Abstract

Crime is a serious cause of concern for all societies, however studies have shown that despite this, often crimes go unreported. This study looks as the campus society of the University of Cape Town and how individuals belonging to this society may benefit from a digital crime reporting solution. The Cry-Help system is designed to facilitate mobile crime reporting from data capture to secure transfer and finally secure storage. This report documents the conception, design and development of the mobile application that acts as an interface for this system. The system was developed in a user centric iterative approach and results of user testing evaluated to show the usability of the system. This report documents the process' entirety.

Acknowledgements

I would like to acknowledge my supervisor Anne Kayem for her guidance and role in helping me realise this work. I would also like to thank Nina Otsweleng and Tami Maiwashe my group members whom I spend many a sleepless nights working with. I would also like to thank Dorothy Mhlanga for helping me realise my project with her photographic input.

I would also like to thank my family and close friends for being considerate and helpful while I worked on my report selfishly and final and most thanks be to the Lord without whom nothing would be possible

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Glossary

CPS – Campus Protection Services

SAPS – South African Police Services

UCT – University of Cape Town

UCT affiliates - UCT members under the protection of CPS such as students, staff and employees

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1 INTRODUCTION

1.1 INTRODUCTION

1.2 PROBLEM DEFINITION

Crime is a plague in any society modern rural or urban. It is the same for university campuses in particular the University of Cape Town (UCT), which is spread across a wide area including numerous residential areas (residences and other UCT service related premises included). In order to enforce order and account for criminal activity Crime protection Services (CPS) employs a typical campus protection system that allows UCT affiliates to come forward and report crime at their station.

CPS provides a platform for affiliates to not only report a crime but also ensure their details are kept as confidential as possible. The report can also be escalated to more senior authorities such as SAPS upon the complainants' request and or protocol.

Crime reporting and indeed the probability of an individual making a report are not as simple as filling a form as researched in [13]. It has been found that the digitising of the reporting process not only improves the likelihood of individuals making crime reports but can also yield more complete and meaningful reports.

In order to help alleviate the scourge of crime and increase crime reports a mobile solution, which would increase the service availability has been suggested. To this regard an interface must be designed that serves the full functionality of the paper based service whilst incorporating good design principles ensuring it suits the mobile platform.

1.3 RESEARCH QUESTIONS AND PROPOSED SOLUTION

There currently does not exist a campus mobile system for reporting crime and having the relevant authorities access the information promptly while storing it securely. To address the problem effectively from a single methodological point of departure the team formulated a primary research question:

- Can a mobile application that allows covert and secure crime reporting and further, supports both safe storage of the crime report data and quick access to it be developed?

To answer this question effectively, the solution was broken down to 2 components, front and back end. The system backend addresses the communication and storage of the application; these components are managed separately by Nina Otsweleng and Tami Maiwashe repectively. Finally, the system front end will be an interactive application solution. This report serves to document the methodological development of this application.

The user interface will have two primary functions, namely, inputting data and reporting crimes. Mobile phones are multi-purpose devices that are not dedicated to emergency

reporting, in practice there exist numerous other devices developed specifically for mobile reporting in varied contexts. The questions the report seeks to answer are thus:

- Is it possible to allow users to report crime digitally on the mobile device?
- Is it possible to develop a system that allows effective covert message passing in an oppressive environment on mobile devices?

The **aim** of this project is to successfully answer the above research questions. The advantages of digitising the crime reporting process have been documented in numerous works [3][13][21]. The mobile cellular device is the chosen platform to implement a similar system that is even more available to the user.

1.4 System Overview

The figure below provides a graphical description of the system as a whole

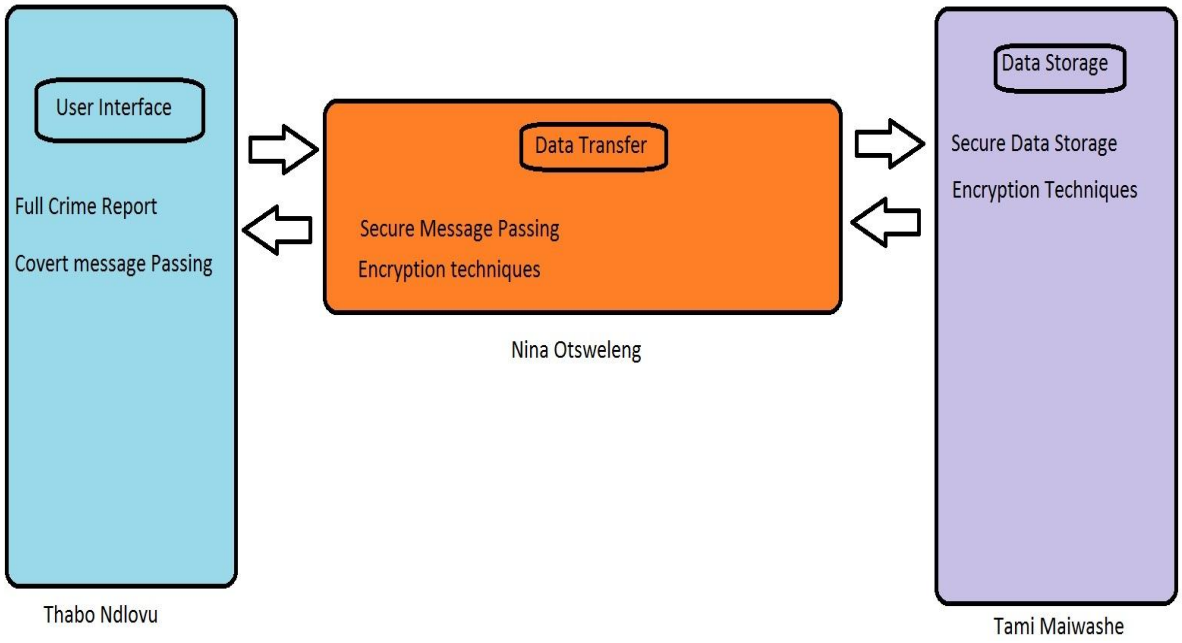


Figure 1 Overview

Depicting an overview of the system

The data storage component manages the data collected from all the user reports that are sent to the authorities. It also manages the Access control to the data within the authority organisation. This module will use encryption techniques to ensure the security of the data.

A separate component is needed to handle the data transfer securely. Security Protocols such as Diffie-Hellman will be implemented to this effect.

This report documents the development of the user interface. The interface will allow users to create and effectively fill crime reports resembling the existing paper based crime report. The interface will also allow for two types if crime reports. The first, a full crime report, based on the paper based reporting system already in place, which includes at least all the information found in the paper based report and instructions on how to fill the form. The

second report type, the emergency report, will automatically compile relevant user data and allow the user to send a report quickly in adverse conditions.

1.5 Layout of the Report

The report chapters methodologically break down the development of the system from its inception to its evaluation, in sequence. In brief the order it follows is as such:

The background chapter covers related readings, texts and systems researched in order to fully understand the problem scope and existing solutions. The chapter covers in general the holistic concept of crime, crime reporting, digital impact on crime and crime awareness mobile devices and the best practices of user centred design.

The Design chapter details the iterative process of developing the application, taking into consideration the intended development environment. The development chapter covers the implementation of the design.

The Evaluation chapter covers the analysis of the interface. The results of user testing against the final iteration will be compared against intended success criteria. Lastly the conclusion will cover the findings of the report, potential impact of the system and any possible future work.

2 BACKGROUND CHAPTER

In this chapter the use of mobile devices as the platform for the interface development is discussed and motivated. Different types of cellular phones will be considered in the papers read, the most prolific and most widely used, the feature phones and, with particular interest, modern cellular phones with touch displays which were the final target devices the solution was developed for.

Digitising the crime reporting process and the benefits of doing so will be discussed with both desktop and mobile implementations along with the social and moral implications of doing so. This chapter will also show how cellular phones already play a role in crime and crime prevention and how some existing crime prevention systems exploit the features of cellular phones. Finally the chapter ends with a study on the usability heuristics often used in user interface design.

2.1 CRIME

Crime is not a foreign concept to any populous of people world over, no matter the background rural to urban, ethnic group or culture [3]. In particular with respect to UCT, a university so large it incorporates neighbouring residential areas and the diverse mix of social, economic and cultural individuals. As such UCT is also affected by crime.

Crimes have traditionally been reported most often by word of mouth [13], either directly in which the victim is the complainant or indirectly by an observer. Crimes have also been reported via mail, computer websites and mobile applications [16][13][29][32]. The concept of digitizing emergency preventative measures is not new; it is being explored with varying levels of success under numerous principles such as functionality, feasibility and privacy for different target groups such as the old aged [4]. Numerous devices are designed for this specific purpose and often mobile devices are not used due to their multi-functionality and the numerous applications they have installed on them [3] [4].

2.2 DIGITISING CRIME REPORTS

Numerous experiments have been done to collect data relating to criminal activity and their effect on communities [4][15]. Digital solutions have been suggested and found to be very effective [15] in increasing citizen awareness and crime reporting. Solutions such as these amass numerous crime reports that otherwise would never have been made via convectional crime reporting [13] and this is largely due to the automated nature (minimised human interaction) of the reports.

An example of the application of mobile phones as a reporting device can be motivated from the perspective of an individual observing a crime. While it has been seen that people not directly involved in the crime being committed are less likely to report it (true even despite the fact that often public opinion of crime is much worse than its reality [8]), the

likelihood of reporting the crime increases substantially, the less the perceived cost of reporting[13]. One of the major factors affecting this cost is credibility when reporting a crime. For some the tension when calling the police, and having to describe the scenario unfolding to an officer is worth avoiding.

2.3 Privacy

The issue of anonymity is a large one with respect to mobile devices. With the advent of the technology more and more applications are designed with the focus of providing relevant information to the individual by means of aggregating data, both from the user and from other individuals, as such compromise to a personal privacy is under question[16]

Personal privacy can be invaded in numerous ways on a mobile device. In order to gain and supply relevant data to users, location based services are often employed. This location data could play a vital role in designing a crime reporting system, allowing relevant authorities to figure out the exact location of victims in order to act swiftly. However the possible intrusion of location data, by unauthorized individuals presents a serious threat to the user's privacy. This vulnerability could result in cyber-attacks, spamming and inference attacks not to mention the physical security risk of strangers knowing the user's movement patterns and current location [18].

2.3.1 Privacy and Context

Mobile applications are increasingly relying on automatic context sensing for utility in the services they provide [17]. A context being the use of the mobile devices' sensors (sensors including physical sensors on the device, body worn sensors, EKG sensors and virtual sensors such as the calendar [18]) to decipher what activities the user is performing, for example location data accumulated over time can tell an observer what mode of transport he user is using. This increase in automatic context sensing has resulted in users being more wary of what use their private information is put to [17][18][20].

2.3.2 Privacy and Autonomy of applications

Numerous techniques have been employed to manage application context sensing which in general is managed in a similar way in all dominant mobile operating systems; once off, during installation, as a list of requested permissions for use in all future transactions [27]. This segment of the background serves to highlight the chief approaches attempted in previous works.

The Super Ego implementation [27], a method of classifying user context through previously learned sample user preferences manages user permissions automatically and allows permissions to vary depending on their context and application requesting them. Super Ego achieves this by being a layer, added between the application and OS layers. In this way it has an overview of all application permission requests and request history; allowing it to manage commonly independently operating applications, preventing inference attacks. The most effective implementations of Super Ego all required a level of user involvement in granting permission (manual or semi manual implementation).

Similar to Super Ego, an approach of selecting exactly what data to share was developed by Supriyo Chakraborty et al [6]. In their work they suggest separating data into two inference lists, black and white, for the users' privacy preferences and the applications information requirements respectively. Effectively the system obscures data that is sent by the application in order to avoid for example an inference attack. The paper illustrates application privacy and utility as points on a continuous line, whose ends are zero utility where the user shares absolutely no information and has complete privacy and maximum utility where the user shares everything the application requests. Each point on this continuous line is realisable using some manner of privacy mechanism. Privacy mechanisms are such that they identify the data to be shared and then apply obfuscation (hiding any black listed inferences that may be made from the data). Three such mechanisms are described namely

- Feature Selection, opposed to sharing high dimensional data, features of the data can be shared instead. Features of the high dimensional data that correspond to black listed data can be removed
- Sharing White listed inferences, involves calculating the inferences on the device and obfuscating the data before sending it. This approach relies on cryptographic techniques which would be difficult to implement on a device.
- Random projection, use a transformation on data that allows users to share projections of the features and not the features themselves. The projection transformation is known by the users only.

Data is obfuscated by a learned function which ensures that it contains no blacklisted inferences, remains utilisable and no inference can be made [6]. Flaws of their implementation include that it does not account for data dependencies overtime or the interaction of different applications as a whole on the device

Numerous techniques of obfuscating data have been used along with methods of classifying (machine learning algorithms) contexts to manage application permissions. The paper [20] suggests a different means of anonymizing and obfuscating data, the PuPPeT algorithm (*POIsafe Privacy Preserving Technique)*. In particular the paper addresses POI (point of interest) permissions services which rely on user location amongst other sensitive data. The algorithm manages to provide exact responses for user location based service for requests while ensuring identity anonymity, location privacy and absence privacy. These algorithms use a location close to the user (any point some radius R from the user position) to perform POI requests, without revealing the exact location of the user they find the best route towards the POI with little overhead. PuPPeT manages to solve a problem two prevalent algorithms did not address. The algorithm improves upon AnonTwist and SpaceTwist which do not assume that the attacker has access to the parameters generating the fake location [20].

2.4 MOBILE

With regards to mobile devices, perceived crime rates or perceived threat of danger plays a large role in use. Foremost it appears that the higher the threat of danger the more likely an individual is to carry their mobile device[7] seeing it as a source of security to be able to contact near-by individuals they know, to come to their aid[13][14]. However the nature of

this occurrence varies dependent on the individual as studied in [21] due to the way users perceive the value of the security offered by their mobile device with some classification of users publicly utilizing the mobile device to express their connectivity as a means to ward off potential attackers while others see value in utilizing the device only after they have been attacked

However our implementation seeks to employ mobile devices primarily due to their great African penetration and versatile situational applicability. We shall argue in fact, by being a well-known and multi-use device a mobile phone is in actuality ideal in helping deter crime

Mobile phones are primarily a means of communication, that statement means distinct things during the day or at night, in safe areas or a hostile environment [3]. Communication at night can mean that an individual is never alone making them less of a target to would be attackers, there is a distinction here however in that the security offered by the mobile may be fabricated/pretence. The mere illusion of having someone to speak to offers preventative measures something inherent in the nature of a mobile phone [21], however this in itself is not useful when eager pursuers actually engage the victim, at this point a mobile phone is no longer as useful. At this point, a natural next step to this preventative technique may be to speak to an individual, such as a police officer or operator who can actually send for help. It is argued however, in [13] that individuals are less likely to use telephone related police services over automated services due to the human element. This is due to having to explain ones situation and having to justify one's concern.

