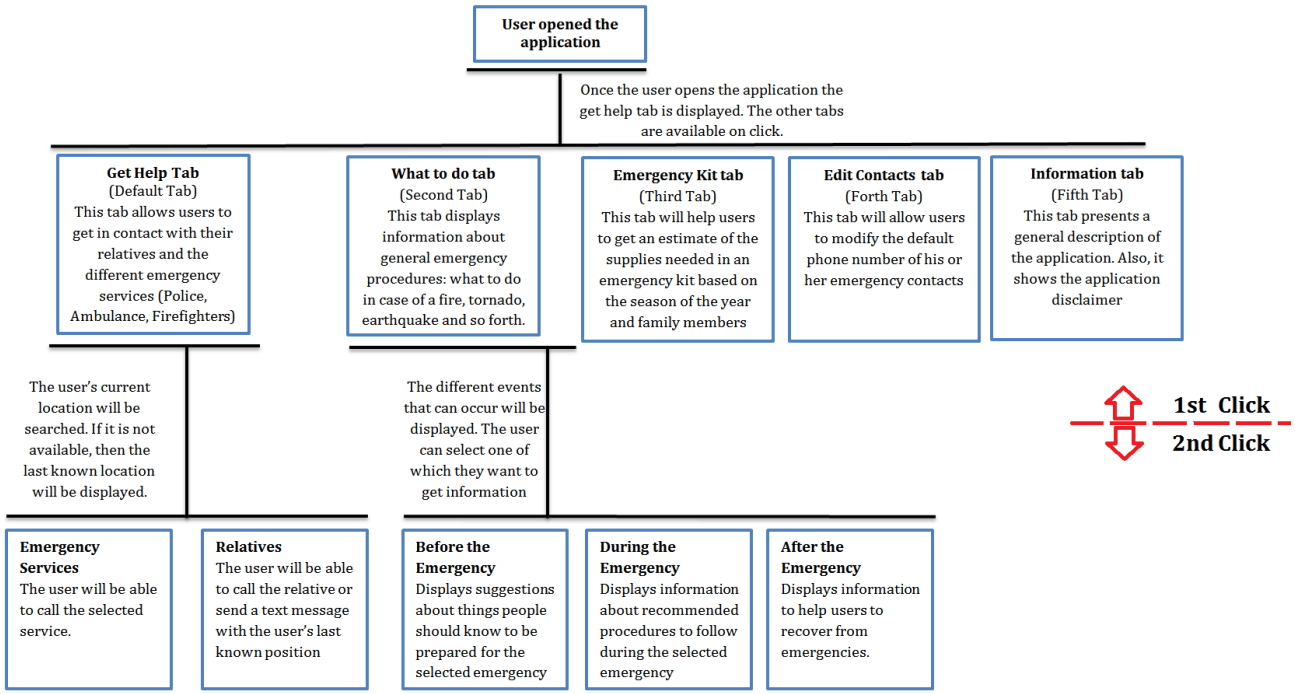

FIGURE 4: INTERFACE STRUCTURE

Once the users touch on one of those options, the second set of options is displayed. In case of the Get Help tab, the process of getting the user's location happens on the background. The following flowchart presents a high level description of the algorithm behind the "Get Help" Tab.

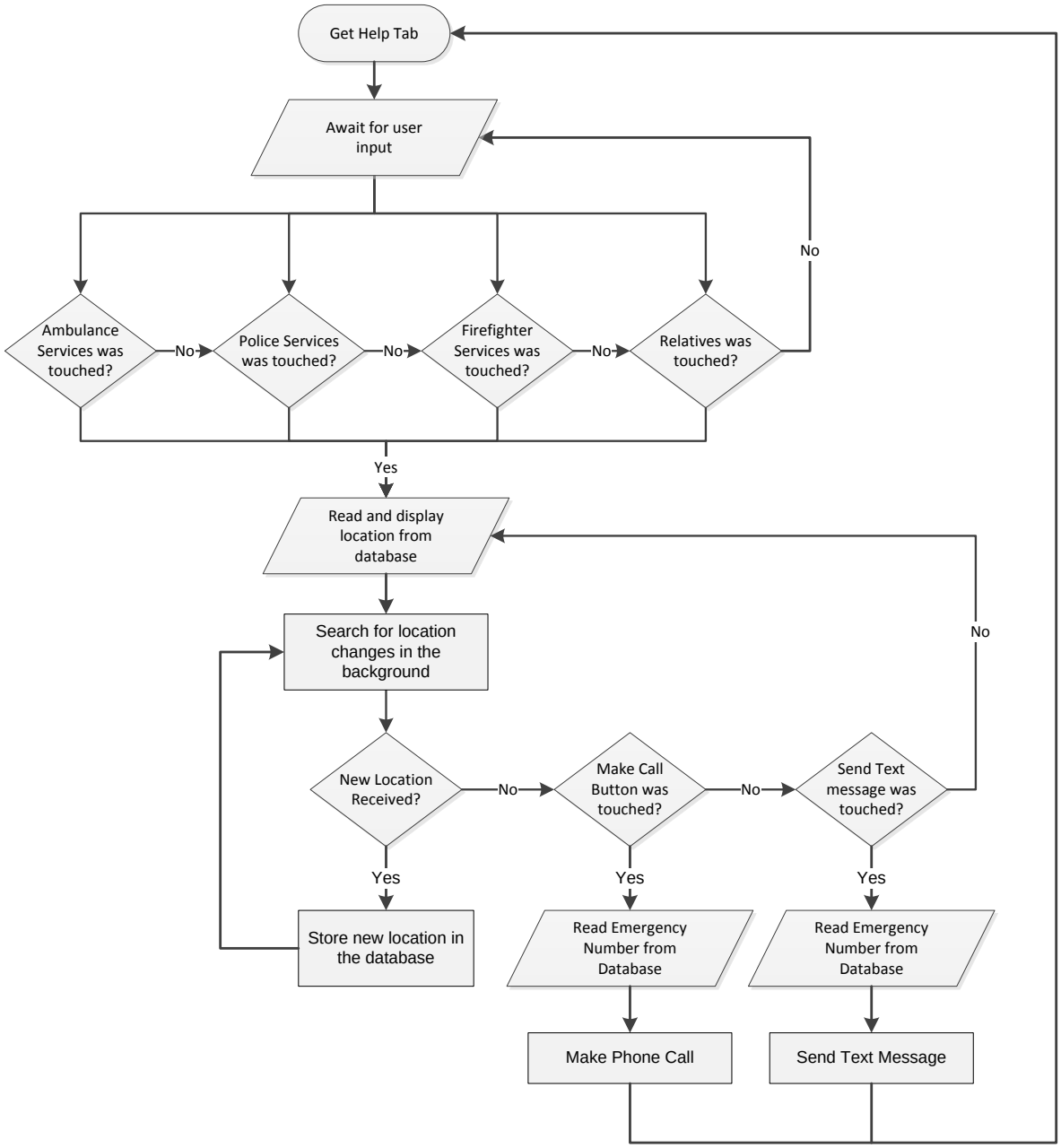

FIGURE 5: GET HELP FLOWCHART

CHAPTER 5

5 HEURISTIC EVALUATION

The results presented in this chapter were mostly taken from a heuristic evaluation made by the master students Víctor J. Vázquez López, Pedro X. Vázquez Rosario and Manuel J. Orán Hernández.

5.1 EVALUATION METHODOLOGY

This evaluation was performed using the ten usability heuristics developed by Jakob Nielsen in order to find usability issues in the Emergency Management Application. The following rubric was used to measure the usability problems:

1 – Aesthetic Problem

2 – Minor Usability Problems: Low priority

3 – Major Usability Problems: Important to be fixed

4 – Catastrophic Usability Problems: Imperative to be fixed

5.2 EVALUATION RESULTS

5.2.1 MAIN SCREEN

FIGURE 6: MAIN SCREEN INTERFACE

Problem: Simple and Natural Dialog

The description of the icons (Ambulance Services, Police Services, etc.) does not present a good description of the functionalities that are available when the buttons are pressed. They indicate that the only functionality that can be performed is to call the authorities. In the case of the relative's screen, it also offers the option to send the position through text massage to the relative.

Severity Rating: 2

Suggestions:

Provide a more specific description or eliminate the description and only leave the title of the service/relative.

Problem Solution

The relatives' description was updated. Now it says "Call Relatives or send a text message".

Problem: Simple and Natural Dialog and Speak the users language

The Get Help icon does not necessary represent a get help action from the user perspective.

Severity: 1

Suggestions:

This icon should be more representative with the "Get Help" action. A possible symbol could be a phone, which is a device that is used when the user is getting help.

Problem Solution

It was an aesthetic problem, according to the results of the usability test the icons of the application were not a problem. Therefore, this icon was not changed.

5.2.2 CONTACT AUTHORITIES SCREEN

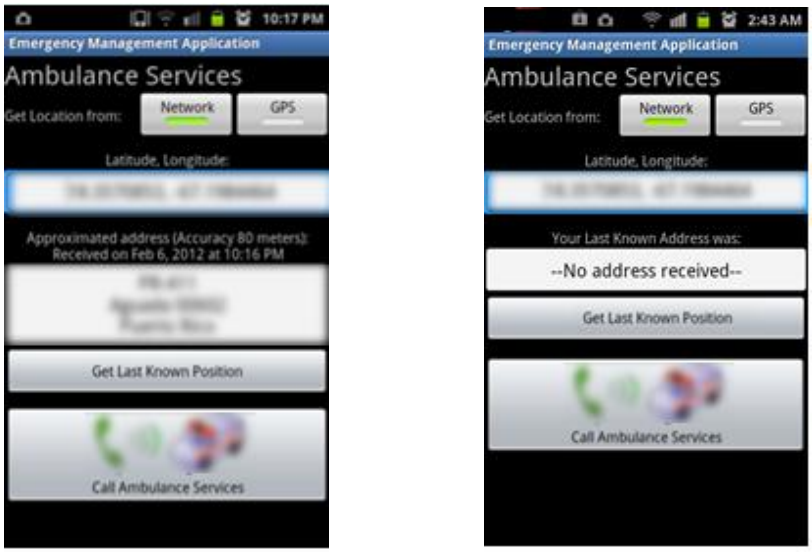

FIGURE 7: CONTACT AUTHORITIES SCREEN

PROBLEM: SPEAK THE USER LANGUAGE AND MINIMIZE USER MEMORY LOAD

This screen presents the option to get the location from the GPS or from the Network. Probably, an Android user will understand what this option means, but for a novice user, it will be difficult to use this option because it requires a more technical background.

Severity: 3

Suggestion: This option should not be provided to the user. The system should provide the location from the source that is more convenient. If this functionality is completely necessary, the labels Network/GPS, should use a language more appropriate for a non-expert user, for example it could be Indoor/ Outdoor.

PROBLEM SOLUTION

The option was evaluated in the user tests and its results showed that users did not had problems with this option. There is option (network) that is checked by default which facilitates the interaction for novice users. In the same way, when an Android user (novice

or expert) activates the location services in their phone, they must decide if they want to get their location from the networks or from the GPS Satellites.

