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WALKSAFE:

COLLEGE CAMPUS SAFETY APP INCORPORATING PEBBLE SMARTWATCH

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by

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ABSTRACT

I present a campus security app incorporating wearable technology like Pebble smartwatch. The app, WalkSafe, is a location-based app that notifies users of emergencies around them. The app is compared to The Pennsylvania State University's emergency notification system - PSUAlert, which provides time-based alerts. I identified weakness of the existing PSUAlert system and addressed them by introducing a location-based emergency notification system with the records of past incidents along with the type of emergency with respect to the user's location. I used a multi-method approach to evaluate WalkSafe and used the PSUAlert system as a baseline. I assessed both the systems with 9 participants by notifying the participants of the fake emergencies and asking them to use both systems to understand details regarding the emergency and its location. The participants were asked to complete pre- and post-surveys that question ed them about the metrics for evaluating both the systems. Results from content analysis and paired T-test indicated that metrics for evaluating both the system namely: user's perceived convenience, perceived security, willingness to use and willingness to share were significantly higher when using WalkSafe. Participants were asked to provide recommendations that would further improve WalkSafe. Based on the recommendations of the participants, features like 911 calling, particular incident on/off button, location of nearest emergency poles phones in the vicinity of the user, etc. were incorporated. The mockups and screenshots of such features have also been presented.

TABLE OF CONTENTS

List of Figures v

List of Tables vi

Acknowledgements vii

Chapter 1 Introduction 1

Background & Motivation 2
Research Scope 4

Chapter 2 Literature review 7

Chapter 3 The WalkSafe App 11

Chapter 4 Methodology & User Study 17

Participants 17
Measures 19

Chapter 5 Result & Analysis 21

Chapter 6 Discussion 24

Measures 24
Limitations 25

Chapter 7 Recommended Features 27

Chapter 8 Conclusion and Future Work 32

Summary 32
Conclusion 33
Future Work 33

References 35

Appendix A Personas and Storyboards 38

Appendix B Pre-Surveys and Post-Surverys 41

Appendix C Interview Guidelines 44

LIST OF FIGURES

Figure 1-1. Breakdown of violent crimes on and off campus. 1

Figure 3-1. The application map of the app 12

Figure 3-2. Persona for Candice: A graduate student at Penn State 13

Figure 3-3. Storyboard and use case scenario for Candice justifying the use of the app 13

Figure 3-4. Notification sent to Pebble and Cellphone main screen 14

Figure 3-5. High fidelity prototypes; Left: Landing page of app showing the emergency (red dot) with respect to user's position (blue dot); Right: Page showing past incidents (green dots) 14

Figure 3-6. WalkSafe App: (a) Incident background alert, (b) Incident alert, (c) Initial View, (d) Previous incidents. 14

Figure 7-1. Notification on the top of the screen shot 1 shows app is running in the background and pressing the home button directs a call to 911 as shown in screen shot mockup 2 28

Figure 7-2. Incident on/off mockup 30

Figure 7-3. Emergency pole phone location nearest to the user 31

LIST OF TABLES

Table 7-1. The Table of Campus Crimes as reported in 2014 29

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Chapter 1

Introduction

Schools and college campuses—where young people spend part or all of their day—are often assumed to be safe places [11]. “The college is no longer perceived as a place with special, erudite atmosphere protected from worldly happenings” [10]. This can be observed in the rise of campus crime that has been steadily on the rise. In 2010, 92,695 crimes are reported to college and university campus police in the United States. Of these reported crimes, 97 percent were property crimes, and 3 percent were violent crimes [11]. The breakdown of violent crimes on and off campus is given below [11]:

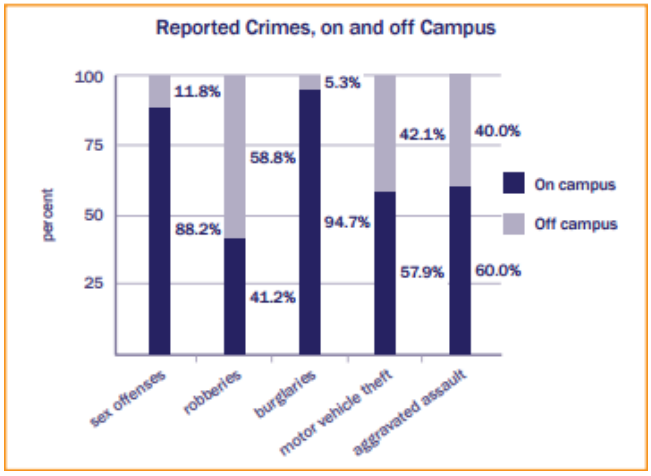

Figure 1-1. Breakdown of violent crimes on and off campus.

The steady rise of crime on campus has generated a lot of media attention and has prompted researchers to study the motivation of such crimes and the perception of fear and safety among the students. Legislators showed concern about the campus safety when they issued Crime Awareness and Campus Security Act of 1990 [7]. The legislation makes the colleges and universities responsible for their annual prevalence and incidence of crime and also provides

federal funds to the institutions to assist in the required reporting of crimes such as personal and property crime, as well as arrests for certain illegal activities such as liquor law violations, drug use/abuse violations. This legislation educates students, parents, staff and faculty about the crime incidents on campus and provide steps to address crime problems on college campuses [7].