Often however having a mobile phone will not help deter some criminals [4] (such as crimes of passion) and at this point it is not prevention that a mobile device can offer but alerting. Often, violence occurs in a residence or home and not in city streets or poor lit corners [8] with on average 20% of women admitting domestic abuse in some areas of urban South Africa to a staggering 80% in some rural areas. It is clear in these cases, the possession of a mobile phone, contacts and communication is irrelevant as often abusers are spousal and aware of the victims' mobile device. In this case it is not the obtrusive but subtle nature of the device that can offer some security.

Devices that use certain aspects already in mobile phones have been employed that offer such security, by recording sound and audio, observers can be alerted of the violent happenings in the home.[4]

2.5 Applications

2.5.1 Emergency 9 (E9)

E9 is a recent attempt at offering mobile crime reporting to users, in a recent collaboration with UCT the E9 system has been integrated into UCT's existing incident management software however despite this the E9 project has hardly seen any traction. E9 is a service offering a means of immediately reporting crime via the use of speed dial. Users must map the speed dial key for themselves and when in an emergency are able to quickly dial that key (marketed as the keypad 9 key), sending their personal data and location to local authorities. The service is targeted at Institutions of higher tertiary education such as UCT; that have an interest in protecting their affiliates and campus premises.

2.5.2 E9 STRUCTURE

To use the feature users must first register for the service. Registration is performed online on the E9 website. Registration involves a service fee a monthly charge for using the service and an alert fee, a once off charge for each alert sent by using E9, this amount is deducted from the users' cellular credits. Upon registration users enter data about themselves and their close contacts; during an emergency, their personal data is sent not only to authorities but also these close contacts.

To obtain the location data from the user the E9 system uses Cell tower triangulation, a technique in which a mobile devices location can be found by calculating the distance between it and the cell towers in its area. This method of triangulation is both less reliable and less accurate than GPS [29].

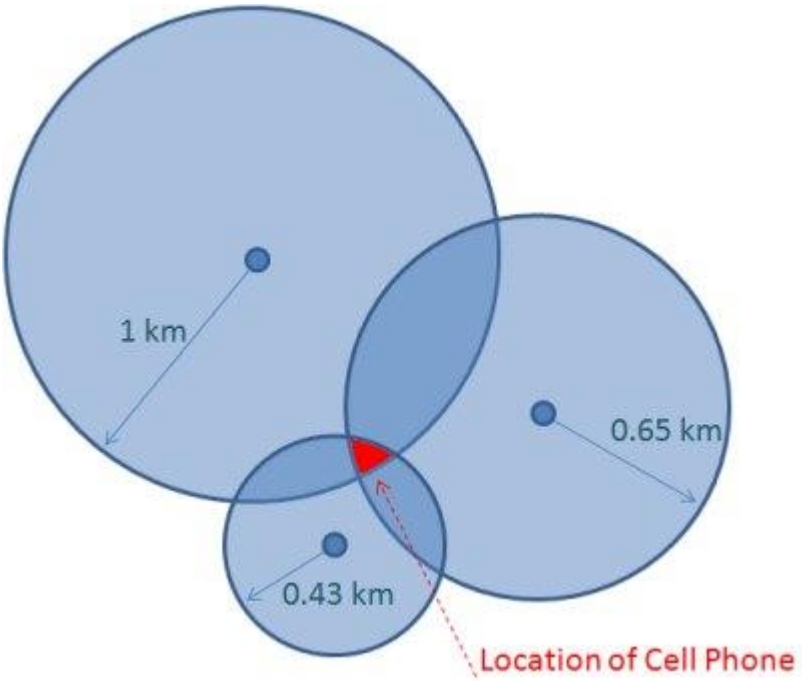


Figure 2 E9 triangulation

Describes Cell Tower triangulation employed by E9

2.5.3 CITY SOURCED

CS describes itself as "a real time mobile civic engagement platform". It allows users who download and install the application to report a public issue. The application neatly categorises the issues for quick selection using a menu, the actual categories being based on the legal terminology used to classify them hence the types of issues being reported may vary. All issues however specifically relate to civil matters such as dilapidation and vandalism of public and private areas, for example broken street lights or graffiti.

User input is kept at a minimum to increase reporting ease and therefore increasing the likelihood of individuals making reports. Users are required to send a picture of the issue they have identified using their smart phone or tablet. They may then describe the image

and optionally add their personal details to the report. Location data is collected from the device and the report can be sent or saved to be continued later on. When the report is sent, the image data is compressed with the message which is sent to the municipal system. A log and real time live feeds inform the user their report was sent and keep them updated about other reports being logged throughout their city.

City sourced backend was developed for municipalities to observe the reports coming in from the users. Using statistical tools, tables and maps, the locations and frequencies of reports are collected. In this way priority can be placed on reports whilst also identifying multiple reports of the exact same issue. The tool can be used analytically by municipalities to manage how to most effectively use their resources such as police patrols to manage more disorderly areas.

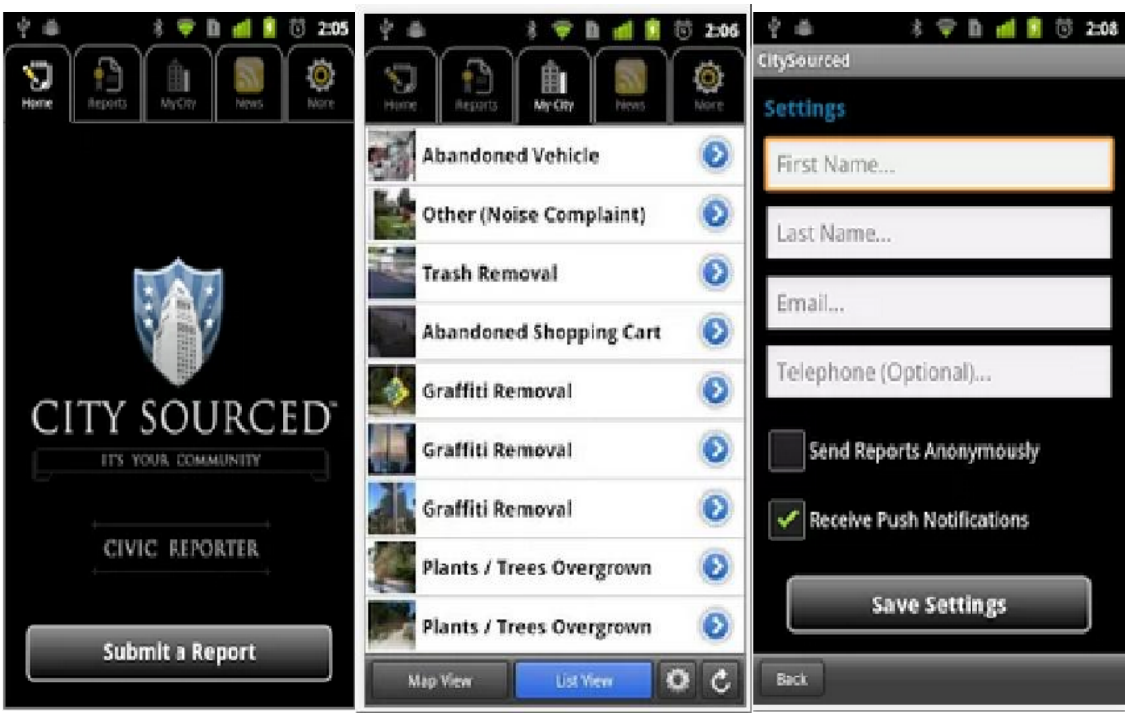


Figure 3 City Sourced

Showing the interface of City Sourced for the Android OS.

2.5.4 Crime Line

Crime Line is an initiative by the South African community, endorsed by SAPS to help report crimes and wrong doers. As a website and hotline it provides a platform for users to give information on a crime that has or is suspected to happen. When reporting via the web, the report is compiled as a tip off; users can report suspicious activity anonymously or supply their contact details. Crime Line then compiles the report and sends it to the relevant local authorities.

The site houses numerous other features of relative importance. A wanted page lists known criminals and their descriptions along with associated images. The details of their crimes are also shown along with their current conviction status. A press centre serves to inform the public on the current crime related news that has been reported by the media around the country.

The tip off reports compiled by the site are implemented using text input forms, the interaction is thus very simple. The site appears to be updated frequently with news articles.

2.5.5 CRIME PUSH

Crime push is a crime reporting mobile application that gained much media attention during its launch, being featured on numerous television reports. Users can send an image and a description of what is happening in their surroundings. It also allows users to choose whom to send the report to, for instance medical contacts, family or the police.

Key points in the Crime Push interface are that it uses icons and descriptions to help users quickly categorise a report, avoiding long possibly unnecessary text input and overall making the reporting process less time consuming. It uses large buttons and icons which also help make the process less daunting for nervous or first time users. Finally a red interactive bar is used to send the final report; ensuring users do not send a report mistakenly.

Figure 4 Crime Push

Showing the interface of Crime Push for the Apple IPhone OS.

2.5.6 UNITEHOOD

Unitedhood, is a mobile application that also allows users to report crimes. Much like City Sourced users can attach images to their report to describe the scene they have observed. Coupled with the image the user may add a sentence describing the scene and the time that it unfolded. This information is combined with the users' location data and sent to the relevant authorities.

Unitedhood however offers an extra layer to the crime reporting process, emphasizing community crowd sourcing. It achieves this by sending details of the crime report the users' select contacts, allowing them to connect together to share information. Contacts or 'responders' are then able to chat with the user; perhaps they are in close proximity to the crime and may be able to add missing detail to the report. The community reporting aspect is designed to enrich the reporting process through communication and information sharing.

The interface of the application is primarily a map displaying the user position overlaid with the buttons allowing users to add detail to the report (such as images), the buttons open separate dialogue windows to perform some function. The map also allows users to immediately see which one of the select contacts is within their proximity.

Unitedhood allows crowd sourcing to work more effectively for the user than city sourced, as the detail fleshed out by different users all perhaps seeing the crime at different angles or times can better enrich the report. Users are also satisfied in knowing that they have also alerted their close contacts of what is happening around them.

This application will be launching in South Africa on the 3rd of November, a week after the completion of this report.

2.6 Usability Section

The purpose of usability testing is to evaluate user interaction with the system, [11] argues that for many scenarios on the mobile platform effective testing cannot be performed in laboratory conditions. It addresses the challenges of evaluating applications on the mobile platform due to the difficulty of collecting data in the appropriate context. It is suggested that laboratory testing should be complemented with testing that considers that "Mobile applications are designed to be used in a mobile context" in other words, field evaluations. The paper suggested a novel approach to gathering data on user experience; the approach involved two users, who would record each other performing a user experience task. The recording was meant to be as natural as possible, so users were left alone with the mobile recording devices. There was no shadowing or detailed test plan, merely user interaction, this novel approach (experience clip technique) resulted in more substantial results than previous laboratory tests. The fundamental principles of this technique and others [27] are to reduce the footprint researchers have on the user experience environment and support mobile usage situations.

Interface design often requires novel approaches for testing [11]. A paper [26] carrying out a study on User Centred Interface Design (UCD) attempts to evaluate the approaches commonly used and taught in the actual field where they are applied to find out what methods are most effective. In a study of 103 UCD experts a comprehensive list of (external objective) measures of UCD effectiveness was compiled and by far the most important was customer satisfaction. While the most important of (internal objective measures) applied measures of UCD practice, was the satisfaction of the design team. These two values highlight the utmost importance of user *and* designer satisfaction in designing a good system. It goes on to address the cost benefit trade-off common to UCD approaches, with the most commonly used approaches including iterative design and usability evaluation. The

paper concludes that UCD experts find that UCD techniques often improve product usefulness and usability considerably.

3 DESIGN

The previous chapter covered usability and interface design principles, important aspects for designing a software solution for real task. The chapter analysed crime reporting and the numerous applications that employ crime reporting for the mobile phone and how interaction can affect how a system is considered.

In the following chapter design principles will be put into practice in order to produce a user centred interface. The chapter will firstly reflect on the usage scenarios of the crime reporting application. The rest of the design will be covered in design methodology where all experiments will be detailed.

3.1 DESIGN AIM

In order to realise the documented advantage of digitising crime reports coupled with investigating the effect of adding convenience to the reporting process through mobile devices, a clear design objective was devised.

The objective of the design is 2 fold, firstly to investigate whether a mobile device can be used effectively to create a crime report based on existing crime reports used by authorities. Secondly to investigate to what extent it is possible to create crime reports instantly to act as panic buttons in emergency situations.

To achieve this, the design must identify what specific requirements must be met in order to create a legitimate crime report and what the user requirements are in order to increase their adoption of the system.

3.2 TARGET DEVICE

Having motivated the use of a mobile device, an android smart phone was selected as the target device for development. Android was the preferred operating system for numerous reasons:

- Due to time scheduling, design and development of the application had to begin much earlier than the date of arrival of the device. As such the android emulator served as a useful tool in prototyping early concepts
- Android is by far the most prevalent smart phone operating system in the world, and is likely to remain that way for the foreseeable future. Android was chosen in order to minimise the learning curve for users using the application to more accurately gauge the usability of the application itself.
- A large variety of devices run android, making it a prime choice for an application designed to offer a public service.

The devices used for design and testing were the Samsung Galaxy S3 and S4 mini running android 4.2 and above. The devices were not developer devices nor were they rooted and fully represented a typical market device.

3.3 Design Methodology

In order to create an application that caters to the user, User centred design was used throughout the development system. This approach covers a broad range of design techniques that all rely on the input of the intended users to create a solution. The amount of input and effectiveness of any given technique varies, however user involvement is an absolute requirement. The role of the designer is to enable users the freedom to shape the final solution.

In the design of this system the following approaches were used:

3.4 Requirements Analysis

Early in design it was necessary to first list all the requirements the application was intended to meet. These requirements align with the aim of the design, and in fact must be met in order to meet this aim.

Requirements analysis was elicited primarily using interviews, discussions and the study of the literature as discussed before in the background chapter. Functional requirements define the function of the system. Key stakeholders identified for identifying these requirements were Dr Anne Kayem and CPS officer Steven Ganger. These individuals helped detail exactly what it is that the application must accomplish.