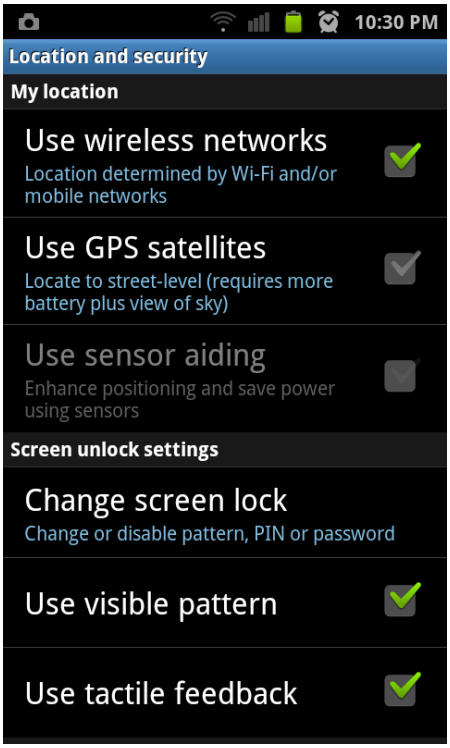

FIGURE 8: ANDROID'S LOCATION AND SECURITY INTERFACE

If the option is eliminated, expert users would not know from where they are obtaining location updates. In the same way, the battery usage will be more and the response time of the application could be reduced (it will take the location from both sources and then choose the best one). After the analysis of the advantages and drawbacks of changing the design, the developer decided that this button was not going to be changed.

Problem: Simple and Natural Dialogue

Having a button to get the last known position could be considered irrelevant. When the user is on an emergency, he/she will need the current position.

Severity Rating: 2

Suggestion: If the application has an already stored position, it should be shown in the interface automatically when the user opens the interface. The label of the button could be changed to "Actualize Location" or "Refresh". Another option could be eliminate this button and let the application update the location automatically.

Problem Solution

The application will search for the location once the user clicks on the emergency service that they need. The last known location and the location updates will be shown to the user immediately. If the users want to request a new location update, they can press the button, whose label change to "Refresh Location".

Problem: Feedback

When the refresh button is pressed and there is no connection to the network, the application does not provide any feedback. Instead, the interface shows a message that says "--Not address received--". That message does not change and it seems to be a default message. In the same way, when the phone is looking for network or GPS signal, a feedback is not provided to indicate that this process is taking place or how much time it will take.

Severity: 2

Suggestion: When there is no connection to the network and the user press the refresh button, the application should show a notification window indicating this problem and possible reasons for it (no signal, etc.).

Problem Solution

The appropriated feedback was added to the application. When the network or GPS signal is low or none, the application shows a notification to the user. The application will search in the background until a location update is received. For the feedback related to the searching process, the application will display a default message when it starts the

search and the application will update the fields automatically once it finds a location update.

PROBLEM: FEEDBACK

The screen does not indicate the phone number that is going to be called when the call button is pressed. When the application is used for the first time, the phone number is not configured, thus if the user presses the call button, they will receive an error message.

Severity: 3

Suggestion: The configured phone number should be presented on the screen. Furthermore, the application should provide a configuration wizard when the application is used for the first time to configure the phonebook.

PROBLEM SOLUTION

A configuration wizard was developed. Furthermore, a Hash map combining town with emergency service number was done, thus when the users clicks on the call button, they will be calling the one of the nearest emergency center (police, firefighter or ambulance).

5.2.3 RELATIVES SCREEN

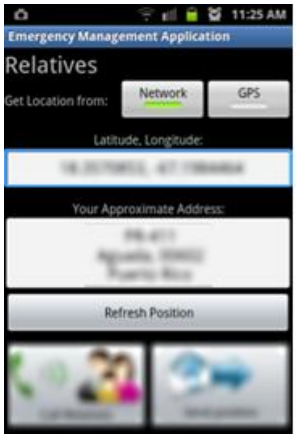

FIGURE 9: CONTACT RELATIVES SCREEN

Problem: Feedback

When the Send Position button is pressed, the application shows a message that indicates that the text was sent but this message disappears quickly. The amount of time displaying the message should be based on the amount of words that a human can read (Kurniawan & Zaphiris, 2002).

Severity: 2

Suggestion: Extend the amount time that the notification window is displayed; in this way the user can read properly the given feedback.

Problem Solution

The feedback that says "Message Sent" time was increased from 1 second to 2 seconds.

5.2.4 Emergency Kit Screen

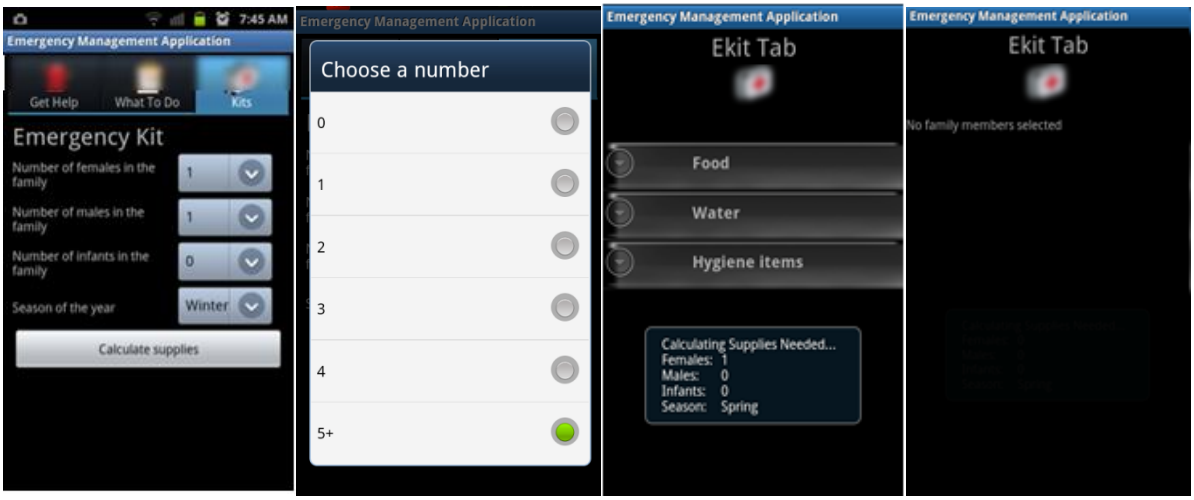

FIGURE 10: EMERGENCY KIT SCREENS

Problem: Simple and Natural Dialogue and Feedback

When the calculate supplies button is pressed, the application presents a notification window to show the parameters that were used to generate the kit. This window provides too much information and it disappears before it can be read. In addition, this window indicates that the kit is being calculated, but this message appears once the kit has been presented on the screen.

Severity: 2

Suggestion: Since the generation of the emergency kit happens in less than one second the feedback is not necessary and could be eliminated.

Problem Solution

The feedback was eliminated.

Problem: Feedback and Prevent Errors

This screen does not indicate which fields should be filled. When the calculate button is pressed, if none of the fields were established, the application shows the following message in other screen: “No family members selected”. When this happens, the user has to press the back button and provide the information.

Severity: 2

Suggestion: The screen should include requirements or instructions to make the engine work properly. The error message should be shown in a notification window on the same screen.

Problem Solution

A notification message is displayed to the users if they did not enter any data. The screen is not changed until the data is entered.

Problem: Simple and Natural Dialog

When the user is selecting the amount of family members, the dropdown menu provides the option of 5+ members, which mean more than five members. This option is not clear because the user will not know exactly what is the value that the application will use to calculate the supplies. Therefore, the system will calculate the same amount of supplies for any group of individual above five members. If the user has a family with more than the maximum amount of members the interface will not change.

Severity Rating: 4

Suggestion: The user should be able to enter the specific amount of members, which could be more than five.

Problem Solution

The drop down menu was changed to text boxes. The user will be able to enter any number from 0 to 99.

5.2.5 Emergency Kit Tab Screen

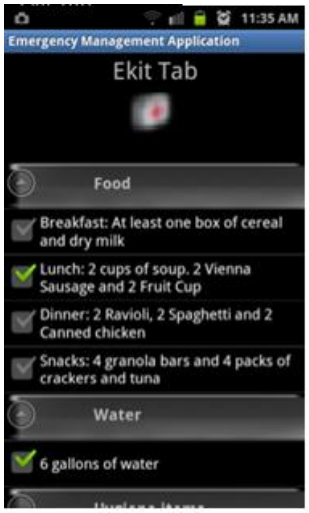

FIGURE 11: EMERGENCY KIT

PROBLEM: CONSISTENCY

This screen provides the results (emergency kit) of the selections performed on the kit screen, which mean that both screens are related and are part of the same section. Also the user could not understand the abbreviation "Ekit" which stand for Emergency Kit.

Severity: 1

Suggestion: The title should be the same in both screens. It can be called Emergency Kit instead of Ekit Tab.

PROBLEM SOLUTION

The name was changed.

PROBLEM: SIMPLE AND NATURAL DIALOGUE

When the items of the kit are shown on the list, the application provides the functionality to checkmark each item. The purpose of these checkmarks is not clear and once the list is close, the selections (checkmarks) are not saved.

Severity: 2

Suggestion: If the functionality of the checkmarks remains on the user screen then selections should be saved and if the user changes some of the parameters, only the required items should be reset. Otherwise this functionality should be eliminated.

PROBLEM SOLUTION

The checkmarks were eliminated; the data is displayed in a list format.

5.2.6 Menu Options

FIGURE 12: MENU OPTIONS

Problem #1 - Consistency

The description of the icon used to access the Get Help screen, is not consistent with the name of the screen. It shows "Homepage" instead of "Get Help".

Severity: 2

Suggestion: The description on the menu item "Homepage" should be changed to "Get Help".

Problem Solution

The name was changed.

Problem #2 - Simple and Natural Dialogue

The description of the third icon says "About/Info", but when this option is selected, the application only shows an information section and the disclaimer. The about section is not present in this screen.

Severity: 2

Suggestion: This screen should include an “About” section (version, developer, etc.).

PROBLEM SOLUTION

The suggested section was added

5.2.7 EDIT PHONEBOOK SCREEN

FIGURE 13: EDIT PHONEBOOK

PROBLEM #1 - FEEDBACK

The application does not show an example of the format of the phone numbers that have to be provided on the text fields.

Severity: 2

Suggestion: The screen should present an example of the phone number format.

PROBLEM SOLUTION

The text box was modified and now it shows the format in which users must enter the data.

Problem #2 - Prevent Errors and Feedback

The format of the phone numbers is not validated and the application does not provide any notification indicating that the format is incorrect. Since the phone numbers could be incorrect, the application will get an error when the user tries to make the phone call or send a text message to these phone numbers.

Severity: 3

Suggestion: The application should present a notification window indicating that the format of the phone number is incorrect after completing the validation of the format.

Problem Solution

The data is validated when the user presses the save button. If the phone number has an invalid format, then the application will let the users know that there is a problem with the number's format.

CHAPTER 6

6 USER TESTING

6.1 PURPOSE OF THE TEST

The purpose of the test was to evaluate possible usability problems of the developed application. Also, the test measured how those problems affect the human-computer interaction in terms of the amount of the navigations and the amount of time required to perform a single task. The users' experience and satisfaction was measured by using two questionnaires, one at the beginning and one at the end of the test. In the same way, moderators observed the users to identify potential design concerns in order to improve the efficiency of the application and end-user satisfaction.