3.4.1 Functional Requirements

The end user can create a standard crime report using a mobile device.

- This includes all the key data represented in the CPS crime report form [Appendix A].

The user can send the crime reports to CPS.

The user can use the functions of the mobile device to help create a more substantial report

The user can store and reuse their personal information for reports

- This function directly corresponds to the emergency report

The user can send emergency reports that require single input using prior data collected

The user receives some response when a report is sent

The system must enquire as to how much privacy the user would require in their reports

- Privacy settings were a request for separate research topic

Non-functional requirements are requirements which specify how the system should perform its functions. The stakeholders identified for this process were again Dr A. Kayem and also the research team.

3.4.2 Non Functional Requirements

The system must run on an Android device

- This was an important requirement that allowed the research team to coordinate the front end system with the communication component
- This was also the most likely available device platform

The system must store user data in a XML file

- XML was chosen as the target output because of the uniformity of the format. In this way the communication component could begin development with test data similar to the final data

These discussions with stakeholders and recorded material helped flesh out an initial system design

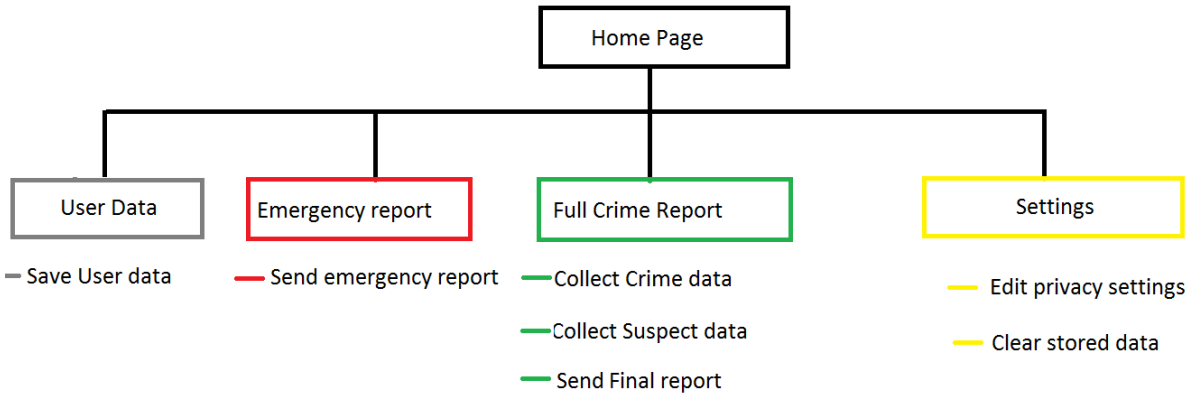


Figure 5: System Diagram

The different Colours represent each different activity

3.5 Iterative User Interface Design

3.5.1 User Requirements

In order to understand the crime reporting process and the users of the system the researcher carried out the process of reporting a mock crime. A small sample of 5 users was then selected to source user experiences with reporting crimes. The sample contained users who had been affected by crime before and not reported the crime, users who had been affected by crime and had reported the crimes, and a user whom had never been personally affected by crime. The following requirements were discovered from the interview.

The user requirements were also supplemented by debriefing sessions carried out after prototype interaction and questionnaires, the table below depicts the user requirements gathered prior prototyping

1.	The application must be easy to use and allow quick convenient input	Often users see something disturbing, such as graffiti, but never go out of their way and take initiative to report the crime, avoiding a lengthy process. The interface must make simple tasks quick to perform, a user suggested the example of using check boxes for yes/no responses
2.	The user must have the option to hide their identity	Users wanted to be able to report some crimes without having the authorities follow up on them personally
3.	The application must be able to save the current report and allow users to fill it later	Users dislike having to restart a potentially lengthy process
4.	Report must allow for detail	Users want the full experience of going to authorities and filling a form. It serves as a guarantee that their report is being considered
5.	User would like to know the privacy policies	Some users wanted a guarantee that their personal information they send will be secure
6.	The application should not rely on help documentation	Users want the application to be simple as possible. Help can be present but it must not be a prerequisite to effectively use the application

3.6 Iterative Design

Using the iterative design model, prototyping is a means of letting users test a tangible element of the system, and is employed as a means of gathering user input. In this project, it allowed designs to undergo criticism and evaluation it also allowed users to engage in the design of the interface, ensuring their interests were always in consideration.

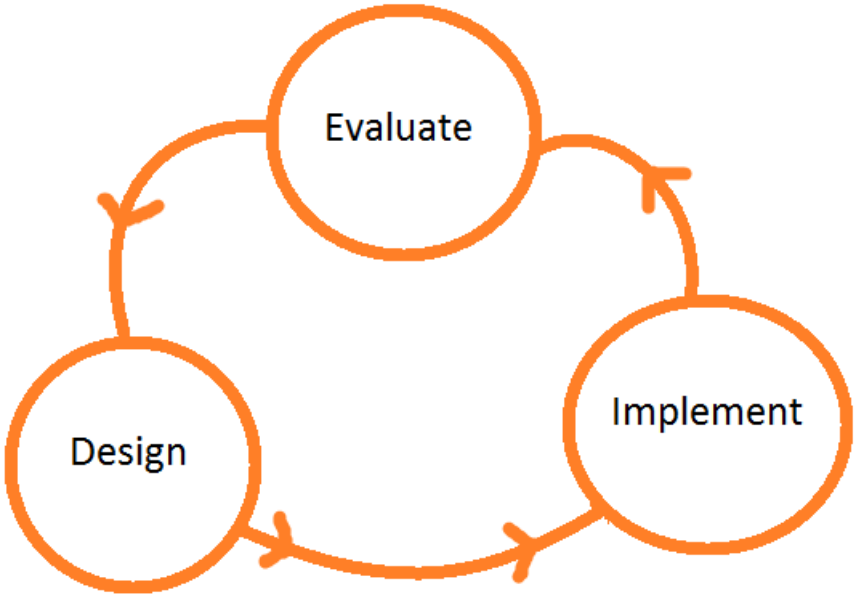


Figure 6 Iterative design cycle

Initially low fidelity prototypes were implemented. Low fidelity prototypes have the advantage of being quick to implement, allowing immediate testing of a concept. They are also low cost and easily discarded.

Paper based prototypes were used for the low fidelity prototyping. These prototypes were not only cheap to produce but also allowed users to manipulate them freely, without having to need computer skills or use a computer at all. Paper prototypes however have the disadvantage of being unable to implement numerous features such as animation and gesture input.

High fidelity prototyping was used when the basic interface model had been fleshed out. Prototypes were more involving and designed to work on the target device

3.7 Emergency Reporting Design

Due to time constraints, the full crime reporting interface was being designed concurrently with the emergency reporting interface. The idea of quickly sending a report even in adverse condition proved a difficult task to design and test, as previous works had stated [11] with regards to limitations of testing natural user interaction on a mobile device.

In order to source suggestions the researcher used the intended users of the system. During design iterations users were asked to brainstorm with the researcher on what means they would employ to interact with their mobile device for the task of emergency reporting. Users brainstormed numerous ideas that covered nearly the full spectrum of sensors available on a typical target mobile device. A few propositions included being able to drop the device in a panic, throwing the device into the air, scribbling letters onto the touch surface or simply pressing a button on the device similar to E9 in effect. However due to the nature of the application, a potential solution would often be difficult to discern or evaluate and there were far too many suggestions to possibly implement them all.

Another source of valuable input were the common device gestures [34] which give insight on what sensors were available on a device and what actions were actually capable to implement. These sources also gave clarity to the intended use of the actions performed on the sensors, for instance, tapping is common for selection while holding and dragging are common for object manipulation [34].

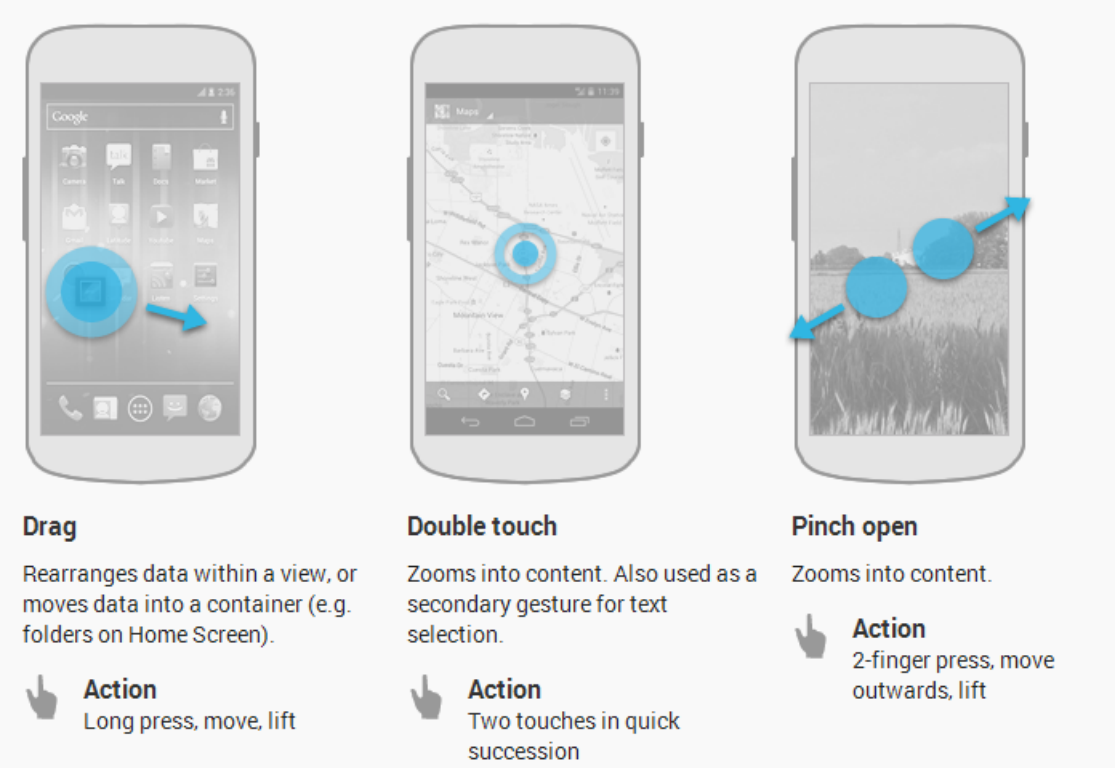


Figure 7 Example gesture functions

It was evident that quick and dirty evaluation would not be effective for this interface, indeed a paper prototype would serve no use whatsoever in this context. Instead the interface was initially designed based on the capabilities of the device and the suggestions made by the users.

3.7.1 Input

3.7.1.1 Touch Surface Based

The touch surface of a device can detect the presence, pressure and location of physical contact on the display. Touch surfaces allow the user to immediately interact with on screen elements and do so without need for any device [5].

The touch surface would be ideal for immediate emergency reporting. Depending on the gesture:

Pressure could be used to send the report, supposing the emergency gesture is a high pressure press of the touch surface, coupled perhaps with a second gesture such as drawing a circle. High pressure touch is not very common use of the touch surface as users have stated, it is thus viable mode of input for emergency reporting due to its uniqueness. The quality of pressure sensor may be a factor, one which is dependent on the device.

Simple gestures such as taps, double taps or flicks could be used to send the report. Quick and easy to perform these gestures could be most effective to perform in the most contexts. However, these are the most occurring gestures and could easily lead to a large number of 'miss fires' in which users send a report unaware.

Figure 8 example touch gestures

Complex gesture, in this case a complex gesture is anything that is not recognised as simple gesture in 34]. Complex gestures can be created that would reduce the likelihood of a user miss firing; however gestures must not be as complex as too difficult to reproduce when situation demands. The gesture should also be as quick and subtle as possible and functional regardless of the device orientation

Angle of gesture could be used to specify an angle for any of the touch gestures. This particular feature will not be useful due to the fact that ideally the application should be able to send a report regardless of the orientation of the device.

3.7.1.2 Accelerometer Based

The integrated accelerometer sensors in the device allow it to pick up physical attributes such as its motion in any of the 3 rotational axes. This means that the device can detect, to a very fine sensitivity, actions such as being picked up, dropped, tilted or spun. Users suggested perhaps being able to perform some physical action to the device to have it send the report. While such an implementation would certainly offer novelty, practically it may prove a disadvantage for a broad spectrum of users. Some users report difficulty in using accelerometer centred applications such as games, which are either too sensitive or too rigid for them. Secondly too abstract a gesture, such as flipping the device or dropping the device some height might prove too conspicuous and impractical.

3.7.1.3 Physical button/Speed dial

Similar to the E9 application, a panic button or speed dial could be used to immediately send the report. Due to the advent of touch surfaces on modern mobile devices however, few modern devices come with a standard keypad input. This would mean that the keypad is no longer instantly available, and in fact would have to be brought up through some touch gestures.

3.7.1.4 Microphone based

Using the integrated microphone, the user is able to use voice commands to perform an action on the device. This means of input normally uses a trigger phrase to begin listening for voice input. There after the program may perform any kind of action based on the following phrases or 'command words'. A microphone based approach could be ideal due to the fact that input does not directly require the device to be in the hands of the user nor does the trigger phrase have to be an obvious phrase. Problems with the microphone however include a chance of miss fire if the trigger word is very common. Another problem may also be that ambient noise may saturate and drown out the users' voice in some situations and of course the user may find themselves in a situation in which they cannot speak.

3.7.1.5 Hybrid

A possible solution to the problem may yet be a hybrid of the above arguments. Using more than one of the features above could allow the user a more responsive and effective means of reporting the crime. However it may also increase the likelihood that a 'miss fire' occurs.

3.7.2 Feedback

Feedback is of utmost importance for usability, a system that gives no feedback and whose inputs have no evident change in the environment can be very confusing and frustrating for users. Feedback not only lets users know what the application is doing, it allows them to anticipate a result and plan the next action based on that result. To illustrate this point,

- If the user were to 'miss fire' without a reliable form of feedback they would never know that they have sent a misreport.
- Secondly if the user were to send an emergency report during an emergency, without some form of feedback then the user would never know whether or not they have in earnest sent a request for help.

The second of these points adds the notion of feedback nature, namely, what type of feedback would be most appropriate for a system this context sensitive. The same approach of researching from sources and users was used in designing a valid form of output for the emergency reports.

3.7.2.1 On screen output

An obvious candidate for output could be to use the device screen. A confirmation message could be shown to provide feedback to the user, the message need not be descriptive and need not be text, an image or flashing screen could suffice. The obvious disadvantage to this approach is that due to environment the device screen may not be visible to the user.

Among the discussed input methods on screen output would pair with the touch surface based input scheme. It is most likely that the user is able to see the response in this scheme, a visual response it also common for touch input [5].

3.7.2.2 HAPTIC OUTPUT

Through the use of vibrating motors mobile devices are able to provide haptic feedback. Haptic feedback is a private medium that provides for unobtrusive modality for interaction [5].It could easily be used to subtly send a response to a user, at the same time requires little cognitive load thus allowing a user more attention to what is happening around them, an important aspect given the environment. Haptic feedback provides a discreet means by which a user can receive messages, as long as they possess the touch device on their person or in contact with their skin.

A second point to consider is the amount of power needed in the feedback, too much and the vibrations will not only be audible but visible as well.

The prerequisite that the device be in the possession of the user or in contact with their skin suggests that haptic output would best correspond with touch screen and accelerometer based input better than with microphone based input

3.7.2.3 AUDIO OUTPUT

Audio feedback is a commonly used form of notification, often used in conjunction with visual cues. Audio cues are highly customisable and users often choose different sounds for different activities, while some of these sounds are synonymous with certain activities and contexts, such as a phone ringer sound, the exact meaning of many sounds are user specific. It is this property that makes audio feedback a viable means of output. Audio output is not a panacea either as it is very dependent on the user being able to hear the message, it is also very invasive, meaning that individuals in the environment could also hear the response.

For the device to output an audio confirmation, it requires the user to be within hearing range and for the environment noise not to conceal the message. As such audio output best corresponds to microphone input.

3.7.3 CONCLUSION

The design finally chosen for implementation was a hybrid of approaches, which implemented touch, microphone and accelerometer based input. The feedback means were screen, audio and haptic output as described above. A prototype was then implemented that users could interact with and gives feedback.

3.8 CHAPTER SUMMARY

This chapter detailed the design method used in developing a design for both the Full Crime Reporting scenario and the Emergency Crime reporting scenario. User centric design was the approach used to design the system this would ensure that user satisfaction was built into the system from its inception.

The actual design implementation follows in the succeeding chapter.

4 Design Implementation

The design implementation chapter serves to detail the implementation of the design techniques used to create the system. The chapter primarily covers the low fidelity prototypes created using User centric iterative design. Each iteration of the design is motivated, discussed, results drawn and summarised. This chapter covers only the Full Crime Reporting component as no means of low fidelity design could effectively design Emergency Reporting.

4.1 Low Fidelity Prototypes

4.1.1 Tools and preliminary

The materials used included paper based crime report form, pencils, eraser, scissors and papers. A private space was also made available where the users felt comfortable, allowing them to utilise the materials in front of them more effectively.

Seven users were selected to perform the paper based evaluations for both iterations. Each session was individual allowing the researcher to fully engage the user. For this phase of design no particular criteria was used to choose the participants, any individual no matter their experience with crime reporting and mobile devices would suffice. The researcher performed the role of designer in all the iterations.

The sessions were informal with no information on the participants collected at all. The researcher was friendly and approachable; however each session followed the agenda below:

- Greetings
- Introduction – the application and reason for its design was made clear to participants. The objective of the session and the intended goals were also detailed. Finally the time it would likely take to complete the task.
- Task
- Debriefing – participants were thanked for their voluntary input.

4.2 First iteration

4.2.1 Objectives

- Get users to understand what a crime report entails
- Get users to help design an interface that is a logical extension of what they understand a crime report to be

4.2.2 Tasks

In this initial phase of design the user task was to give design input on the full crime reporting scenario, particularly the data capture. The design arguments and notes were written down by the designer for later reference.

4.2.3 Results

Taking all the input from the session with users the researcher compiled the information into sheets of ballots. Similar design ideas were tallied together to give them precedence

while less common ideas were considered with less priority, however all ideas were considered based on the explanations and justifications the users had suggested. The resultant paper prototype:

4.2.4 Main Screen

The Users immediately identified 3 main functions with regard to the reporting process. Compiling report information, storing personal information and sending the report information. The standard was to create a home page that contained 3 buttons that allowed users to perform these 3 tasks. The user details button allowed users to enter their personal information, information that was immediately available for emergency reports, and never changed from report to report.

- Password login was the agreed means of protecting this sensitive data in the case that the device was stolen potentially compromising the users privacy

The second button, Full Report, opened a window in which users could write out their crime reports in the standard of the paper based form. Finally the Immediate report button was used to implement an immediate crime report. [Please see Appendix B for images]

4.2.5 User Details Form

This form was kept very simple and contained the information identified as being particular to the user of the device, or the complainant section of the actual crime report form. Participants used text fields and labels similar to the paper based form. A save button was located at the bottom of the screen. The researcher decided to also add a cancel button as this was left out by the participants who argued that without filling those vital details a crime could not be reported. However due to anonymity the researcher anticipated that perhaps these fields could be left empty.

4.2.6 Full Report

This operation was facilitated by using 2 screens serving as forms. The first form collected all the data pertaining to the crime itself. This included description, date and time. A fourth field was added to facilitate location. Stolen items were also added to this page. A save and a cancel button were added to the bottom of the page

The second page stored the details of the suspect. All the information pertaining to the suspect was collected again in a fashion fairly similar in design and ordering as the paper based form. Clicking save on this page resulted in the user being taken to the camera input screen. In this screen users could take a picture of the scene they were reporting. Snapping an image would lead to the final screen, that requests confirmation to send the report. Selecting save from this screen would send the report and return the user to the main screen.

4.2.7 Summary

In this stage, participants came up with numerous ideas such as using video and audio capturing to enrich the report. While these ideas were certainly valid and could provide an extra layer of depth to the reports, they would also add a level of complexity in the storage and secure transmission of the final report resulting in scope creep.

Users preferred the words Save and Cancel for the next and previous buttons on the application. This could have been a result of the facilitators' bias in using those words themselves however the words are very descriptive of exactly what it is the buttons do.

No help features at all were suggested by the users. While a user requirement was to keep the user documentation to a minimum, it would be a design flaw not to include some form on help in the application. It is likely that users having both the paper based form and the facilitator at their disposal did not need any help, nor did they think any was necessary. A help button was added by the facilitator however, that explained some of the more obscure fields in the report, such as suspect description fields.

4.3 SECOND ITERATION

4.3.1 OBJECTIVES

- Present and evaluate the aggregated interface. Implement scenario tests and perform finer changes on the existing system

4.3.2 MAIN SCREEN

The main screen received significant changes. The User Details button was removed completely, instead, new users would receive user details as the first window when they start the application. From this window users could enter and save their details permanently or cancel and close the application. The main reason for this was to increase the likelihood users entered their details in order to fully benefit from the application. A new field was also added to the User Details form to handle privacy, users could choose to have high or low privacy settings instead.

Removing the user details button freed the main screen of space necessary for the new Settings page users devised. The other two buttons, Full Report and Emergency report remained unchanged.

4.3.3 SETTINGS PAGE

The new Settings page was devised to clear User Details and change the access password. Adding the Settings page also made it possible to easily change the privacy settings of the user.

4.3.4 FULL REPORT

The full report scenario also received considerable change. The first being the inclusion of a camera button in all its different screens. Users decided that taking an image of the scene should be left optional. They also did not want to traverse between screens to find the camera button, and decided on being able to call the camera from any individual reporting screen.

At this point the facilitator suggested a new feature for the camera, the ability to tag different elements of the image as victim or suspect. This tagging feature could of course be alternated for a description field however participants preferred the tag method which they thought would be faster as it requires less typing

Other changes included the separation of fields for the crime details. Users wanted a quick means to describe a crime and introduced tags to the crime description as well. This would allow them to quickly describe crimes. The effectiveness of such a feature was dependant on the crimes however as other users thought it idiosyncratic to be able to tag crimes such as rape or assault in the same manner as vandalism. The final decision was to leave the crime description field on the form and add the tag field as supplementary. Checkboxes were used for tags, as a crime could contain numerous tags.

4.4 FINAL DESIGN HEURISTIC EVALUATION

Heuristic evaluation provides a quick and efficient means of evaluating the design, without need for users or a functioning prototype. Nielson provides a list of 10 [Appendix A] heuristics for mobile development. The approach used is a standard heuristic evaluation conducted in closed (laboratory) conditions with few contextual elements; a full contextual walkthrough would require too many resources to implement successfully.

The final design was analysed against the heuristics and the following was found to be of note:

Users had **control and freedom** in manipulating the application. Each page offered a next and previous option that ensured users could return to previous pages at any point.

Consistency and Standards and the match between real world and the system were a natural extension of the design approach. Involving users along with designing the system with the actual tangible crime report form in mind meant that the system was consistent to a real world example and used appropriate terminology.

Error prevention and flexibility of use are afforded by using relevant input fields when implementing the final solution. The use of Tags also adds flexibility and a quick means of describing the crime

Recognition over recall ensures that all functions are mapped to the same location on every page. Help will always be in the same location and so will other actions such as Cancel and Save.

Aesthetic and minimalist design is of utmost importance as the application must be accessible to users of varying knowledge of crime reporting. Use of large buttons, consistent recognisable icons and a form layout for the application screens keep the design minimalist and relevant.

4.5 SUMMARY

The second iteration helped to efficiently flesh out the finer details of using the application. It also allowed the researcher to gauge how well they had aggregated the initial input from users.

Users found the inclusion of help to describe obscure terminology in the form to be relevant.

4.6 CHAPTER SUMMARY

This section of the design chapter presented the implementation of the iterative design technique used to create the low fidelity prototypes. The results of this chapter are the low fidelity prototypes which form the basis for the actual implementation of the system. Overall the Design chapter presented Iterative user centric design as an efficient method of designing the crime reporting application.

The following chapter, Implementation, makes use of the low fidelity prototypes as a reference model and discusses the development of a practical solution.

5 IMPLEMENTATION

5.1 INTRODUCTION

The previous chapter discussed the methods used to design the interface, by first gathering requirements using techniques such as interviews. In order to create a user centric application, users were used to prototype the initial designs using quick and dirty techniques, paper and other materials. The design was iteratively developed to a point that high fidelity prototypes could be developed.

The goal of this chapter is to outline firstly the technologies used in developing the final solution, the development of the high fidelity prototypes and final implementation. The chapter will also cover the implementation of the emergency reporting application.

5.1.1 PLATFORM

As previously mentioned the target devices for the final solution are Android Devices, the particular development device used was the Samsung Galaxy S3 running android 4.2. In order to meet the specifications of this device the following environment was used:

5.1.1.1 SDK

A development platform had to be selected that would allow effective implementation of both the interface and communication components of the project. After deliberation the team members decided that the use of the JAVA language and the many libraries available therein would accommodate both components. For the development of the interface the eclipse SDK for android development, a tool made available by Google, was used. The target API for the application was the latest Android available at the time of development, Android 4.3 Jelly bean.

The initial prototypes based on the paper based model were developed using the android emulator available on the SDK. The tool allowed development of all the features in the design including touch gesture input, however it did not reflect true performance of the final application as it was much too slow. The emulator ran on a desktop machine capable of GPU acceleration; however the emulator never peaked more than 10fps (frames per second). Despite this set back implementation was still possible.

5.1.1.2 STORAGE

During implementation multiple device memory options were used:

- To operate, the system requires the user enter sensitive information such as their address and contact numbers and store it on their device. Due to the fact that this could result in their personal details being easily intercepted if the device were taken from them, a password login was implemented. This would provide authentication at a low level. The memory used to store the password is shared preferences memory, persistent memory quickly accessible by the application.
- The application stores report data persistently to avoid re-entering user data and to allow for saving the report. The user report data is stored in application memory as a text file. This ensures that access to this information is limited to access via the application itself vis-à-vis the login. The text file is used in order to reduce the

amount of memory the application uses in shared preferences. Because the text files are based on reports of a specified format the average size of a file can be approximated, and even on larger files users would not notice any data retrieval delay (files were less than a kilobyte in size for the most verbose of reports).

- Before the final report is fully compiled and sent as output it is saved in application memory.

5.1.1.3 Output

The final report output was a compiled XML format file that contained all the fields of the final full report. [Appendix B].

5.2 Implementation

5.2.1 High fidelity Prototypes

The two core features of the final application, full crime reporting and emergency crime reporting, were tested as two separate applications during prototyping. This was done so users could focus one test scenario at a time.

When initial implementation began the practical issues of performing mobile application evaluation of a crime reporting app surfaced; these had to be addressed. Often novel solutions must be devised to face these challenges [11]. As discussed in the Background, standard laboratory tests lose the mobility aspect of the mobile device while real life contexts evaluation requires difficult to implement data collection methods.

The nature of the application meant that unfortunately testing could not be done in an environment with real context, it would likely not only be unethical to test the application by observation in a real crime it would also be dangerous . The researcher decided that re-enacted crimes would have to serve the function for testing however, due to time and resource constraints crimes could not be re-enacted each time. A more tactical use of resources was to re-enact crimes beforehand and document them by means of images. These images would then serve as sample crimes users would report for testing.

In total 5 different scenes depicting a crime occurring were captured. Some of the images depicted graphic violence to a small degree however participants were informed of this and were re-assured that no one was hurt at any time during the capturing of the images.

The images were taken at high resolution, 3264 x 2448 pixels and printed in full colour onto individual A4 sheets of paper. They were taken in such a way that participants could clearly identify the intended suspect and victim in the images.

The goal of the images was to create a scene that participants could easily identify as a crime scene and would feel motivated to report. The angle and distance to the crime of the camera were used as tools to ensure this. The full crime report is not intended for immediate or emergency use. Hence the images were designed to be visualised as taken during the crime while the report itself was compiled sometime after the crime. Still the images could be viewed as faux memories a participant has of the crime

These images were then given to participants, by random selection, to be documented in the crime report. Due to the lab context of the testing the following weaknesses in the testing were identified:

- The lab tests did not cover all manner of crimes but instead only a handful of scenarios were depicted (five in total). The extent to which a mobile application is effective for crime reporting cannot be fully realised using this approach
- The images and scenes compiled were taken by amateurs in the field of photography and crime scenes. More accurate data could be compiled by using real scenes or perhaps real actors, photographers and crime scene analysis
- In some cases the individuals were recognisable by the participants. This did not discredit the tests these participants performed; instead they enriched the result space. Participants could recognise either the victim or the suspect and add more detail to their report. This models the real world
- Realising they are looking at a picture participants had no sense of urgency as they record the crime. Users performance would likely be affected by anxiety and time since the crime, in this particular case neither of these factors were considered
- Crimes were depicted as still moments in a scene, making the task of reporting the crime likely too easy (users could take their time to take in the detail of the scene)

However despite these weaknesses the images still served their fundamental purpose of presenting a crime that would allow how a user would capture information to be evaluated.