6.2 PRE-TEST INFORMATION

Before the test, the following information was needed:

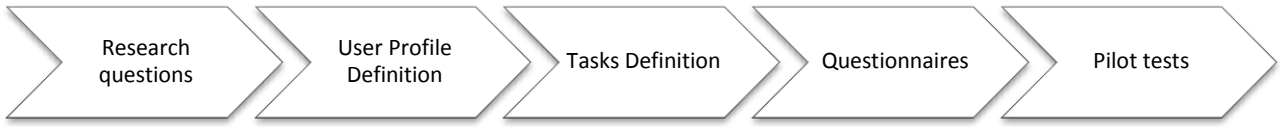

FIGURE 14: STEPS FOLLOWED TO PREPARE THE TEST

As shown in the previous figure, before the test, the researcher developed a set of research questions aimed to verify different usability aspects of the application. Based on those questions, the researcher defined a group of tasks that could be done with the application and the profile for the testers. Two questionnaires, one to be given before test and one to be given after the test, were also developed. The first one was to measure user's knowledge with Android devices and the other second one was to measure their satisfaction with the application and to get general feedback. Two pilot tests were conducted. Since the first set of pilot test did not show major issues with the documents

and the tasks, a second set was not needed. The following sections explain each step in more details.

6.2.1 Research Questions

The research questions are basically the test objectives. For this test the research questions were the following:

1. Do users understand the meaning of the icons and labels?
2. Do users use the toolbar icons or the standard Android menu?
3. The data is easy to read (the font style and size are good)?
4. The users are having navigation errors? What kind of errors?
5. Do users complete each task successfully? How fast do users perform each task?
6. What is the time required by a novice Android user to accomplish each task?

6.2.2 User Profile

All the subjects that participated in the test had at least 18 years old or more. No previous experience with Android devices was required, but all of them had general knowledge using computers. The ones that did not have previous experience with Android received a short training about Android features. This training included playing with a game and reading news on an Android phone. Also, a quick review about the hardware buttons of Android (back button, menu button, and home button) was given to the users with no previous experience.

6.2.3 Tasks Description

6.2.3.1 Task 1: Configuration Wizard - Add phone Numbers

Materials: Android phone with the application installed, and a paper with the phone numbers to be added

Description: The task will start with the application closed. The moderator will show the users which is the application that they must open. The users should add a given phone numbers to the emergency contacts and finish the configuration wizard.

Expected path: The user clicks on the boxes and adds each phone number correctly. They use the next button provided to move further through the interfaces. They touch on the finish button when they have added all the phone numbers.

Estimated time: 2 minutes

Successful criteria: The user clicks the finish button and the homepage of the application is displayed.

6.2.3.2 Task 2: Initiate a Phone Call with the police

Materials: Android phone with internet access, paper, and a pencil

Description: The task will start with the application open in its home page. They are going to be asked to initiate a call to the police officers. After that, they will be asked for their current position.

Expected path: The user clicks on the police services button and clicks the call button. Then, the user touches the refresh location button and tells his/her approximate address to the moderators.

Estimated Time: 1 minute

Successful criteria: The user clicks the call button and is able to tell his or her current position.

6.2.3.3 Task 3: Send a text message with the user's position

Materials: Android phone with the application installed

Description: The task will start with the application opened in its home page. The users will be asked to send a text message to the relatives with their approximate position.

Expected path: The user clicks on the button labeled as "Relatives" and then they click on the send position button.

Estimated time: 1 minute

Successful criteria: The message is sent (the user touches the send position button)

6.2.3.4 Task 4: Prepare an emergency kit

Materials: Android phone with the application installed, paper, and a pencil

Description: The task will start with the application opened in its home page. The users will be asked to search for the amount of water that a woman should have in her emergency kit during the summer.

Expected path: The user clicks on the tab labeled as "Kit", puts the number one on the females text box and clicks on the "calculate supplies" button. Then, they select the water expandable box and show the information to the moderator.

Estimated time: 1.5 minutes

Successful criteria: The user writes down the supplies in a piece of paper

6.2.3.5 Task 5: Edit the phone number of the firefighters

Materials: Android phone with the application installed, paper with the new phone number.

Description: The task will start where the previous task was supposed to be finished (the food supplies of the emergency kit). The users will be asked to change the phone number of the firefighters to the one given in the test.

Expected path: The user clicks on the menu tab and selects the "Edit Contacts" option. Then, the users change the phone number of the firefighters and clicks on the Save button.

Alternate path: The user clicks the back button and then scroll to the "Edit Contacts" tab. Then, the users change the phone number of the firefighters and clicks on the Save button.

Estimated time: 2 minutes

Successful criteria: The user touches the save button.

6.2.3.6 Task 6: Initiate a Phone Call with the Firefighters

Materials: Android phone with internet access, paper, and a pencil

Description: The task will start with the application open in its home page. They are going to be asked to initiate a call to the firefighters. After that, they will be asked for their current position.

Expected path: The user clicks on the Firefighter services button and clicks the call button. Then, the user touches the refresh location button and tells his/her approximate address to the moderators.

Estimated Time: 1 minute

Successful criteria: The user clicks the call button and is able to tell his or her current position.

6.2.3.7 Task 7: Determine what to do in case of a tornado

Materials: Android phone with the application installed

Description: The task will start with the application open in its home page. The users will be asked about the steps that they must follow after a tornado according to the application.

Expected path: The user clicks on the back button (or menu and then homepage), touches the *What to do* tab and finally selects the After a tornado expandable view.

Estimated Time: 1 minute

Successful criteria: The user clicks the *after a tornado* expandable view.

6.2.3.8 Task 8: Obtain Information about The Application

Materials: Android phone with the application installed

Description: The task will start with the application open in its home page. The users will be asked about the description of the application.

Expected path: The user clicks the menu button and selects the Info option.

Estimated Time: 1 minute

Successful criteria: The user clicks the *Info* button.

6.2.4 Questionnaires

The questionnaires were given in Spanish, as it is the first language of all the testers.

6.3 Methodology of the Test

The testers were divided in 2 groups. The first group, that had 3 persons, they did the tasks using a simplified think aloud methodology and informal questions (similar to the ones in the questionnaires) were done based on their impressions. The second group followed the steps explained in the following sections.

6.3.1 Time Division and Arrangements for the Test

All the tests were done in a closed room and they last for about 45 minutes each. The first 15 minutes were used to introduce the application, to fill the pre-questionnaire and for them to sign the informed consent form. Around 5-15 minutes where used for the test and the last 15 minutes were used for them to fill the post-questionnaire.

Each subject had an assigned participant identification number. Their questionnaires and tests are linked by that number. All users accepted been monitored by the researchers while they were interacting with the application.

6.3.2 Introduction to the Session

The introduction to the test had the following parts:

- A short application description – this description was given verbally to the users. The description was as follows:

> *"This application is aimed to help citizens in case of an emergency or major disaster. It allows them to get in contact with their relatives and different emergency services, such as ambulance, police and firefighters services. The users' position, including latitude, longitude and an approximated address is shown to the users before making the phone call. In the same way, the users are able to send their position to their relatives via text message. Also, this application provides guidelines about steps that users can follow in case of a fire, tornado, earthquake, or flood. Furthermore, it helps users in the creation of an emergency kit based on the amount of family members and the season of the year."*

FIGURE 15: DESCRIPTION OF THE APPLICATION

- Informed consent form – it presents the purpose of the test, and the conditions that users must accept to participate. It was given in Spanish, since that is the first language of all the testers.

Consentimiento Informado de Participantes

Como parte de un proyecto de investigación, estaré realizando una evaluación de usabilidad a una aplicación para el manejo de emergencias en celulares Android. El propósito de la prueba es identificar los problemas de usabilidad y su severidad cuando el sistema interactúa con el usuario o la usuaria. En la prueba solo se evaluará a la aplicación y no a los(as) usuarios(as).

A las personas que participen en la evaluación se les solicita que realicen una serie de tareas en el celular. Posteriormente deben indicar los problemas que encontrados y el grado de severidad durante su interacción con la aplicación. La identidad de los/las participantes será protegida y solamente los/las investigadores/as tendrán acceso a ésta información.

Yo, _____, voluntariamente consiento a participar en el estudio antes descrito. Se me ha orientado sobre el propósito y procedimiento del mismo. Entiendo que no serán revelados mis datos personales y que los resultados de la evaluación pueden ser utilizados como parte de un proyecto de maestría. De la misma manera, entiendo que puedo abandonar este estudio cuando lo desee y que se garantiza mi confidencialidad.

_____ _____

Firma del participante *Numero de Identificación del Participante*

_____

Fecha

FIGURE 16: INFORMED CONSENT FORM

Información adicional

Para mantener la calidad de la prueba, usted no debe tener interacción con el moderador (a no ser que sea necesario y estipulado por la prueba), debe tener su celular apagado o en silencio y estar concentrado en la prueba. Inicialmente le entregaremos un cuestionario que nos permitirá conocer su experiencia con celulares Android, el tipo de aplicaciones que utiliza y otra información general. Si usted acepta se procederá a la realización de las tareas. El análisis de los datos se realizará basado en su interacción con los programas y de ninguna manera se le medirá a usted como individuo. Para garantizar la confidencialidad durante la prueba usted no será identificado por su nombre si no por un código que le será asignado al comenzar la prueba. ¿Está usted de acuerdo con estos términos?

Para la ejecución de la prueba debe tener claro el funcionamiento de celulares Android y que es un kit para el manejo de emergencias:

•Todos los celulares Android tienen un botón para regresar a la ventana anterior (se muestra cual es el botón).

•También los celulares Android tienen un botón para desplegar opciones de la aplicación (se muestra el botón de Menú).

•Cuando ocurre una emergencia o desastre grave, los servicios básicos (como agua, electricidad, etc.) se ven afectados. Un kit para el manejo de emergencias es un maletín (bulto) el cual debe incluir suministros que permitan que la persona sobreviva por al menos tres días. Se consideran suministros los siguientes artículos: agua, comida, kit para primeros auxilios, refugio, ropa, productos de aseo personal, etc.

Por favor, lea las instrucciones de cada tarea. De tener alguna duda o problema con alguna de ellas, notifique a las personas encargadas antes de comenzar la prueba.

Las personas encargadas son: Marinés Chaparro-Acevedo y Víctor A. Asencio-Casiano

- Pre-questionnaire – it asks for information about the user's knowledge about Android applications and whether out not they are familiar with emergency management applications.

- Tasks – they were created to answer the research questions. Below are the tasks that were given during the test. Again, they are in Spanish because of the testers.

Tasks List

1. Tarea: Configuración de los números de teléfono de emergencia

Descripción:

Le entregaremos un celular con la aplicación instalada. La aplicación se llama Emergency Management. Usted debe abrir la aplicación y configurar los números de teléfono de emergencia con los siguientes números:
Número de la ambulancia: 787-111-2222
Número de la policía: 787-123-1234
Número de los bomberos: 787-123-3210
Número del pariente: 787-888-0000

Cuando termine la tarea debe notificarles a los moderadores.