5.2.2 Program structure

The following section highlights some of the key points of the program development; it covers the features implemented in the application.

As previously mentioned the application was developed on the Android development Toolkit for Eclipse. Each individual page of the application is reference as an Activity. An activity is a single, focused thing that the user can do [34]. In this environment an activity has both a graphical representation expressed in XML and supporting code written in Java, this is in the Model View Controller schema.

In android new activates are called by the current activity using intents. Intent is an abstract description of an operation to be performed and provides a facility for performing late runtime binding between the codes in different applications [34] this means that intents can call code such as Activities during runtime. Each intent has a calling activity, each called activity must end with some output after completing its task and return to the calling activity. This creates a linearly hierarchical structure to a program from its start (parent activity).

5.2.2.1 Main Page Activity

As described in the Design chapter, the main page served as the application home screen. When the application starts, this page loads all the stored user data. This includes their personal details and the crime report they had last worked on had they not completed it.

If user data is not present, this page immediately loads the User Details page

5.2.2.2 User Details Activity

The user details page captures the participants' personal details. For the purposes of experimentation users were supplied with faux details in order to ensure their privacy. On this users may also set their privacy setting.

The Help Cancel and Save buttons function exactly as previously explained in design. A question mark icon was used for the help feature. Icons help reduce screen clutter, and if they are sufficiently common knowledge are just as effective in communicating an idea as words. Icons were used whenever appropriate to increase screen aesthetics.

Saving the personal details would write them to application memory and return the user to the Main Screen

5.2.2.3 Full Crime Report

The pages of the full crime report have the following similar features.

Help button – as previously described

Camera button – this button is located next to help and labelled with an image of a camera, using an icon consistent with the help feature

Cancel button – returned the user a page back

Save button – On selecting the save button, the current details of the Activity were saved and the succeeding activity was called using an intent.

5.2.2.4 Crime Data Activity

This page recorded the data associated with the time, location and location of the crime. Participants could enter custom values or quickly select current for each value to set the location and time to the present location and time.

5.2.2.5 Crime Details Activity

This page was changed from the original paper based form by including the Tags field. This field could only be edited by clicking the tags below it. These tags described the crime quickly and could be used to classify crime by type in a database

5.2.2.6 Camera Activity

The camera activity allowed user to take a picture of something relating to the crime. The image could be tagged with a description or quickly tagged suspect or victim. The camera itself was called using an intent, hence the camera application was not native to the application but a separate program altogether. The native camera application was used instead of a custom camera application in order to increase user familiarity with the camera features. Pictures taken are stored in application memory away from public or default memory of the camera application.

5.2.3 Tools and preliminary

The materials used included the high fidelity prototypes these solutions were installed on an Android mobile device and sample images of crimes. A private space where the users felt comfortable, allowing them to utilise the materials in front of them more effectively.

Ten users were used for each individual iteration cycle of high fidelity testing. Users were chosen with the only the criteria that sexes had to balance. Each session was individual allowing the researcher to fully engage the user. The researcher performed the role of designer and developer in all these iterations.

These sessions were more formal than the previous paper based sessions. Participants were required to sign a consent form and contribute their input using a questionnaire for the final implemented solution. User input was simply recorded for the initial iteration.

5.3 First iteration

The prototypes used in this iteration were vertical prototypes that allowed the functionality of reporting a crime and implemented all the methods of input as described in Design Methodology

5.3.1 Session Structure

The first iteration sessions followed the following structure

- Greetings
- Introduction – the users were asked to select a random number from 1 to 5 inclusive. They were then assigned a crime based on this number. The objective of the session was explained to the participants. Finally participants were given an the estimated time the whole session should take to complete
- Task
- Debriefing

5.3.2 Objectives

- Present a vertical prototype that offers the implemented interface features of the final solution.
- Record by shadowing the process users followed in interacting with the application
- Record user input

5.3.3 Tasks

The user task was to record a full crime report using the system. Freely use the features of the application to achieve this task.

5.3.4 Results

The results are categorised by reporting style, Full Crime Report and Emergency Report

5.3.4.1 Full Report

The results of the user task were recorded on the device. The device stores the user report and allowed the designer to see how much detail users input during the reporting process. This data also showed which fields were most likely to be filled by users.

Users were shadowed during the use of the application and the researcher recorded notes of the users' actions when using the application. Finally user input and suggestion were recorded at the end of the session during debriefing. Images of the first implementation can be seen in the appendix.

The high fidelity prototype was effective in that users were now faced with the technical challenge of using the application as opposed to the paper based prototype. Users provided feedback on the system that would help further refine design with a focus on interaction. Some user feedback of note that users contributed included:

1. Users wanted more detail when filling fields:
    a. As compared to application help, which users hardly ever used users often wanted help on how to correctly fill the fields in the report.
    b. Questions such as "What complexion options can I enter?" were very common place.
    c. The help feature failed to address this issue and instead was addressing the issue of usability making it redundant.
2. Users wanted more feedback after sending a report
    a. Some users completely missed the message that confirmed their completion of the report leaving them confused at the end
    b. Users wanted to know how many reports they had made
3. The help and camera buttons were too inconspicuous
    a. Some users never used the camera because they simply did not see the button
4. The suspect details section of the application was confusing
    a. Users did not understand how they could know the suspect. It often took a discussion to clarify that unlike in their image they may know exactly who the suspect is, it was context dependant
    b. The users wanted more clarification on this section as they are often tempted to fill all the fields they come across to some detail, in order to create a more full report

5.3.4.2 Summary

Users found the application to be simple to use, hardly ever using the help option. Shadowing revealed that many users were confused by the 'Save' and 'Cancel' terminology of the navigation buttons. Most users did not realise that pressing cancel would take them back one screen and not to the Main Screen.

Users found that for forms with large volumes of input details, scrolling was difficult. The results of this session were used to refine the prototype and present a final iteration.

5.3.5 Emergency Reporting

This section documents the development of the Emergency reporting application.

In order to test the input methods described in Design methodology a simple application was developed for the specific purpose. The application was designed to record, evaluate

and output a response to user input. To restate, the application allowed the following input touch based gesture, motion based and audio input.

Each input method was mapped to a different output method. Correct touch gestures resulted in a visual response. When a motion based input was detected haptic feedback was used for output. For microphone input, a sound was used to confirm the acknowledgement of the message.

This method of testing allows users to input a gesture and receive feedback in a means similar to that of the final application. Due to the nature of the input mechanisms users needed time to adjust to the degree of sensitivity required to perform a successful gesture.

To perform successful input participants had to:

1. Draw a circle on screen as a touch based gesture. This gesture had to be predefined as a pattern before testing. The circle pattern was defined as a single line whose ends touched each other. Due to the nature of the touch device and user error, the definition of a circle had to include open ended circles as well, such as [**fig].

   For a gesture to be recognised against a pattern, gesture start points had to be relatively aligned to the pattern start points as well. A second parameter considered was the direction of the gesture input, with regard to recognising a pattern drawing a circle counter clockwise was a different gesture from drawing a circle clockwise. In order to allow participants to draw a circle from different start points the circle gesture was replicated in 3 of its incarnations as shown in [*8fig]) from 2 different start points to ensure users could draw the circle without difficulty.

   The circle pattern was created using the Android Gesture Builder Application. The application allows the creation of predefined gestures stored in file.

2. Use motion detected by the accelerometer. Participants had to wave the phone around in order to receive a vibration response. A threshold value was used to control the sensitivity of the accelerometer. The threshold was calibrated to allow user to walk with the device without triggering a response.
3. Use the built in microphone by uttering a key phrase followed by a command phrase. The actual phrase is of arbitrary importance, the goal instead is to get the device to correctly pick up user speech and perform the desired function.
   Android Jellybean allowed for locally stored speech recognition language files. European English was the selected language for speech recognition. This language most resembled the dialect of the area and had the highest recognition rate.

The application first demonstrated to users how to correctly perform an input gesture. The user was instructed to perform a single input of a touch gesture, motion gesture and an audio key phrase. These gesture tests were performed in sequence, where on successful completion of a gesture the next gesture was tested. This exercise functioned as a tutorial for participants to understand the calibration sensitivity of the device.

[Insert emergency reporting activity image]

5.3.5.1 OBJECTIVES

- Record user feedback on performing task
- Record user task success ratio
- Use shadowing to record user interaction

5.3.5.2 TASK

The user task was to record as many successful attempts using gesture input and give feedback on the experience

5.3.5.3 RESULTS

The results of the user task further exacerbated the difficulty of capturing mobile user interaction in a lab environment, which is far removed from the context of the application. Users commented that their biggest concern was the ease with which they would trigger a response from the application using motion recognition. A large number of participants also struggled with the speech recognition which would not pick up their instructions. These 2 features needed refinement however they liked the use of touch/drawn gestures to send a report. The gesture they requested would have to be difficult to perform by accident such as the circle.

With regards to output, users preferred haptic feedback overall. This form of feedback could also serve as visible and audible. Screen output in the form of a flashing screen could easily be missed by the user and users found audio output too mundane in it of itself.

5.3.6 SUMMARY

The emergency reporting testing was done and users had decided that the best feature for implementation would be the touch/drawn gesture. This feature was the best option because of its high success rate in recognising a pattern and the low chance of mistakenly sending a report.

6 EVALUATION

6.1 INTRODUCTION

The goal of the project interface component was to provide a mobile solution to crime reporting that allowed user to create, complete and send a detailed crime report without interacting with an officer. The interface must be intuitive and simple enough for users of any background to utilise without external aid. The ultimate goal of the project is to increase user likelihood of crime reporting by making the services more available to users, as such users were involved throughout the development of the final solution.

The previous chapter provided the implementation specifics of the high fidelity prototype and the final iteration in detail. The following chapter will focus on the assessment of the final iterations of the Full Crime Report and Emergency crime report implementations for mobile devices. The chapter will first detail experimental design, the steps performed and resources acquired to prepare for experimentation. This will lead to results and findings where the results of tests are discussed. Finally the chapter ends with feedback on the final solution from stakeholders.

6.2 EXPERIMENTAL DESIGN

As previously mentioned in the design chapter, the interface for the application was developed in a user centric approach, users helped develop all the features of the application from concept. This section describes the experimentation detail.

6.2.1 PARTICIPANTS

As previously mentioned in the design chapter, there were no prior skills needed from participants. The testing was open to any individual living in the general area of the university to partake in the study. Close proximity to UCT made testing participants easier (testing premises were in UCT) but also made CPS crime reporting a relevant matter for participants. The only criteria for participants pool was a balanced number of the sexes.

Participants needed no prior knowledge of crime reporting or have had interaction with CPS or any security services. Applicants needed no prior knowledge of the device platform and operating system it was running. This is because the application is designed for all users in the general public.

Ethical clearance was obtained from the Science Faculty Ethics in Research Committee for testing on human subjects. As the application collected potentially sensitive information (such as ID numbers, address and contact details) about the applicants, it was ensured that participants did not enter their real details into the personal fields, instead a fake identification was given to them to use. Anonymity and confidentiality were ensured for participants, participants were insured that the information collected was for the purpose of the research and no other function. It was also communicated clearly to participants that the system was under evaluation and not themselves

10 participants were chosen for evaluation of the final iteration. The gender distribution was again, even at 5 per gender. The age distribution was between the ages of 20 and 24 inclusive and all participants resided in the area of the University of Cape Town and its

residences. All 10 participants were in possession of a mobile device which they all reported to use daily, however only 4 users reported familiarity with the android platform. 8 of the participants had never reported a crime before. All the participants had attended higher learning institutions and can be presumed they hold high enough of a grasp of the English language to be able to carry out the tests.

The participants used in the final evaluation were all compensated for their time and commitment, limited resources were used to maximise participant numbers however for a full usability study more participants would be necessary.

6.2.2 Experimental Procedure

Participant experimentation was carried out individually upon arrangement by the researcher and participant. Each session was overseen by the researcher who monitored interaction by means of shadowing users as they used the application this allowed the researcher to observe how exactly users interacted with the device. The researcher made participants aware of their observation beforehand.

The testing took place on UCT premises in Observatory. The environment was a quiet and private testing room so users could focus more on the task at hand. Prior to the test a device with the application installed was prepared for use by the participant. Images of a crime to report were compiled as described in implementation, these images were taken by the researchers for the research and no one was hurt in their production.

6.2.3 Session Structure

Greetings and Introduction – at this point participants were given a consent form for their participation. The purpose of the project and experiment were explained to the participants along with the purpose of the participation and their assured confidentiality. The structure of the assessment was also explained.

Tasks – The user had to complete two tasks before filling the questionnaire. One regarding full crime reports the other, emergency crime reports. Users would then answer a brief questionnaire after these tasks. They were informed that at any time, if the felt the need, could choose not to answer a question in the questionnaire. The researcher was available for users had they any questions. If the user needed any help, the researcher would log whether the manner of aid was related to the application or the device (Operating System or otherwise).

Debriefing – participants could give comments or feedback on their experience.

6.2.4 Tasks

The tasks of the assessment were designed to expose the implemented the features of the application, allowing participants to test their usability. The goal was to have a defined image detailing the effectiveness each feature.

Each experimentation session was divided in two main tasks as previously stated, a Full Crime Report and an Emergency Crime Report, each of these tasks was comprised of lesser tasks. 3 of the 4 lesser tasks were carried out in the Full crime report component while a fourth was carried out in the Emergency crime reporting section. The sessions did not follow a defined time restriction but interaction time was recorded by the application.

The first main task, Full Crime Report was comprised of the overall task of sending the full crime report (filling in data), taking an image of the scene of the crime and tagging the image either suspect or victim. This session was intended to allow users to their faux details into the system. It allowed participants to use the system to report the crime before them as they saw fit and for evaluation as to see how well the technology supported this task.

The second task was only possible after the first, participants faux details would be used to send emergency crime reports. Users were given an opportunity to perform the task and send an immediate crime report; the difficulty they faced was recorded by the researcher.

6.2.5 Questionnaire

The questionnaire used to record user interaction for evaluation was given to users after they had performed all the tasks previously mentioned. The questionnaire contained 22 questions that evaluated system usefulness, information quality and interface quality. Ideally the questionnaire should be tested on 98 users.

The questionnaire used is a resource adopted from [14]. The Likert style questionnaire was modified to suit this context. The usability questionnaire was psychologically evaluated and found to have high scores for reliability, validity and sensitivity. Reliability being a quantitative measure of a questionnaire's consistency, Validity is the extent to which the questionnaire measures what it purports to measure.

The first four scenario questions of the questionnaire are scaled with 5 steps while the rest of the questionnaire is scaled in 7. Though a higher number of steps results in better results [14], the fewer number of scenario questions makes it highly accurate regardless.

6.3 Results and Findings

This section discusses the quantitative findings of the final iteration; it focuses on the data extracted from the questionnaire. Results of experimentation is given and discussed, followed by user experiences and feedback from the tests.

6.3.1 Outcomes

When formulating tables and graphs the following constraints were placed in the analysis of the data

- For the sake of logical graphs; where questionnaire results were small values for positive responses and high values for negative responses all values were subtracted from the maximum. This gave graphs natural readability.
- User responses left as inapplicable or 0 in the data (Appendix B) were not included in calculating averages or standard deviation.

6.3.2 Scenario Questions

The graph below shows the final average outcomes for the first four questions on scenario questions. These questions were based on the IBM ASQ[14] and they were designed to be given to a participant after completing a series on tasks. The questions measure the ease of task completion and the time to complete the task.

The questionnaire was modified by adding a focus on time taken for each task. Participants graded both the ease of completing a task and the time taken to complete the task,

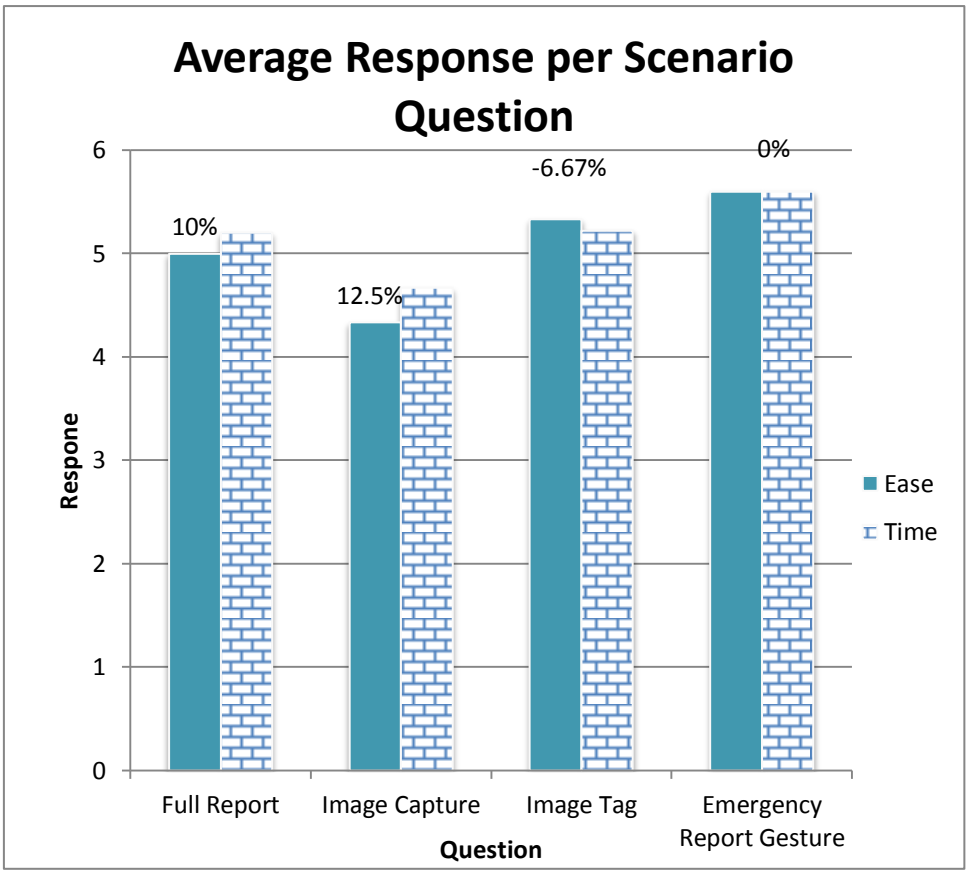
effectively doubling the number of questions from 3 in the original ASQ to 8 in this example. As can be seen in the graph this often resulted in users giving the same score to the time taken as that of the ease of use. This correlation could be a natural response or a user bias to grade the two as effectively the same. The average percentage difference between correlating ease of use and time taken is 3.96%. This suggests that the time it takes to perform a task is directly proportional to the perception of ease of the task.

The results show that the tasks were all of acceptable ease and the time taken to complete, the least satisfactory of all the tasks being the Image Capture task. Taking images is a common task for any mobile phone user who has a phone with a camera. All participants had mobile phones whose use they described as frequent. It is hence reasonable to assume that participants would find it easy to capture an image however this is not the case. The lack of a good response could be the result of the fact the camera button was so small, often users would not find it without being made aware that they could capture an image to add to their report. Secondly, due to the intent launching implementation of the camera as described in implementation, there was a brief activity switch to and from the camera application and the reporting application. This brief switch could have been the result for the low image capture time.

It must also be noted that although the gesture field was the most satisfactory in terms of both time and ease, based on the data it also had the most number of inapplicable responses, 50% to be exact. Therefore half the entire participant population could not comment on using the Emergency reporting gesture. This is due to the fact that participants struggled with getting the application to recognise their input. Of the 50% that got the gesture recognition to work, the average satisfaction was the highest of all the tasks (93.3%). These results suggest that the **Emergency Crime Report** gesture may need recalibration but is **very successful in the cases that it works.**

Based on percentage difference it can be seen that tasks are marginally quicker to perform than they are easy to perform when reporting a crime and taking an image. Tagging an image is slightly easier to perform that it was fast for a single participant; this outlier resulted in the slight disparity in the two on the graph. Ignoring the outlier suggests that image tagging is largely as easy to do as it is fast.

Graph 1 Scenario Questionnaire



The chart for the Scenario Section of the Questionnaire (5 scale step), standard deviation of 0.54 Ease and 0.38 Time

6.3.3 Main Questions

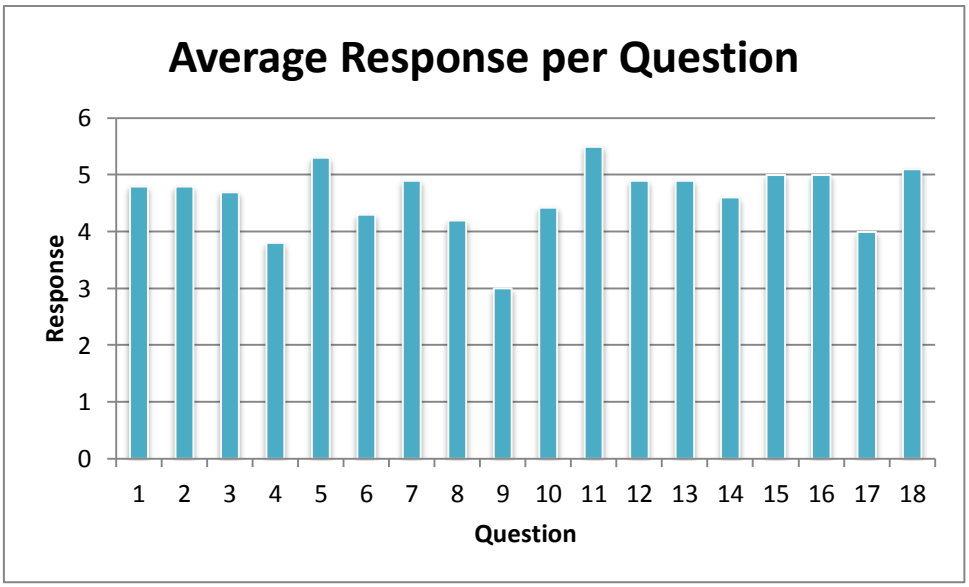
The graph below shows the average participant response for each question in the questionnaire. These questions were based on the IBM CSUQ [14] and they were designed to be given to a participant after completing a series on tasks. The questions measure the user satisfaction with system usability. It provides a more detailed and holistic view of the system and needed more time to complete than the previous questionnaire. This questionnaire was also a more finely scaled 7 steps as compared to the 5 steps in the questionnaire, making it more reliable.

All the questions receive at least a moderate response. Question 9 had the least positive response “The system gives error messages that clearly tell me how to fix problems”. The participation for this question was also the lowest at 60% (6 in 10 users), the remaining 4 could not comment on the question because they did not see any error messages. A common comment by the users was that the system lacks sufficient error messages.

The next lowest responses were 4 and 17 respectively the time it takes to perform a report and the expected functions of the system. While both are above average they are only just, suggesting that the interface is not as satisfactory as a whole. The result of 4 could also easily be a consequence of the device and OS as users unfamiliar to Android OS (60%) struggled slightly with manipulating the device. The result of 17 could be far more dynamic, based on user responses it was a mix of wanting more from the application such as error messages and wanting more features such as voice or video recording.

The highest positive responses were 11, 5, 18, 15 and 16 respectively. Users found the help that was available to be useful despite the fact that they found very little help. More work could be done to improve the help feature to add more content. In 5, users were happy that they could create a crime report satisfactorily using the application, it is important to note however that only 20% of users have ever reported a crime and can be seen as ‘experienced’ enough to recognise a satisfactory crime report. Questions 15, 16 and 18 all relate to the interface, layout of screens, how much the user likes the system and overall satisfaction respectively. This suggests that the user centred design process was effective in creating a system users could enjoy, found aesthetically pleasing and functional.

Graph 2 Main Questions



The chart of the Main Questions in the questionnaire (7 step scale), with standard deviation 0.60

6.3.4 Final Scoring

The advantage of the IBM CSUQ is that the questionnaire can be divided into scores, specific categories addressed by segments of the questionnaire, these categories are:

System Overall – the average of questions 1 to 18 give an overall score for the system

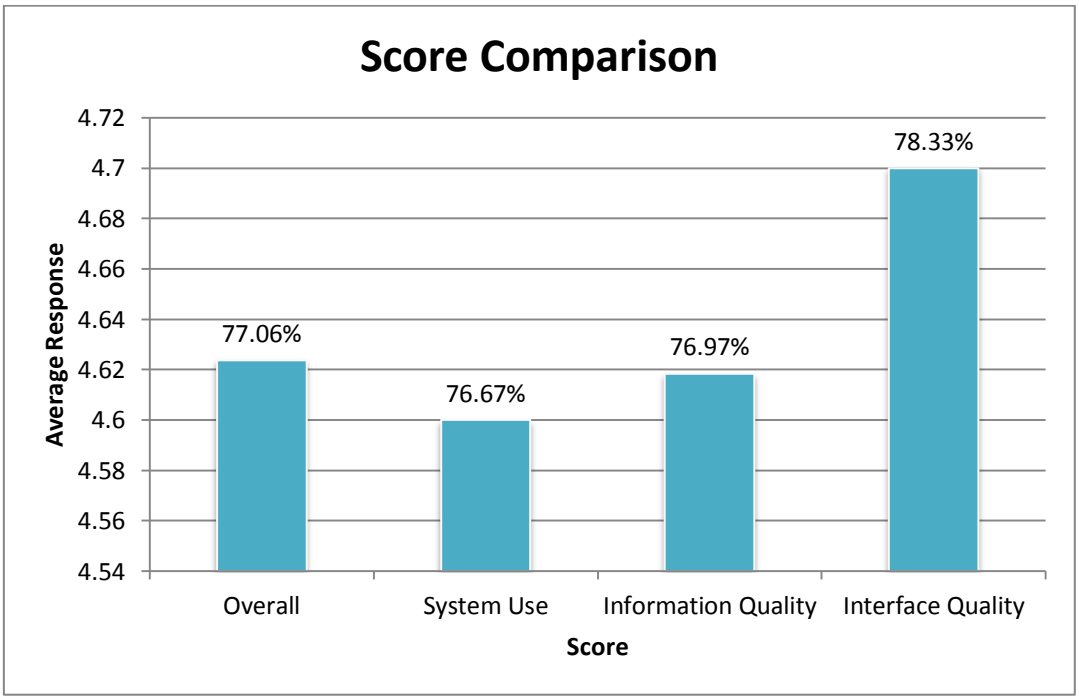
System Usefulness – the average of questions 1 to 8 give an overall score for how useful the participants find the system.

Information Quality – the average of questions 9 to 15 give an overall score on the information provided by the system

Interface Quality – the average of questions 16 to 18 give an overall score on the effectiveness of the interface.

These categories allow evaluation of each individual component of the system to gauge which aspects perform well or poorly on average. These results directly address the issue of whether a mobile device can be used to effectively send a crime report.

Table 3 Score Comparison



The chart of the questionnaire score breakdown, with standard deviation 0.05

It can be seen that overall the system was well received with an overall system score of 77.06%, this suggests the users found the system very usable with a standard deviation of 0.05 for contributing scores System Use, Information Quality and Interface Quality.

It is not surprising to find that the interface quality (78.33%), though marginally, is the most appreciated aspect of the system as the design process was centred on the users. These results bode very well for the feasibility of a mobile solution for crime reporting, they prove that users would find the system to be functional, System Usefulness 76.67%, and to present and report high quality information 76.97%.

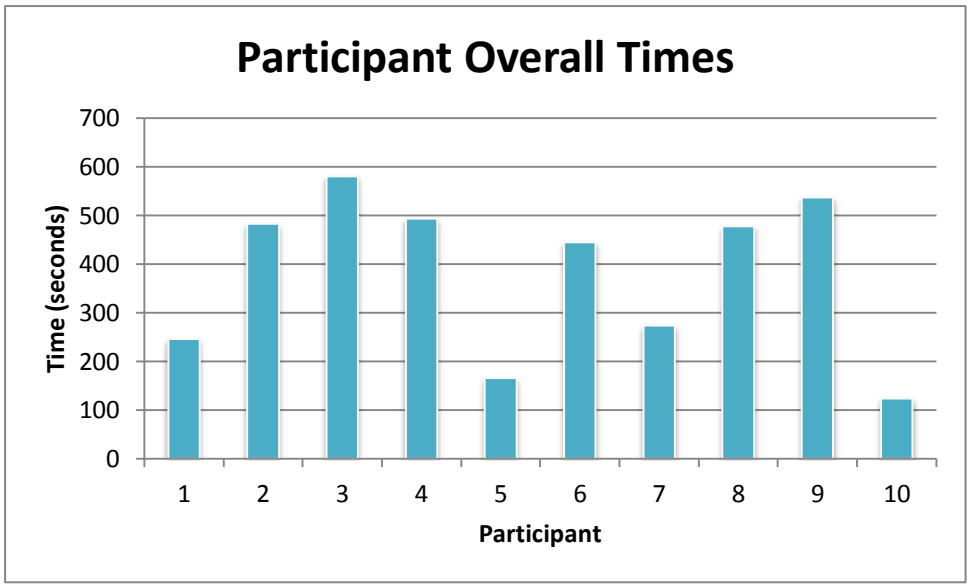
6.3.5 TIME ANALYSIS

The following section looks at the time taken to complete the tasks given in each session along with the perception of time participants gave in their responses. The overall participant times were measured by the application on each screen as described in implementation.