¿Logré completar esta tarea?
_____ Sí _____ No _____ El programa no permite realizar la tarea

FIGURE 17: FIRST TASK

Tasks List

2. Tarea: Iniciar una llamada a la policía

Descripción:

Para esta tarea usted debe iniciar una llamada a la policía e indicarles a los moderadores cual es su dirección actual de acuerdo a la aplicación. En otras palabras, usted le informara a los moderadores cual es la dirección que usted le daría al oficial de la policía en caso de que tuviera una emergencia.

¿Logré completar esta tarea?
_____ Sí _____ No _____ El programa no permite realizar la tarea

FIGURE 18: SECOND TASK

Tasks List

3. Tarea: Enviar un mensaje de texto a su pariente o contacto de emergencia

Descripción:

Usted debe enviarle un mensaje de texto a la persona que selecciono como pariente o contacto de emergencia en la aplicación. El mensaje debe su posición actual.

¿Logré completar esta tarea?
_____ Sí _____ No _____ El programa no permite realizar la tarea

FIGURE 19: THIRD TASK

Tasks List

4. Tarea: Obtener información sobre suministros en el kit de emergencia

Descripción:

Usted debe buscar cuanta agua debe tener una mujer en su kit de emergencias. Una vez encuentre esa información debe decirle a los moderadores la cantidad de agua o si el programa no provee esa opción.

¿Logré completar esta tarea?_____ Sí _____ No _____ El programa no permite realizar la tarea

FIGURE 20: FORTH TASK

Tasks List

5. Tarea: Editar el número de teléfono de los bomberos

Descripción:

Usted debe modificar y guardar el número de teléfono de los bomberos. El nuevo numero será el siguiente:

Numero de bomberos: 787-333-4444

¿Logré completar esta tarea?
_____ Sí _____ No _____ El programa no permite realizar la tarea

FIGURE 21: FIFTH TASK

Tasks List

6. Tarea: Iniciar una llamada a los bomberos

Descripción:

Para esta tarea usted debe iniciar una llamada con los bomberos e indicarles a los moderadores cual es su dirección actual de acuerdo a la aplicación. En otras palabras, usted le informara a los moderadores cual es la dirección que usted le daría a los bomberos en caso de que tuviera una emergencia.

¿Logré completar esta tarea?
_____ Sí _____ No _____ El programa no permite realizar la tarea

FIGURE 22: SIXTH TASK

Tasks List

7. Tarea: Determinar que hacer en caso de un tornado.

Descripción:

Para esta tarea usted debe buscar cuales son los pasos que debe seguir después de un tornado. Le debe indicar a los moderadores cuales son estos pasos. Si la aplicación no te indica cuales son los pasos que debe seguir, entonces debe indicárselo a los moderadores.

¿Logré completar esta tarea?
_____ Sí _____ No _____ El programa no permite realizar la tarea

FIGURE 23: SEVENTH TASK

Tasks List

8. Tarea: Obtener información sobre la aplicación

Descripción:

Para esta tarea usted debe mostrarles a los moderadores la información general sobre la aplicación.

¿Logré completar esta tarea?
_____ Sí _____ No _____ El programa no permite realizar la tarea

FIGURE 24: EIGHTH TASK

6.3.3 End of the Test

Using the post-test questionnaire, information about the user satisfaction and suggestions about application improvements was collected. Other data, such as number of accomplished tasks, time needed to perform the tasks, types of errors, and number of errors, was collected via observation. Questions about their overall impressions of the application, suggestions and problems during the test were asked in the questionnaire. The analysis of the results of this test is below.

6.4 Test Results

6.4.1 Pilot Test

Pilot tests were conducted with 2 participants. These participants were sought according to user profile described in section 6.2.2. The objective of the tests was to detect potential errors associated with the questionnaires and task descriptions. Also, the pilot tests were used to estimate the amount of time required for each test. The test was performed maintaining the same conditions, the same material and the same tasks that were done in the final test.

During development of the test, there were problems with the description of one of the tasks, specifically the one to determine the amount of supplies needed in the emergency kit. The user was not sure about proceeding because the task did not specify the season. Appropriate corrections were made and the final version of the tasks is available in section 6.2.3.

In terms of time, the user needed less than one minute for most of the tasks. Based on this measure, it was determined that a bigger group of individuals could be used for the tests.

6.4.2 Pre-Test Questionnaire Results

The information retrieved from the pre-test questionnaire is below:

1. **Did you use applications on a smartphone before?**
   73% of the users said that they have used a Smartphone before.

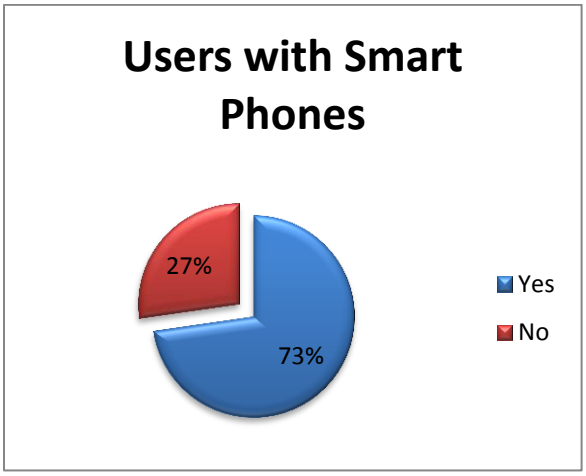

FIGURE 25: AMOUNT OF USERS WITH SMART PHONES

1.a. In which phone?

The operating system or phone with more popularity between the users was the iPhone (iOS), followed closely by the Android phones.

TABLE 1: OPERATING SYSTEM USED PREVIOUSLY

OS	Participants	Percentage
Android	5	45%
iPhone	6	55%
BlackBerry	3	27%
Windows phone	1	9%
None	3	27%

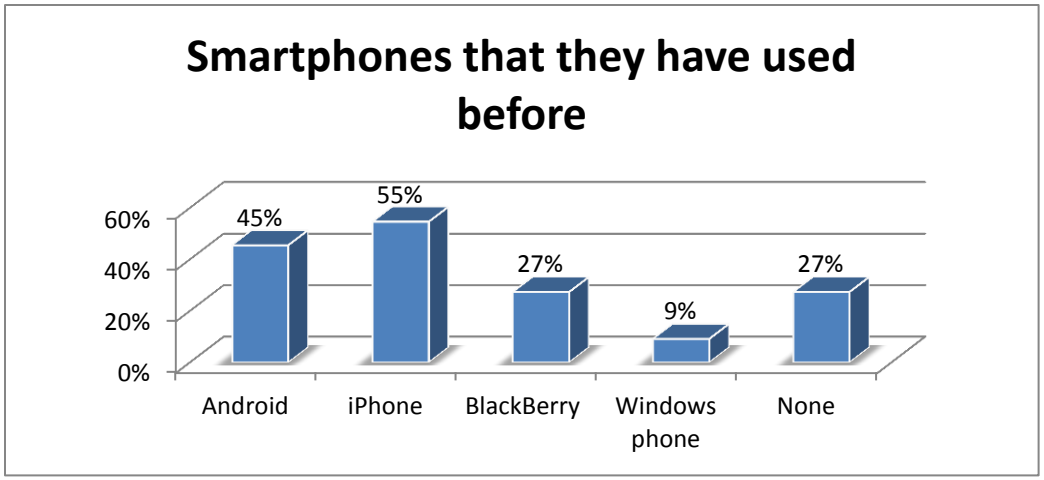

FIGURE 26: SMART PHONES THAT TESTERS HAVE USED

1.b. What kind of applications you use? (Please check all that apply)

TABLE 2: APPLICATIONS USED BY TESTERS

Answer	Participants	Percentage
Agenda/Calendar	7	64%
Camera	3	27%
GPS	3	27%
Games	5	45%
Messaging/Social Networks	6	55%
Music/Videos	6	55%
News/Notes pads	6	55%

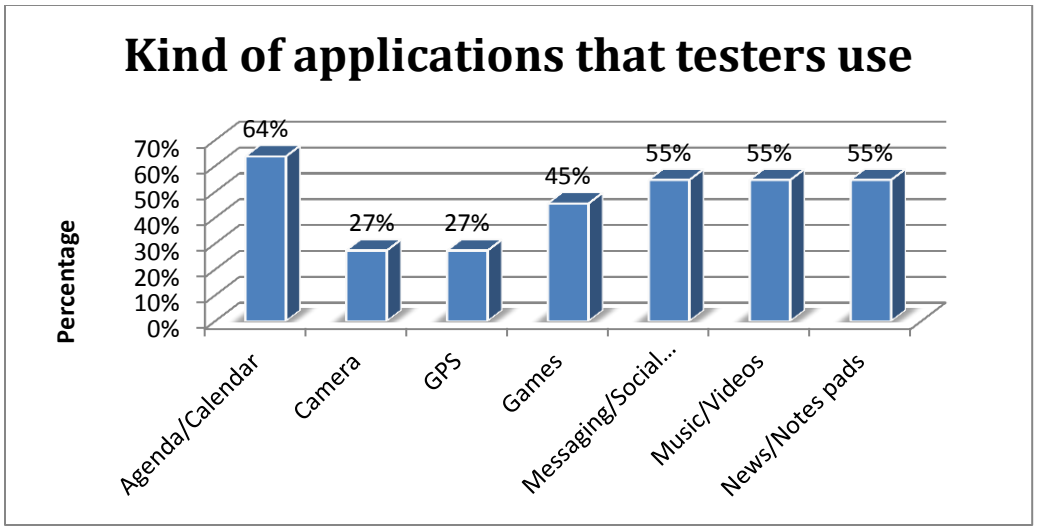

FIGURE 27: APPLICATION THAT TESTERS HAVE USED

2. Have you ever used an application for emergency management?

TABLE 3: PARTICIPANTS THAT USED AND EMERGENCY MANAGEMENT APPLICATION BEFORE

Answer	Participants	Percentage
Yes	2	18%
No	9	82%

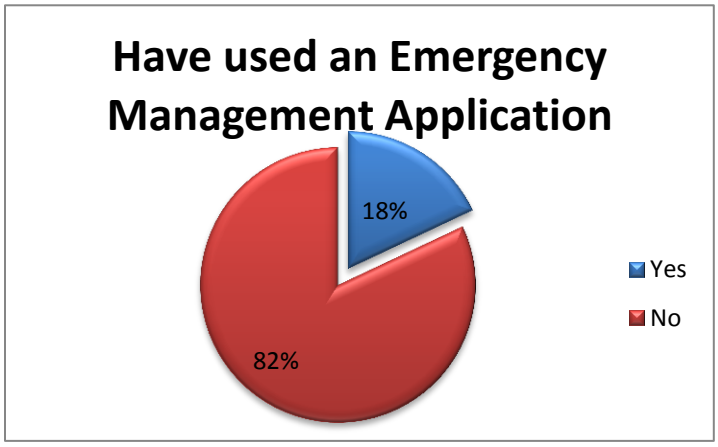

FIGURE 28: USERS THAT HAVE USED AN EMERGENCY MANAGEMENT APPLICATION BEFORE

3. What services did you use when you have an emergency (car accident, fire, health problem, etc.)? Check all that apply.