Of the entire set of recorded values of the study, participant overall times were the most varied with values between 124.55 to 580.3 seconds, and a standard deviation of 164.18. In this case an average time for reporting would serve very little use and perhaps the range would be more effective as a description of the time taken to complete a report. The reason for the large range is firstly largely due to the fact the participants were not reporting the same crime and secondly that the detail some participants put into the report was much more in depth than others, this was seen by observing the participants. Of course interaction also played a major role in the time taken to complete the task; however on average all participants were more than satisfied with the time they took.

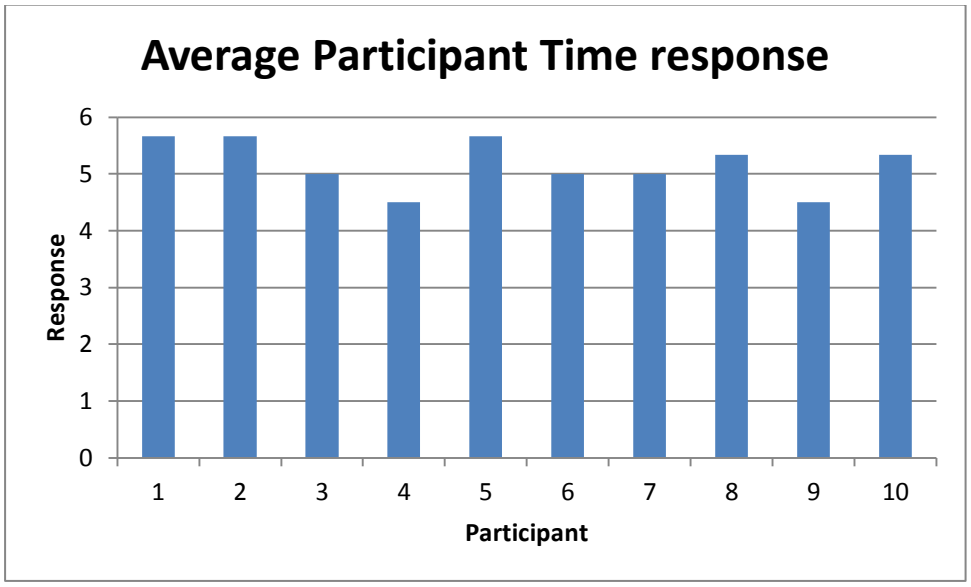
It must also be noted that in general users who reported their crimes the fastest also had the best impression of the amount of time it took. Participant 5 was the fastest time recorded and also the most satisfied with the time it took to report the crime, while participants 3, 9, and 4 were the slowest to record crimes and also the least satisfied with the time it took to complete the report. This suggests that user perception of the system depends on how users themselves reported crimes using the system. In general however participants were happy with the time it took, with a standard deviation of 0.44 and an average of 5.167

Table 4 Participant Overall Times



The chart of application user, with standard deviation 164.18

Table 5 Average participant Time Response



The chart of average participant time responses, with standard deviation 0.44

6.4 User Experiences and Feedback

In general all users expressed satisfaction with the system. The interface was for the most part intuitive and user did not need training to operate it. However these are the key errors and difficulties participants faced

Application Specific

1. Users struggled with some of the fields of the report and requested explanations of what values they could enter in them. This is a recurring issue identified from the first high fidelity prototype that was apparently not fully solved
2. The camera button was too small and unpronounced for participants to see.
3. User found the initial dialogue box that explained requirements to the user to be too small to notice.

Platform Specific

1. Users not accustomed to the Android OS had difficulties using the device. The largest difficulty was the location of the return button. Users often got confused when attempting to close the on screen keyboard due to low visibility of the return key on the phone (the key is only shown with a backlight which is often dimmed when typing). This was solvable by changing the settings on the device. Other difficulties included mistakenly closing the application and shortcut bars obscuring the application screen elements
2. Numerous pages of the application were not scrollable, due to the small number of fields on those pages. Some users however filled in long statements in these fields causing the elements to become obscured beyond screen space. This was a simple fix, making sure all screens were scrollable

6.5 CPS FEEDBACK

The researcher met with the investigations Manager, Steven Ganger to present the final solution and receive his feedback on the design. Mr Ganger was very knowledgeable in the process of crime reporting and had to say the following:

The application interface was simple and effective, however he cautioned that when using the Tags system in the Crime Details Page, that terminology such as misdemeanour were confusing to people as this was a legal term, a misdemeanour being a crime less severe than a felony.

He suggested a tip off mode more streamlined in the application as opposed to privacy settings. This would make it easy for people sending anonymous tip offs to simply do so and not have to worry about what level of privacy to set their application.

He otherwise found the application to be similar enough to a paper based report that it could facilitate a detailed crime report.

6.6 Functional Requirements Evaluation

Functional requirement	Result	Conclusion
The end user can create a standard crime report using a mobile device.	Using the Full Crime Report option users can create a full crime report	Success
The user can send the crime reports to CPS.	Although users could compile the report and click send, the report does not go to CPS	Failed
The user can use the functions of the mobile device to help create a more substantial report	The mobile platform is utilised to create the report. Functions supporting this activity include the camera, location data, phone memory and the touch surface	Success
The user can store and reuse their personal information for reports	Users can store their personal information by filling the required fields. This information is kept in the applications private memory	Success
The user can send emergency reports that require single input using prior data collection	Through use of the Emergency Crime Reporting System users can send crime reports using a simple touch gesture. The likelihood of the gesture misfiring was found to be acceptably low by users	Success
The user receives some response when a report is sent	Not only must a user confirm sending a report, the user receives a message of this. The report is also logged. Messages sent using the emergency report are confirmed using haptic feedback	Success
The system must enquire as to how much privacy the user would require in their reports	The system requests privacy settings. These are however not implemented to perform any task as yet	Success

6.7 Chapter Summary

This chapter covered the evaluation of the final implementations of both the Full Crime report and the Emergency Crime report. User results were brought forward, tabulated (Appendix B) and charted to find how well the system performed.

After analysis the results of participant testing were positive for the overall application, suggesting a mobile device may offer a viable crime reporting application. The approach used was effective in documenting the results. The major challenge faced was the small number of participants used in tests, which reduces the statistical value of analyses. Perhaps in future a broader testing can be performed to amend this.

From the analysis conclusions can be drawn about the effectiveness of the solution. The following chapter Conclusions and Future Work documents these.

7 REPORT CONCLUSION

In the introduction chapter the paper described the general problem of crime and how UCT affiliates currently go about reporting crime, at a single point, the CPS office on the campus grounds. The potential for an improved digital solution for crime reporting is one documented [13], in a work that justifies the digitisation in order to improve likelihood of increased crime reporting.

The aim of this project was also defined clearly in the introduction as a solution that could successfully answer the research questions posed initially. The solution would be a mobile application capable of sending crime reports both in an emergency or normal context.

To fully understand the available resources and techniques currently developed, a background study was carried out in the context of crime, crime reporting, usability and preserving privacy on mobile devices. Numerous examples of crime reporting applications were presented and analysed in order to extract useful information to put forward in the system.

In order to develop this solution an iterative user centric approach was used throughout the design and development process. This ensured that the solution being developed was centred on catering to the users while also allowing it to be revisited and refined gradually. Initially Stakeholders were used to gather the system requirements in a detailed list of user requirements. These user requirements would be used in the final evaluation to gauge application success. From the requirements analysis, design and development were carried out iteratively using a small pool of participants.

The final solution comprised of one solution developed separately as two components. The Full Crime report component dealt with creating a digital solution to the existing paper based model of crime reporting. The Emergency Crime Reporting component dealt with sending a crime report instantaneously without filling any information at the time of emergency. The split in functionality of the application was in order to focus the development of each individual component.

The final solution was evaluated against users, stakeholders, heuristics and user requirements. The overall response from all of the above was very positive. A digital crime reporting solution could be brought onto the mobile platform with reasonable success. Evaluation of data revealed that users needed hardly any aid in using the application which was deemed to have high overall usability and function in studies.

Users also found it was possible to send a crime report covertly with little more than a gesture. The testing carried out was limited by resources and the application could not be tested in context, instead the environment for crime reporting was simulated using images.

The system interface can be considered as successfully usable however the results of final evaluation suggest improvements of implementation and functionality could further enhance positive feedback.

7.1 Future Works

During the development of the solution numerous suggestions were made by the stakeholders for improvement of the final solution. Some of these included:

Mr Ganger suggested that the report allow users a streamlined option for creating crime tip offs. Crime tip offs would not contain the details and contact details of the complainant. As it was currently implemented the system would send complete report information. Potentially the amount of personal information could be adjusted relative to the user privacy setting. This method could send tip offs but is too involving for users. This feature would not be too difficult to implement and would add extra functionality to the application

Mr Ganger also suggested that user be able to add extra details to the crime report. This field would not have a correlating field in the report but would allow users to add any extra details they felt they could not have in the previous fields. He pointed out that often complainants have information that they cannot immediately categorise due to their nervous state after a traumatic event like a crime. This feature would provide a more sensible application, without experience such as that of Mr Ganger such an idea would have been completely overlooked.

Users suggested that the interface be able to record videos and audio or even perhaps more than a single image, as often times a scene could be taking place, that could be better documented by audio or a series of images. Although this would increase storage and communication costs, the feature could prove to be an effective crime reporting tool.

An idea that formed during the development and testing of the application was that perhaps instead of help being provided by text boxes, CPS officers could be recorded performing typical dialogue they give when aiding a complainant fill the report. Use of the microphone could also allow users to enter text into the application using speech. The combination of these two features could turn the application into a spoken language dialogue between user and application. This may result in a more intuitive system for crime reporting, that allows users to be more descriptive with their input.

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[31] https://www.crimeline.co.za/

[32] http://crimepush.com

[33] https://www.facebook.com/Unitehood

[34] http://developer.android.com/

[35] http://static.lukew.com/TouchGestureCards.pdf

Appendix A

7.2 QUESTIONNAIRE

Instructions

This questionnaire, which starts on the following page, gives you an opportunity to tell us your reactions to the system you used.

Your responses will help us understand what aspects of the system you are particularly concerned about and the aspects that satisfy you.

To as great a degree as possible, think about all the tasks that you have done with the system while you answer these questions.

Please read each statement and indicate how strongly you agree or disagree with the statement by circling a number on the scale. If a statement does not apply to you, circle N/A.

Please write comments to elaborate on your answers.

Consent

If you take part in this study you accept that the researchers will uphold your privacy and confidentiality and you will not be personally identifiable. You are not be obligated to take this test and can leave at any stage during the test.

I _____ agree to take part in this questionnaire. I accept that my responses will be used purely for educational research. I have read this consent form and agree to the terms.

Signed

_____

Date

_____

Cry-Help user Interface Questionnaire

Gender	Age

Pre-test Questions

Are you student?

Have you ever reported a crime before?

Do you possess a cellular phone?

How often do you use your phone?

How familiar are you with the Android OS?

Scenario Questions

For each of the items below, please circle the response that best describes your experience with the app for this scenario.

1.

Sending a Full Crime Report

Time to Complete Task

ACCEPTABLE AS IS 1 2 3 4 5 NEEDS A LOT OF IMPROVEMENT

Ease of Performing Tasks

ACCEPTABLE AS IS 1 2 3 4 5 NEEDS A LOT OF IMPROVEMENT

2.

Taking an image of a scene

Time to Complete Task

ACCEPTABLE AS IS 1 2 3 4 5 NEEDS A LOT OF IMPROVEMENT

Ease of Performing Tasks

ACCEPTABLE AS IS 1 2 3 4 5 NEEDS A LOT OF IMPROVEMENT

3.

Tagging the image

Time to Complete Task

ACCEPTABLE AS IS 1 2 3 4 5 NEEDS A LOT OF IMPROVEMENT

Ease of Performing Tasks

ACCEPTABLE AS IS 1 2 3 4 5 NEEDS A LOT OF IMPROVEMENT

4.

Inputting gesture

Time to Complete Task

ACCEPTABLE AS IS 1 2 3 4 5 NEEDS A LOT OF IMPROVEMENT

Ease of Performing Tasks

ACCEPTABLE AS IS 1 2 3 4 5 NEEDS A LOT OF IMPROVEMENT

Questions

For each of the items below, please circle the response that best describes your experience with the app for this scenario.

1.

Overall, I am satisfied with how easy it is to use this system.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

2.

It is simple to use this system.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

3.

I can effectively complete a crime report using this system.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

4.

I am able to report a crime quickly using this system.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

5.

I am able to efficiently perform a crime report using this system.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

6.

I feel comfortable using this system.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

7.

It was easy to learn to use this system.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

8.

I believe I became productive quickly using this system.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

9.

The system gives error messages that clearly tell me how to fix problems.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

10.

Whenever I make a mistake using the system, I recover easily and quickly.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

11.

The information (such help, on-screen messages and other documentation) provided with this system is clear.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

12.

It is easy to find the information I need.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

13.

The information provided with the system is easy to understand.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

14.

The information is effective in helping me report a crime.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

15.

The organization of information on the system screens is clear.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

16.

I like using the interface of this system.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

17.

This system has all the functions and capabilities I expect it to have.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

18.