TABLE 4: SERVICES USED IN EMERGENCIES

Answer	Participants	Percentage
Police	6	55%
Ambulance	4	36%
Relatives	9	82%
Firefighters	0	0%
None	1	9%
Other	0	0%

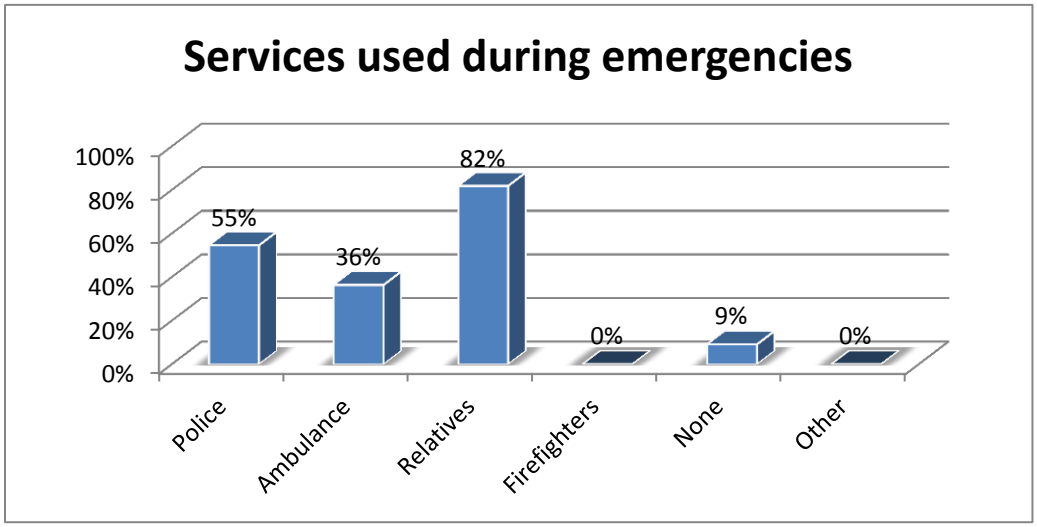

FIGURE 29: SERVICES USED DURING EMERGENCIES

3.a. What steps did you follow to solve your situation?

Most of the users said that they follow these steps:

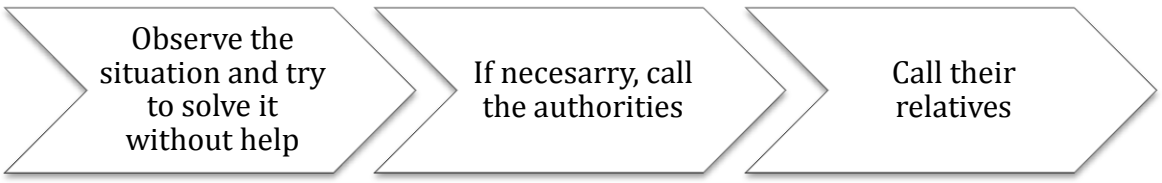

FIGURE 30: PROCEDURES FOLLOWED BY USERS IN EMERGENCIES

6.4.3 *Post-Test Questionnaire Results*

The information retrieved from the post-test questionnaire is below:

1. Tasks difficulty

TABLE 5: TASK DIFFICULTY

	Very Easy	Easy	Normal	Hard	Very Hard
Prepare an emergency kit	3	5	2	1	0
Call the authorities	7	3	1	0	0
Determine what to do in case of an emergency	7	4	0	0	0
Edit phone numbers	2	2	4	0	3
Send text message with position	8	2	0	1	0
Get information about the application	5	3	2	1	0

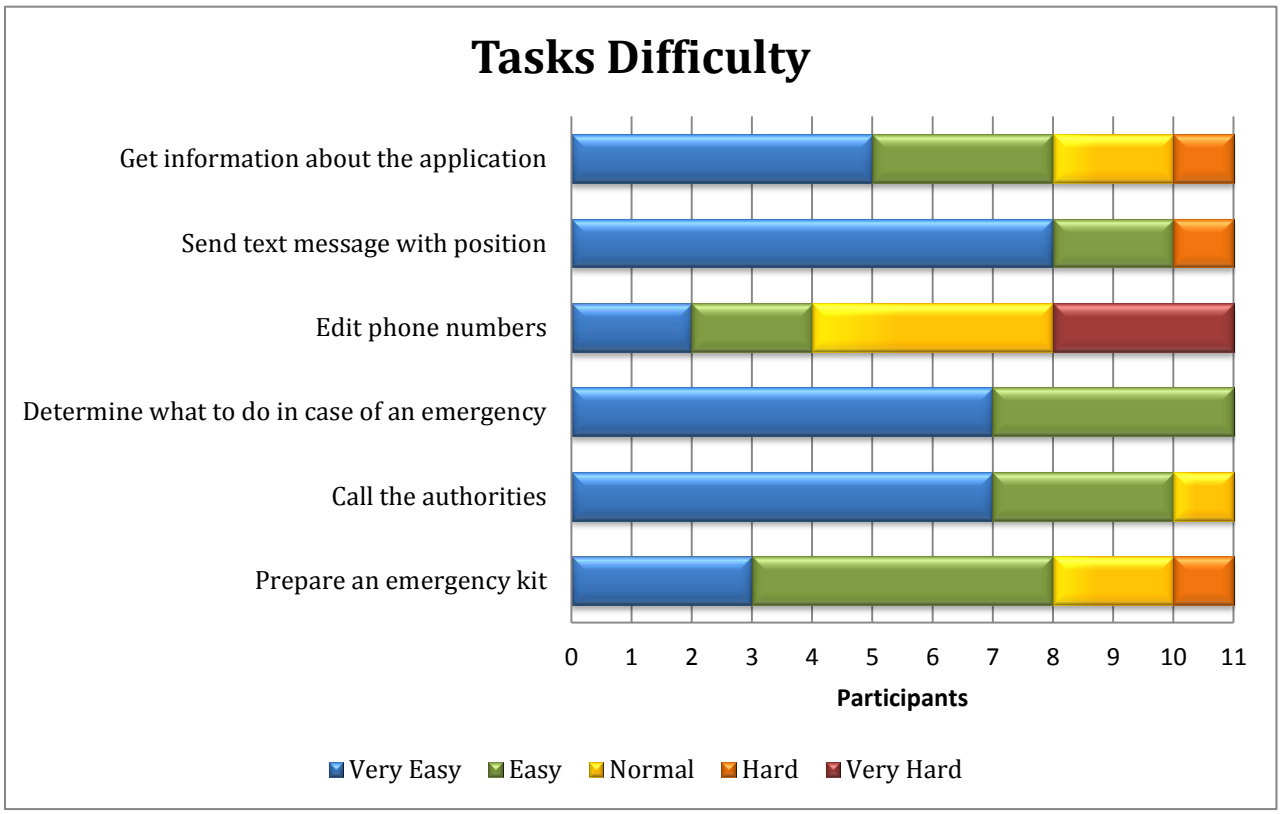

FIGURE 31: TASK DIFFICULTY CHART

2. Perceived Satisfaction

TABLE 6: PERCEIVED SATISFACTION

Perceived Satisfaction

	Very Satisfied	Satisfied	Neutral	Unsatisfied	Very Unsatisfied
Icons	10	1	0	0	0
Text Size	4	5	2	0	0
Ease of Use	4	6	1	0	0

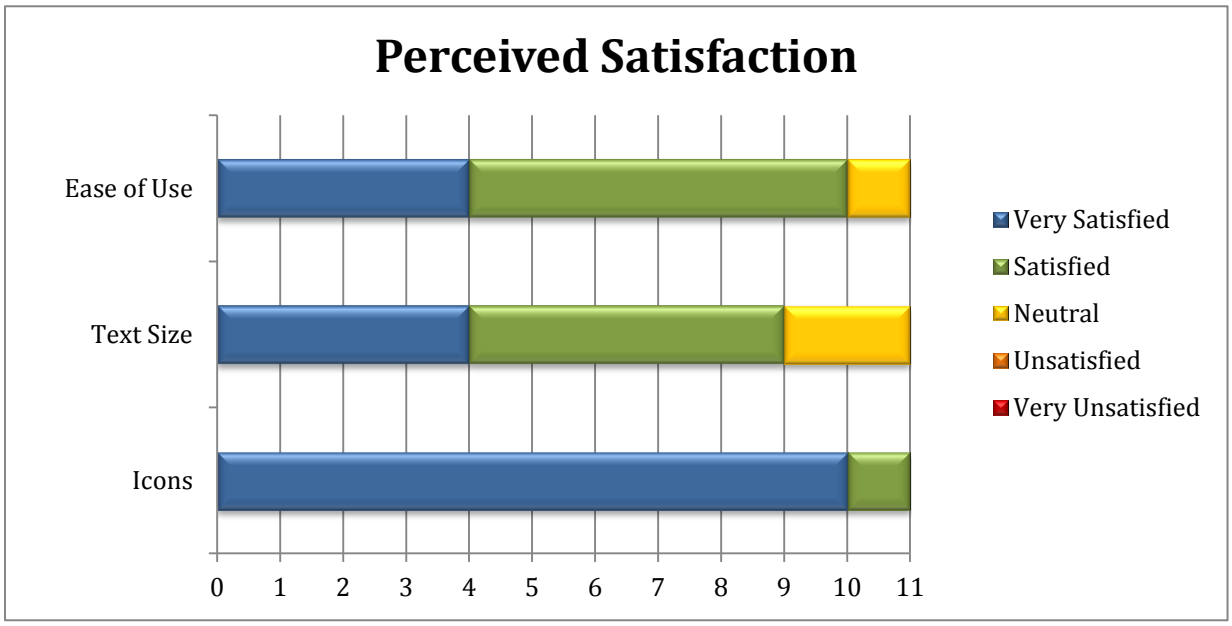

FIGURE 32: PERCEIVED SATISFACTION CHART

3. Satisfaction with the application tools

TABLE 7: PERCEIVED SATISFACTION WITH APPLICATION TOOLS

Perceived Satisfaction with Application Tools

	Very Satisfied	Satisfied	Neutral	Unsatisfied	Very Unsatisfied
Call emergency services	9	2	0	0	0
Information about emergency procedures	8	2	1	0	0
Emergency kit preparation	6	4	1	0	0
Obtain current position	8	2	1	0	0
Smart phone search	8	2	1	0	0

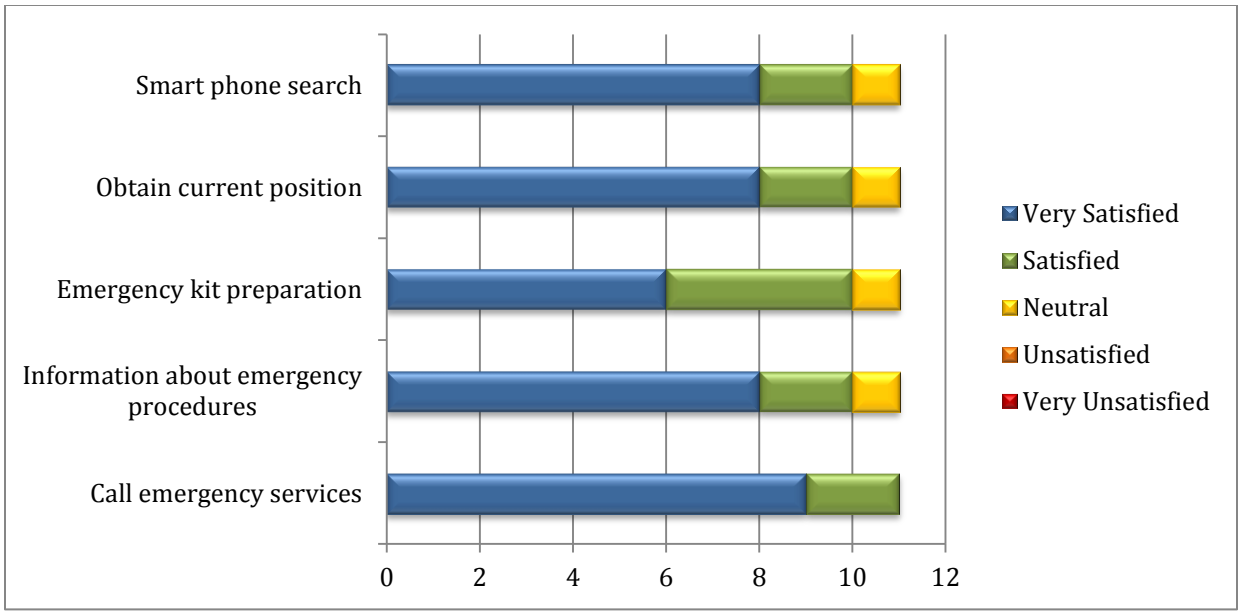

FIGURE 33: SATISFACTION WITH APPLICATION TOOLS

4. What usability problems you encountered in the application?
    - It is not obvious that there are more options in the tabs menu
    - The Relatives section does not indicate that users can send a message by selecting that option
    - The back button closed the application
    - Cell phone size[4]
5. What things should be added or changed in the application?
    - An arrow that indicates that there are more options in the tabs menu
    - Create an emergency management center that can receive photos of the emergency and send information to other people
    - An option to change the main menu from the list format to the squares format
    - An option to call 911 automatically
6. What things you expected from an emergency management application that you did not find in this application?

[4] This is not a usability problem of the application, but that was one of the answers.

- A direct option to call 911
- Full integration with the emergency centers, so users can send pictures of the accident or emergency
- Option to receive alerts from emergency agencies.

7. Would you use an emergency management application in the future? Why?
   Just two of the testers said that it will not use an emergency management application, one because of its age and the other said that probably it will download an application like that when something bad occur. All the others think that an emergency management application is useful for the following reasons:
   - Applications are fast and easy to use
   - One of the testers said that it had an accident because of the lack of information
   - An application is always available even when there is no electricity
   - It is faster search for information in an application than looking for that information in the web
   - It is easier to get in contact with the authorities and get help
8. Comments
   - The application should be free of charge
   - Very useful application
   - The pictures are very intuitive and make the application easier to use
   - The application should be make for iPhone
   - It is good for young people, it has good information
   - Very easy to use

6.4.4 THINK ALOUD RESULTS

The following data was obtained from the think aloud tests:

- Configuration wizard

- Even though the format of the phone numbers was written in the text box, one of the users was not sure if the dash was necessary. The others did not use the dash by default

- Send a text message to the relatives
  - The label did not says that users can send a text message from that menu
  - One of the users said that a better label for the option to send a message with the users' position can be "Send a text message" instead of "Send position".
- Edit phone numbers
  - The users had problems finding the option to edit the phone number of the firefighters. All of them touched the firefighter services searching for an option to edit the phone number.
- Obtain information from the application
  - Even though this option is hidden in the tabs menu (like the edit contacts option), users found this task very easy since they already knew that the tabs were scrollable and the icon used is intuitive.

6.5 Accomplished Objectives

6.5.1 Do users understand the meaning of the icons and labels?

The results of the post questionnaire show that all the users were satisfied with the icons (see figure below).

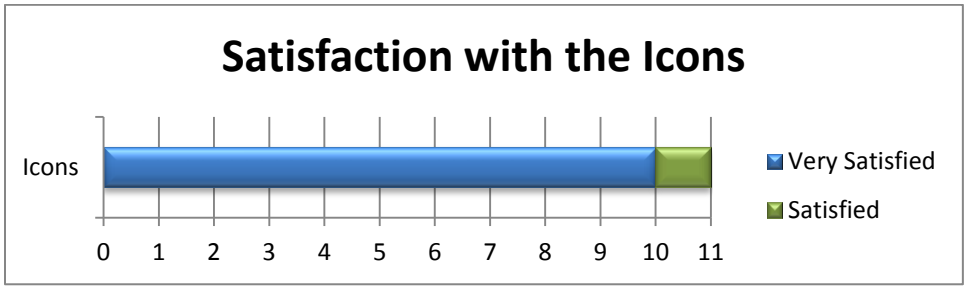

FIGURE 34: PERCEIVED SATISFACTION WITH THE ICONS OF THE APPLICATION

Furthermore, their comments during the test and in the questionnaire showed that most of them did not read the labels; instead, they were driven by the pictures. An example of this was the edit contacts task. After they finish the configuration wizard, notification indicating where they can modify those numbers was given to the users. All the users look at the notification before pressing the "Ok" button, but just one of them followed the instructions presented in there.

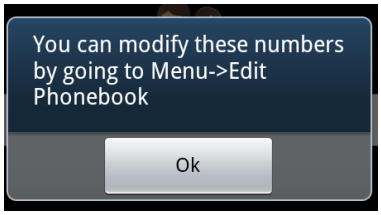

FIGURE 35: DESCRIPTION SHOWED TO USERS AFTER THE CONFIGURATION WIZARD

On the other hand, when they found the edit contacts in the tabs bar and they were able saw the "App Info" icon. The users that were doing the think aloud said that they were able to do the last task (get information about the application) faster because they saw the information icon when they were searching for the Edit Contacts option. We can conclude that the same thing happened with the rest of the users, since the time required to find information about the application was a couple of times less than the time required editing the firefighter number.

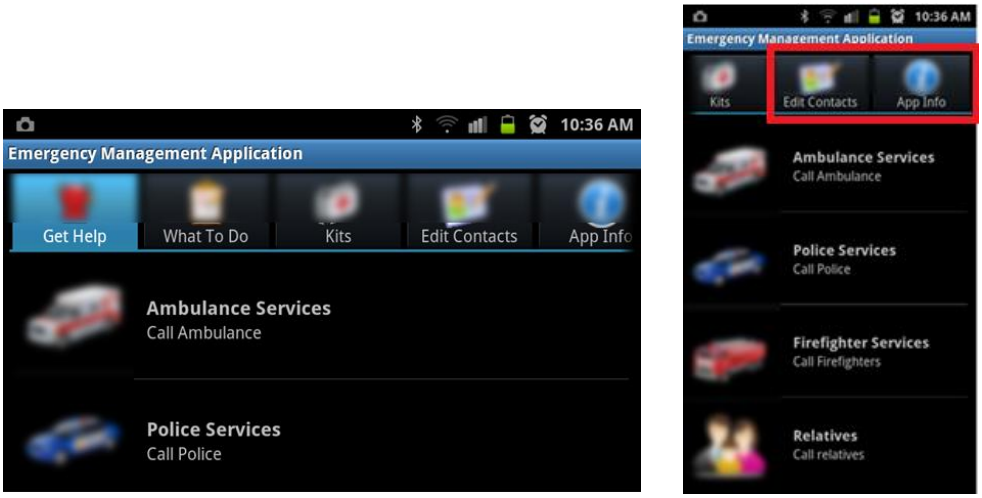

FIGURE 36: LANDSCAPE AND PORTRAIT VIEW OF THE APPLICATION

6.5.2 *Do users use the toolbar icons or the standard Android menu?*

There are a big number of persons that do not use the standard Android menu. There was an explicit notification asking the users to press the menu button to change the phone numbers (see Figure 35: Description showed to users after the configuration wizard), but only one person used that menu. Instead, people used the tabs bar displayed in the main interface to change the phone numbers.

The opinions gathered from this research shows that the main reason of why people are not using that button is because they think that all the important options of the application should not be hidden. Another reason that they mentioned is because the main competitor of the android devices, the iPhone, does not have that button.

6.5.3 *The data is easy to read (the font style and size are good)?*

None of the users had problems or were not satisfied with the font size and style. The persons that were Neutral said that it was fine, but they prefer a little bit bigger fonts.

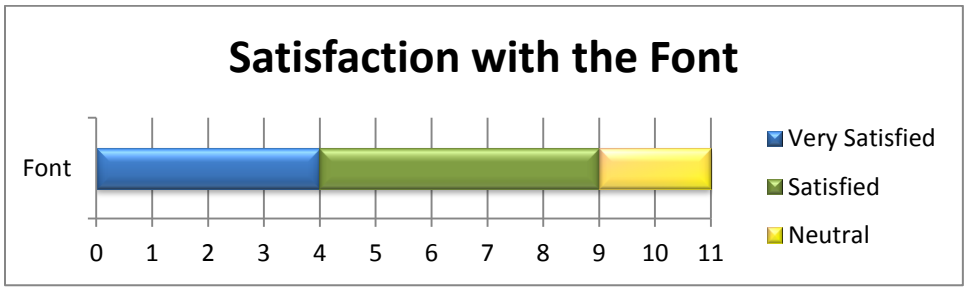

FIGURE 37: PERCEIVED SATISFACTION WITH THE FONT SIZE

6.5.4 *The users are having navigation errors? What kind of errors?*

In general, the users did not have navigation errors. The only task that presented problems was the one to edit the phone number of the firefighters. The expected path was the following:

FIGURE 38: EXPECTED PATH

Instead, the most of the users were taking the following path:

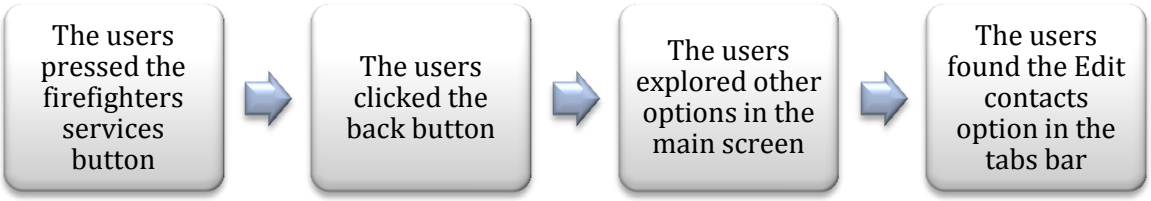

FIGURE 39: PATH FOLLOWED BY MOST USERS

6.5.5 Do users complete each task successfully? How fast do users perform each task?

All the users were able to finish all the tasks successfully. One of the users needed assistance performing the fifth task. The time required to perform the tasks by each participant is below:

TABLE 8: TIME SPENT BY USER IN EACH TASK

Time in Each Task by Participant (mm:ss)