Overall, I am satisfied with this system.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

Data for Scenario Questions in Questionnaire

		Ease of Use				Time			
	Task	1	2	3	4	1	2	3	4
Participant									
1		2	1	0	1	2	1	0	1
2		2	2	1	0	1	2	1	0
3		1	0	2	0	2	0	2	0
4		2	5	1	2	2	5	1	2
5		3	2	1	0	2	1	1	0
6		2	3	2	1	2	3	2	1
7		2	3	1	2	2	2	2	2
8		3	2	1	0	2	2	1	0
9		2	4	4	1	2	3	4	1
10		1	2	2	0	1	2	2	0
Average		2	2.666666667	1.666666667	1.4	1.8	2.333333	1.777778	1.4

Data for Main Questions in Questionnaire

					Assistance	Assistance							
	Participant	1	2	3	4	5	6	7	8	9	10	Average	Standard Deviation
Question													
1		2	2	1	3	3	1	2	3	2	3	2.2	0.788810638
2		3	2	1	2	3	3	3	2	1	2	2.2	0.788810638
3		2	2	2	2	3	2	2	3	2	3	2.3	0.483045892
4		4	3	4	2	3	3	4	2	4	3	3.2	0.788810638
5		2	1	2	2	2	1	1	2	2	2	1.7	0.483045892
6		3	2	3	2	4	4	3	3	2	1	2.7	0.948683298
7		3	2	2	1	3	2	1	2	2	3	2.1	0.737864787
8		4	1	4	2	2	2	3	3	4	3	2.8	1.032795559
9		4	0	4	4	0	0	0	4	4	4	4	0
10		4	4	2	2	0	2	2	0	2	0	2.571428571	0.975900073
11		2	0	2	1	2	2	1	2	2	1	1.5	0.5
12		2	2	4	1	2	2	2	3	1	2	2.1	0.875595036
13		2	2	2	2	2	3	3	1	2	2	2.1	0.567646212
14		2	1	4	1	3	2	3	4	2	2	2.4	1.0749677
15		1	2	2	2	3	3	2	1	1	3	2	0.816496581
16		1	1	4	2	2	4	1	1	2	2	2	1.154700538
17		2	1	5	3	3	4	4	2	3	3	3	1.154700538
18		1	2	3	2	2	3	2	2	1	1	1.9	0.737864787

Table of recorded user times

Participant	Overall Time (milleseconds)		
1	245934		
2	482914		
3	580443		
4	494243		
5	165948		
6	445789		
7	274220		
8	477980		
9	537164		
10	124550		
			382919
	Average		164181
	Standard Deviation		

h

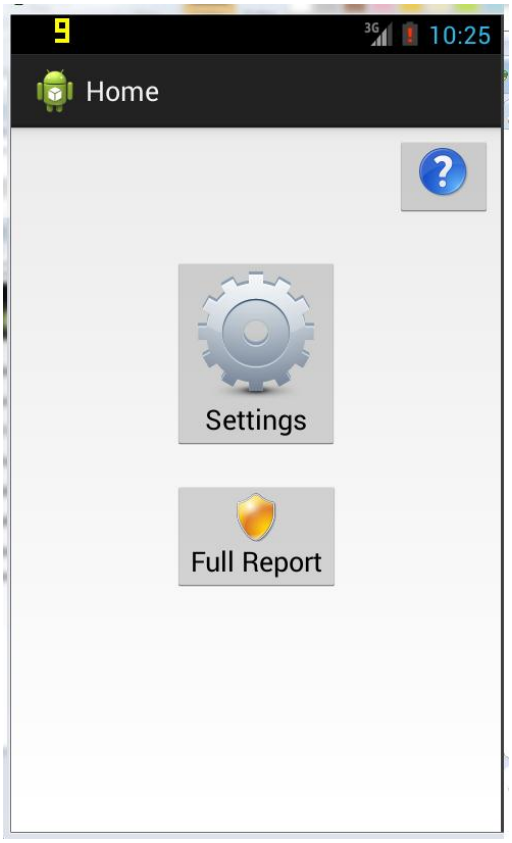
Nielsons 10 heuristics

1. Visibility of system status
2. Match between system and real world
3. User control and freedom
4. Consistency and standards
5. Error prevention
6. Recognition rather than recall
7. Flexibility and efficiency of use
8. Aesthetic and minimalistic design
9. Help user s recognizes, diagnose and recover from errors
10. Help and documentation

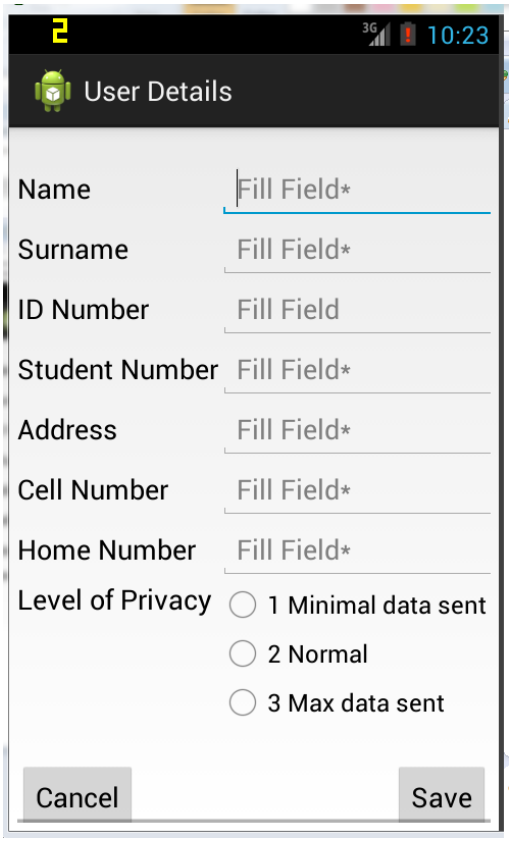
Appendix B

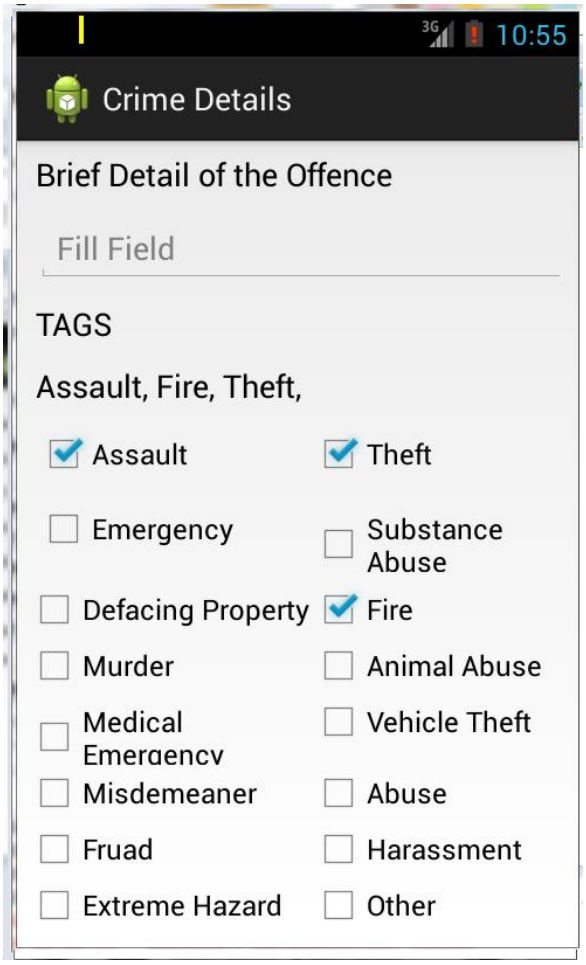
Final Interface Screenshots

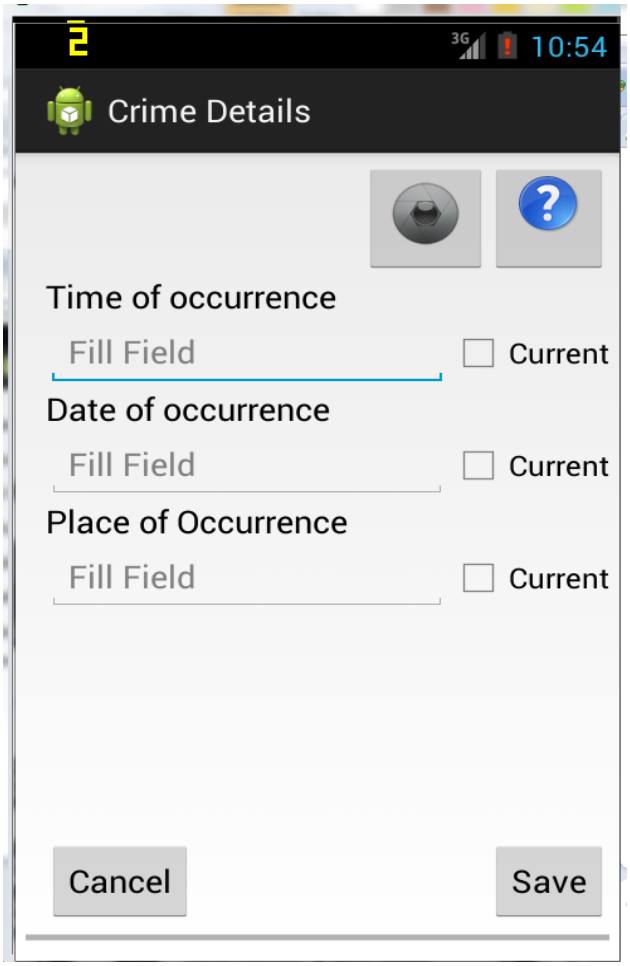
Application Main Screen



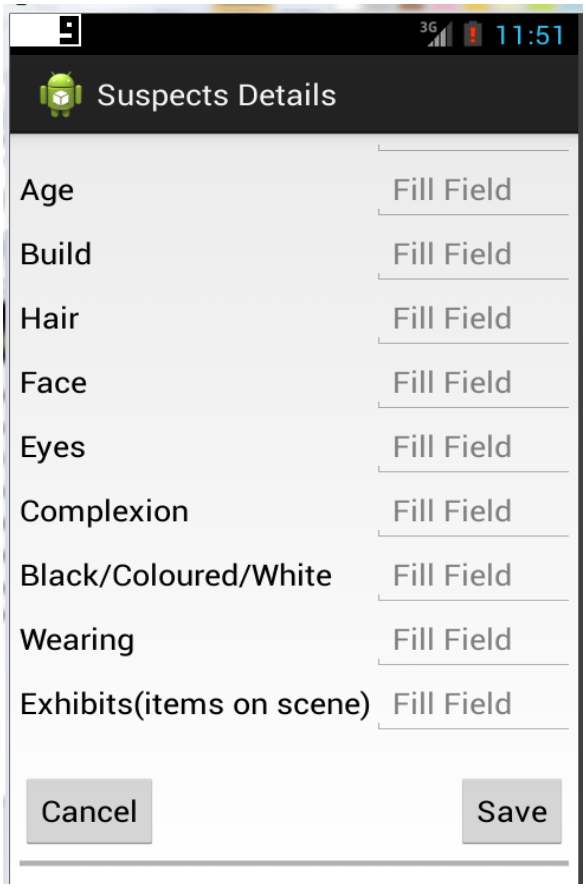
User Details Screen

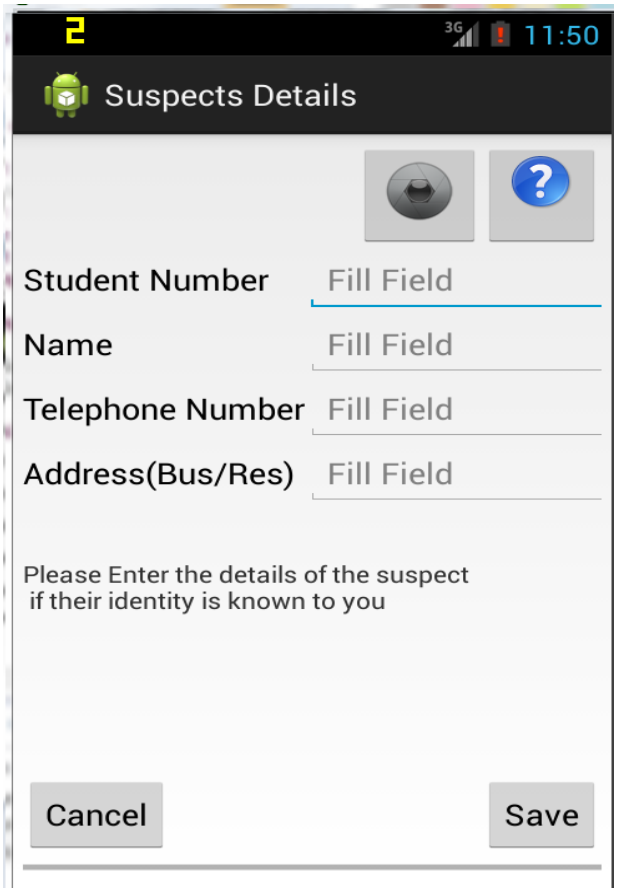






Crime details and Suspect details Screens





Sample Report Output XML file


```
<?xml version="1.0" encoding="UTF-8"?>
- <UserReport>
  - <User>
      <Name> Anonymous</Name>
      <Surname> </Surname>
      <ID_Number> </ID_Number>
      <Student_Number> </Student_Number>
      <Address> </Address>
      <Cell_Number> </Cell_Number>
      <Home_Number> </Home_Number>
      <Level_of_Privacy> 1</Level_of_Privacy>
    </User>
  - <CrimeData>
      <Time_of_occurrence> </Time_of_occurrence>
      <Date_of_occurrence> </Date_of_occurrence>
      <Place_of_Occurrence> </Place_of_Occurrence>
    </CrimeData>
  - <CrimeDetail>
      <Brief_Detail_of_the_Offence> </Brief_Detail_of_the_Offence>
      <TAGS> </TAGS>
    </CrimeDetail>
  - <SuspectData>
      <Student_Number> </Student_Number>
      <Name> </Name>
      <Telephone_Number> </Telephone_Number>
      <Address_Bus_Res_> </Address_Bus_Res_>
    </SuspectData>
  - <SuspectDetail>
      <Male_Female> </Male_Female>
      <Height> </Height>
      <Weight> </Weight>
      <Age> </Age>
      <Build> </Build>
      <Hair> </Hair>
      <Face> </Face>
      <Eyes> </Eyes>
      <Complexion> </Complexion>
      <Black_Coloured_White> </Black_Coloured_White>
      <Wearing> </Wearing>
      <Exhibits_items_on_scene_> </Exhibits_items_on_scene_>
    </SuspectDetail>
</UserReport>
```

Crime images

The following pages contain the images used in testing for participants to visual the crime. Participants were warned of the graphic violence depicted in the images.

Cast

Female Victim Nina Otsweleng

Masked Assailant Thabo Ndlovu

Drug Abuser Thabo Ndlovu

Camera Dorothy Mhlanga

No humans or animals were harmed during the production of the footage

e

f

g

h

Sample paper prototype Images