User Id	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
Task											
1	00:01:24	0:01:29	0:01:43	0:01:20	0:01:17	0:01:30	0:01:25	0:02:03	0:01:27	0:01:20	0:01:39
2	0:00:21	0:00:31	0:01:01	0:00:18	0:00:23	0:00:26	0:00:31	0:00:44	0:00:23	0:00:20	0:00:33
3	0:00:07	0:00:33	0:00:28	0:00:13	0:00:20	0:00:27	0:00:18	0:01:01	0:00:09	0:00:08	0:00:38
4	0:00:44	0:00:54	0:00:31	0:00:33	0:00:29	0:00:46	0:00:50	0:01:03	0:00:40	0:00:42	0:00:51
5	0:00:44	-	0:00:38	0:00:29	0:01:15	0:00:45	0:01:01	0:00:49	0:00:42	0:00:41	0:01:02
6	0:00:09	0:00:21	0:00:11	0:00:08	0:00:10	0:00:10	0:00:13	0:00:28	0:00:12	0:00:11	0:00:28
7	0:00:10	0:00:38	0:00:16	0:00:10	0:00:11	0:00:14	0:00:15	0:00:49	0:00:11	0:00:10	0:00:13
8	0:00:03	0:00:10	0:00:06	0:00:04	0:00:05	0:00:07	0:00:04	0:00:14	0:00:05	0:00:04	0:00:06
Total	**00:03:42**	**00:04:36**	**00:04:54**	**00:03:15**	**00:04:10**	**00:04:25**	**00:04:37**	**00:07:11**	**00:03:49**	**00:03:36**	**00:05:30**

TABLE 9: AVERAGE PER TASK AND STANDARD DEVIATION

Task Number	Average	Standard deviation
1	01:31	00:13
2	00:30	00:13
3	00:24	00:16
4	00:44	00:10
5	00:49	00:20

6	00:15	00:07
7	00:18	00:13
8	00:06	00:03
Total	**00:04:36**	

As seen in Table 9: Average per task and Standard Deviation, the average time required to perform all the task was 00:04:36. Eliminating the first task, the configuration wizard, the time spent performing each task was less than one minute. This fact, make the application usable in case of an emergency. A detailed explanation of the time spent in each task is below.

6.5.5.1 Average time spent by user.

TASK 1: CONFIGURATION WIZARD

The time spent by each user was around 1:30 (mm:ss). This time was expected since this task involved a data entry.

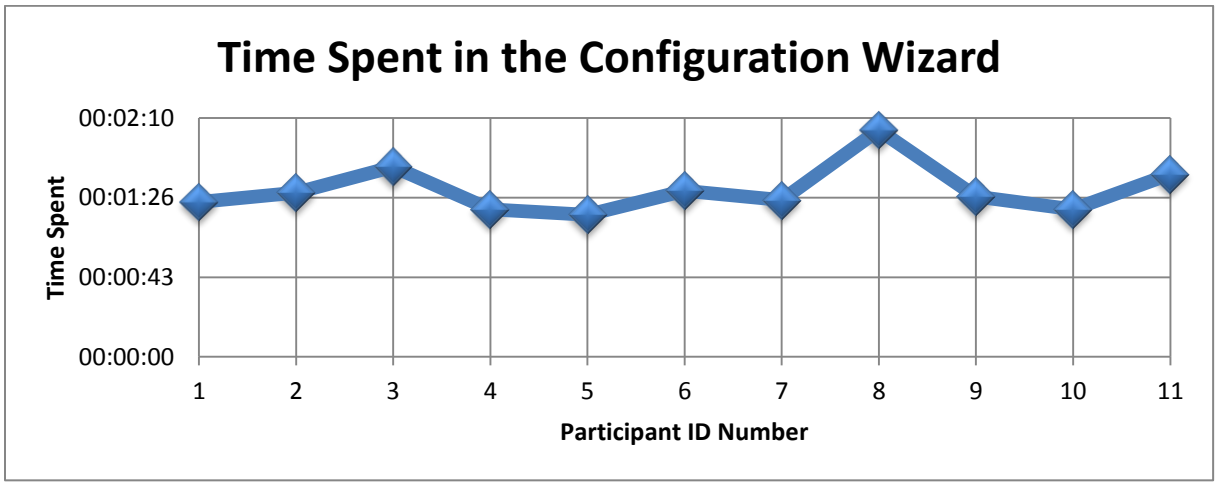

FIGURE 40: TIME SPENT IN THE CONFIGURATION WIZARD

TASK 2: MAKE A PHONE CALL TO THE POLICE

The time spent by most of the users was around 00:30 (mm:ss). Assuming that the person has the phone number of the police, this time is similar to the time needed to make a phone call from the phone. If the users did not have the phone number of the police, this time can increase since they should search online or ask other people for that number.

With this application, if the user is in Puerto Rico, the phone number of the authorities is searched automatically. If the user is outside of the island or if for some reason the application does not know the users location, then users can call the authorities using the default phone number that they entered the first time in the configuration wizard.

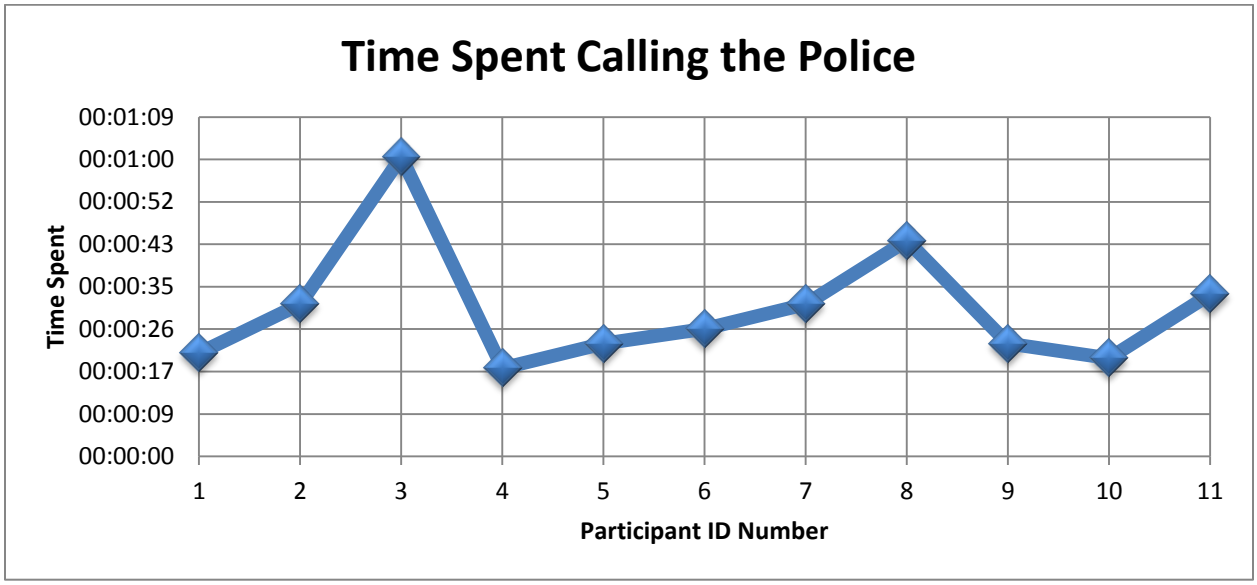

FIGURE 41: TIME SPENT CALLING THE POLICE

TASK 3: SEND A TEXT MESSAGE WITH POSITION TO RELATIVES

The time spent by most of the users was around 00:24 (mm:ss). An empirical study made by Miika Silfverberg, Scott MacKenzie, and Panu Korhonen demonstrate that text entry for expert users with the traditional multi-press method can support rates up to about 25 words per minute (Silfverberg, MacKenzie, & Korhonen, 2000). When users are typing alphanumerical values, the amount of words per minute decrease. The text message sent from the developed application includes the latitude, the longitude and the approximated address of the user. Searching for that information without the application involves time, but the application does it automatically. This fact facilitates the interaction and the communication with relatives in case of an emergency.

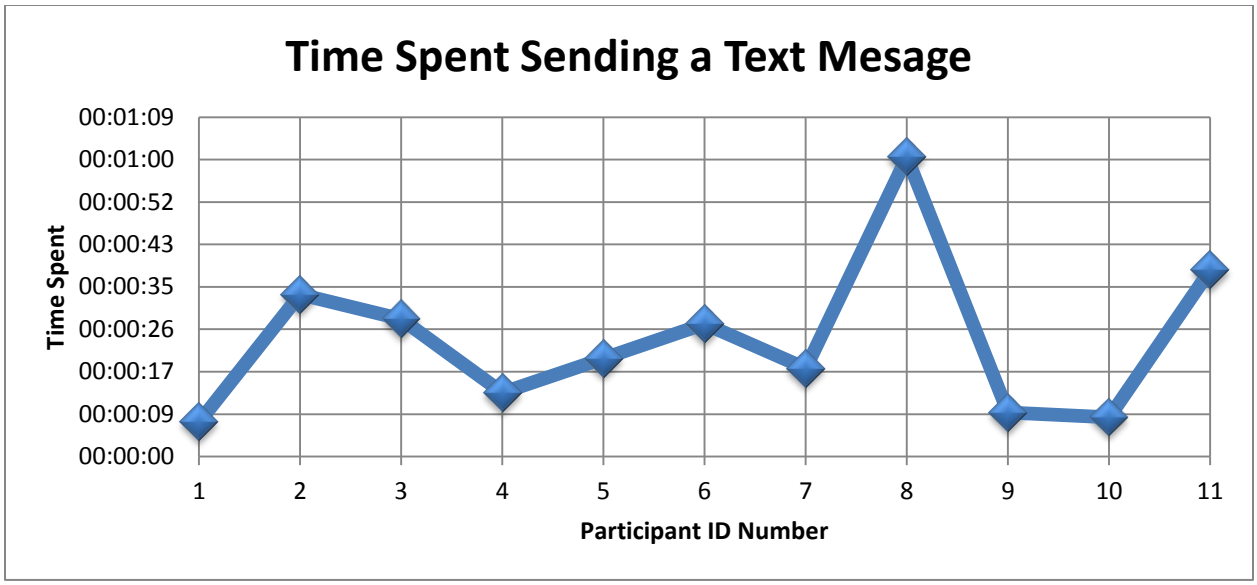

FIGURE 42: TIME SPENT BY USER SENDING A MESSAGE

TASK 4: PREPARE AN EMERGENCY KIT

The average time spent in this task was 00:44 (mm:ss). Since this is for emergency prevention instead of emergency mitigation, time is not crucial. Therefore, the time results of this task were not analyzed.

TASK 5: EDIT THE PHONEBOOK

Like the previous task, time was not crucial for this task. The average time spent in this task was 00:49 (mm:ss) with a standard deviation of 00:20 (mm:ss).

TASK 6: MAKE A PHONE CALL TO THE FIREFIGHTERS

The average time spent by the users was around 00:15 (mm:ss). This task was similar to the second one, and the results show that the time spent by the users was reduced to its half. The following graph shows the individual results of the participants. As shown in the chart, once the users learn how to use that feature, their interaction speed increased significantly.

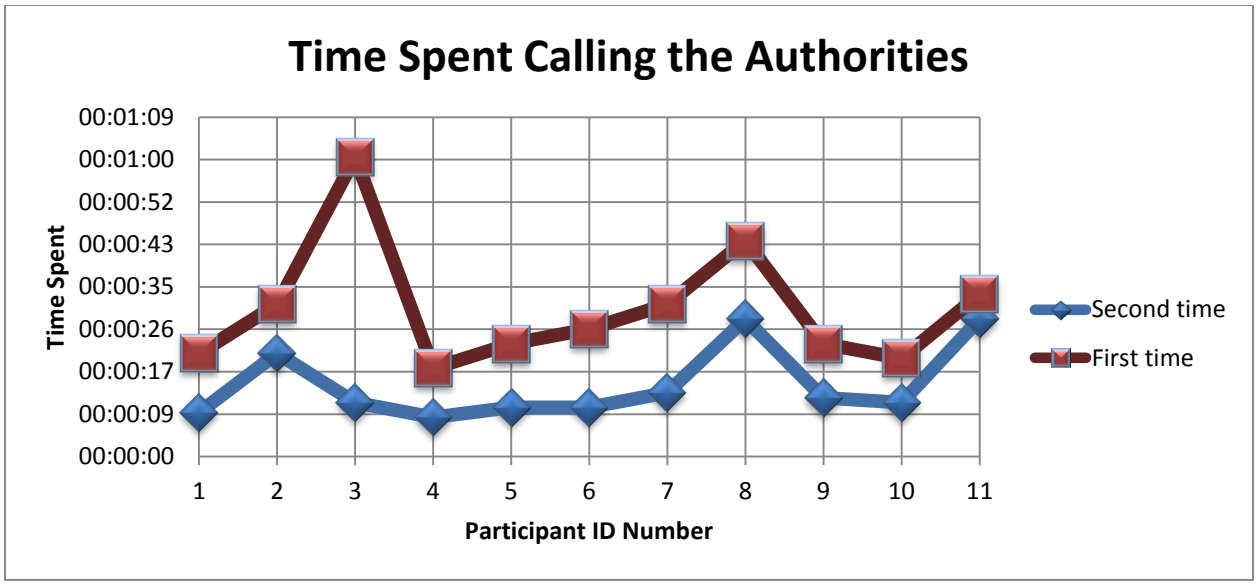

FIGURE 43: TIME SPENT REPEATING AN ACTION IN THE APPLICATION

TASK 7: DETERMINE WHAT TO DO IN CASE OF A TORNADO

The users were able to find the information in approximately 00:18 (mm:ss).They did not have navigation problems. According to their questionnaire, the users were very satisfied with the time performing this task.

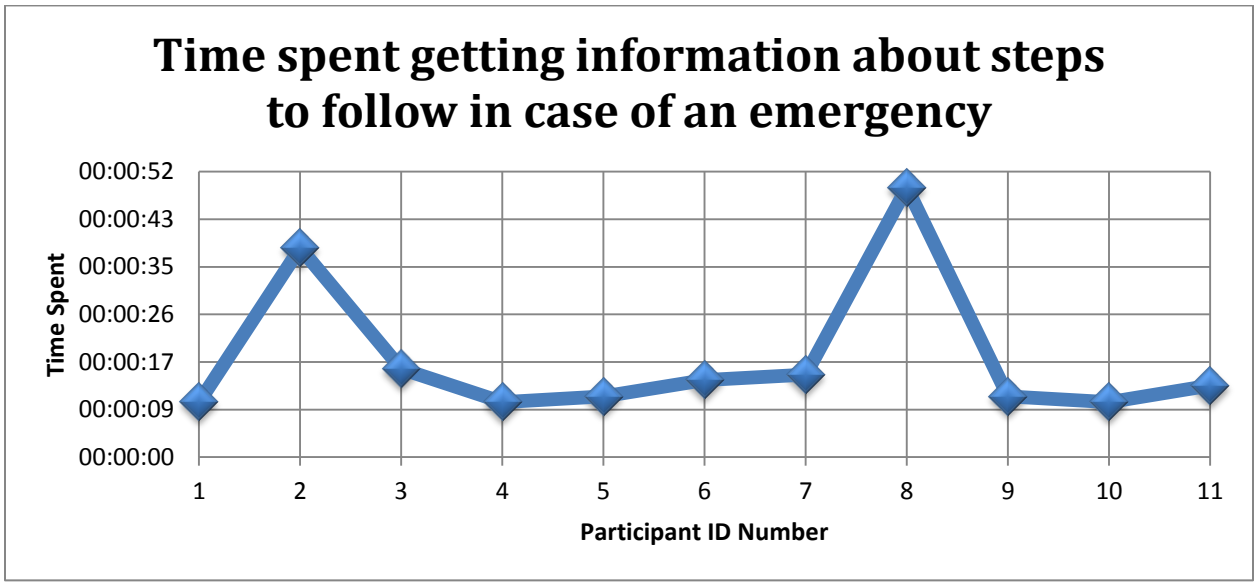

FIGURE 44: TIME SPENT GETTING INFORMATION ABOUT EMERGENCY PROCEDURES

Task 8: Obtain Information about the application

The users were able to find the information in approximately 00:06 (mm:ss). The time was not important for this test, but these results show that once the users learn that the tabs bar was scrollable, they were able to accomplish the this task faster.

6.5.6 What is the time required by a novice Android user to accomplish each task?

Most of the users were able to accomplish the tasks in less than one minute. The following chart shows the time spent by the novice participants (P2, P3, P8) performing each task and a line that shows the average time spent by all the users.

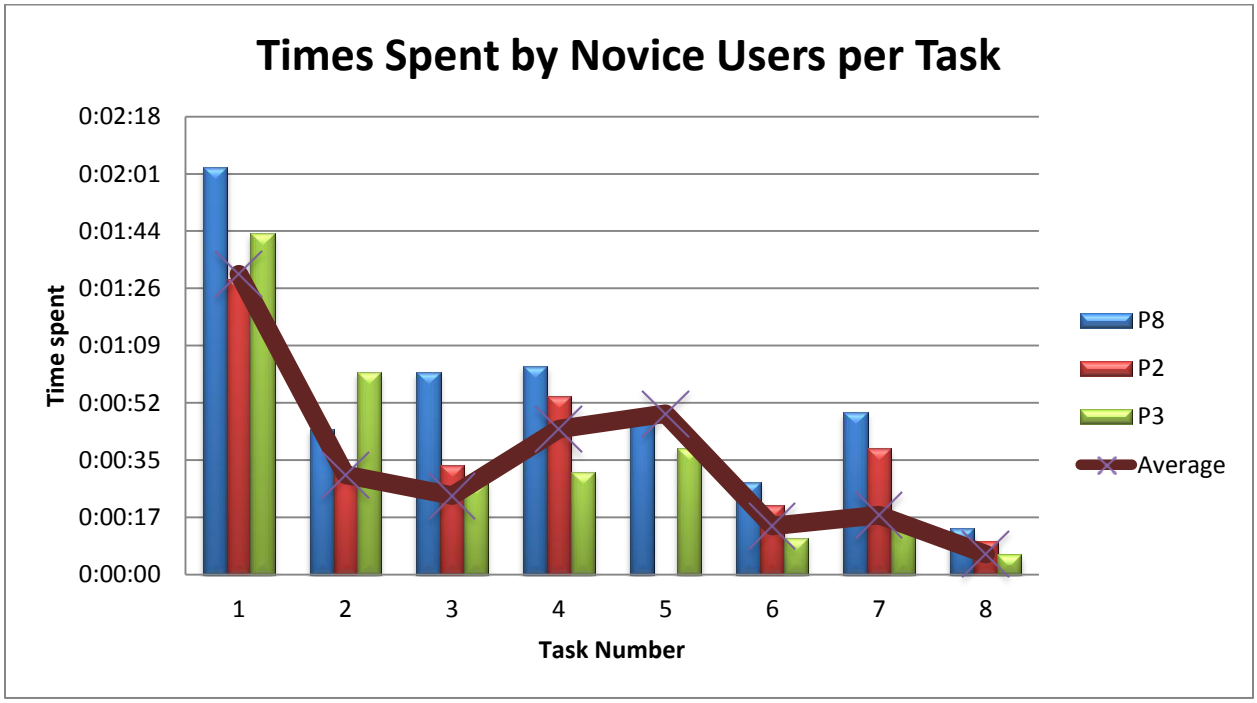

FIGURE 45: TIME SPENT BY NOVICE USERS

As shown in the chart, the time required by a novice user to accomplish the tasks in the application is very similar to the time needed by the average user. This information shows that any user, including the ones with no experience with smartphones, can utilize the application.

CHAPTER 7

7 CONCLUSIONS AND FUTURE WORK

7.1 CONCLUSIONS

The amount of natural disasters, deaths by car accidents and other hazards have increased significantly during the last decades. Even though there are a lot of initiatives from the government aimed to help people in case of an emergency, there is a big group that is not reached by those initiatives, mostly because of the information is not always available or because it is very hard to find. This document presented the design and implementation of a usable Android application for emergency management. As seen in this document, Android devices have gained a lot of popularity in recent years; therefore they are a good approach to help citizens in case of an emergency.

There are several factors that must be considered when developing application for emergency management, especially when developing for mobile devices. Some aspects that developers have to take into consideration when developing mobile applications for emergency management are the following: the time needed to complete a task; the number of clicks that users must do in order to find information; the amount of data displayed at once; the size of the screen; and the amount of colors in the screen. Those aspects were addressed in this project and the final version of the application was tested with potential customers to verify its compliance. The results of test demonstrated that the users were able to finish all the tasks successfully; they were satisfied with the icons, the font size and the tools provided by the application; and they did not have major navigation errors. Furthermore, the results of the test demonstrated that the users were able to finish most of the tasks in less than a minute which makes this application usable in case of an emergency.

7.2 FUTURE WORK

The following features are going to be included in this project as a future work:

- Add more emergency procedures for hurricanes, car accidents, tsunamis, volcanos and other emergencies.
- Integrate an offline chat application that is been developed by a Master student in the University of Puerto Rico
- Add features to receive alerts from different emergency centers and/or government agencies.
- Increase the amount of phone numbers of emergency centers.
- Publish the application in the Android Market (now called Google Play).
- Support multiple languages
- Operate based on VESO-MESH platform connecting through Wi-Fi[5].
- Enable feedback submissions by users
- Create a webpage where emergency centers (police officers, firefighters, or paramedics) can update the phonebook. Allow users to download updates to the phonebook when available.

[5] VESO-MESH is a service-oriented wireless mesh network platform that can provide storage and computation services without connecting to the Internet. It is also self-sustainable with the design that integrates solar panel for power supply (Chaparro-Acevedo, Lu, Rodríguez, & Valera, 2011).

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9 BIOGRAPHICAL SKETCH

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In October of 2010 she received the tittle Bachelor in Science in Computer Engineering from the University of Puerto Rico, Mayagüez Campus. The same year she began her master studies at the University of Puerto Rico at Mayagüez with a specialty in Usability Engineering under the supervision of Dr. Kejie Lu, Dr. Néstor Rodríguez and Dr. José Borges.

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