High campus crime rates may discourage prospective students from attending certain universities and may similarly dissuade parents from paying tuition to send their children to institutions that could be regarded as unsafe [5]. Campus crime can also be seen as an issue that destabilizes the core principles of higher education itself, and "criminal activities on campus not only undermine the quality of the learning environment, but also reduce the positive activities of people associated with the campus [19].

Background & Motivation

Campus crime is a serious issue of concern for current university students, parents of prospective students, campus law enforcements personnel, and the campus community as a whole [7]. Crimes and fear of crimes have serious threats to the quality of life on campus [5]. Campuses have characteristics that make them attractive target for criminals and that generate fear of crime [5]. They are places of many opportunities, a pool of motivated offenders, and a lack of guardianship that can place people at risk [5]. The diversity of students, their transient tenure, and their belongings give potential offenders many opportunities [5]. The surrounding neighborhoods tend to have the physical and social disorders that would yield a pool of motivated offenders. Campuses tend to have easy access, free movement at all hours, and the diversity that allows offenders to remain unnoticed, all of which contribute to a lack of guardianship [5].

Fox and Hellman (1985) and McPheters (1978) were among the first scholars to empirically examine campus crime issues and explore associated with its occurrence [7]. Relying on data

from 75 universities, McPheters found that the proportion of students living in dormitories and the proximity of the campus to urban areas with high unemployment rates were strong predictors of campus crime [9]. Similarly, Fox and Hellman (1985) expanded the scope of their study to include 200 universities, and found that campus size and scholastic quality were also significantly related to higher rates of campus crime [6].

More recent campus crime research has focused on other campus characteristics that were not examined previously. Morriss found significant relationships between the intensity of deterrents, level of public transportation, and campus crime rates [10]. Consistent with the two aforementioned studies (Fox and Hellman 1985; McPheters 1978), location (i.e., urban versus rural) was not found to be a significant predictor of campus crime rates [7, 6, 9]. Morriss suggested that the lack of an observed relationship between campus location and crime rates provides an indication that "no higher education institution can consider itself immune to crime" [10]. Comprehensive review of the campus crime literature points out that rates of violence against women on campus may actually be greater than off campus rates. They also note that alcohol and drugs are connected to many of the violent and sex-related crimes that occur on campus [7]. Additionally, Sloan et al. (2000:7) argue that students whose lifestyles are characterized by "partying" experience an increased risk of victimization, which points to the idea that there are "hot spots" and "hot times" for campus crime to occur [7].

Keeping the campus safety of college community in mind and to address this challenge, I present a campus safety app, WalkSafe, integrating Pebble smartwatch (a wearable smartwatch) that helps the college community by giving them locations of the campus crimes. The application (app), WalkSafe, is a new improved proactive version of the PSUAlert, Penn State University's email, call and text alert system in case of campus wide threat. WalkSafe, previously called Campus Alert, uses the user's GPS location to track the crimes that are reported on the campus and provide a geographical view of the incident with respect to the user's location. The incident

also consists of the nature of the incident such as robbery, sexual assault, accident, etc. along with the time and date of the incident when reported to the user. This gives user a compact yet pertinent information regarding their safety and gives them the power to prioritize their safety if need be.

The app also keeps track of the previous incidents that have already been reported to the campus/local police and shows the incidents to the user on the map. In addition to this, the app includes the feature of calling 911 by pressing a designated combination of button on the cell-phone. Based on the crimes that have been reported in the Annual Security and Fire Safety Report (2014), a list of crimes have been included whose notification can be turned on/off depending on the user's priority. The app also provides the nearest location of the emergency poles phones in the vicinity of the user so that the user can run and press the help signal on the pole to attract attention and safeguard their safety.

Research Scope

In this paper we strive to investigate the following research questions:

RQ: *In comparison with the PSU Alert system, Alert will provide users a higher level of perceived sense of security.*

RQ: *In comparison with the PSU Alert system, Alert will provide users a higher level of perceived convenience.*

RQ: *In comparison with the PSU Alert system, Alert will provide users a higher level of willingness to use.*

RQ: *In comparison with the PSU Alert system, Alert will provide users a higher level of willingness to share.*

This paper addresses the limitation of the PSUAlert and proposes WalkSafe as its alternative to make the campus more safe and harmless for its community. More specifically this paper provides the following contribution:

- I identified situations that lead PSUAlert to not perform upto the user standards of safety and propose solutions with respect to these problems that is solved by my app:
    - *Location based alert system:* I define a location based incident alert system that gives user the proximity of the incident from his/her location along with incident's type, time and date.
    - *List of previous incidents:* My app gives a compact view of all the previous incidents around the user for a designated period of time. All the previous incidents list the incident type, time and date.
    - *Inclusion of Pebble smartwatch:* My system incorporates Pebble smartwatch and explores the use of wearable technology in situations other than commercial.
    - *911 Calling:* User can call 911 in case of emergencies if the app is running in the background by pressing designated button on cell-phone. This feature allows police to track the location of the user if the user is unable to talk to control room on the other end.
    - *Incident on/off icon:* A list of incidents, based on the incident crimes reported in Annual Security and Fire Safety Report, 2014, have been included. The notifications from these incidents can be turned on/off depending on the user's priorities, so that user can receive notifications only from the incidents that he/she considers harmful or threatening.
    - *Location of on-campus emergency poles phones:* The location of the emergency poles phones nearest to the user will also be provided on the app so that the user can run to

pole and press the help signal to draw attention of the people and police in the vicinity, to the threat they are under or incident/crime happening nearby them.

- I conducted usability testing to compare PSUAlert and WalkSafe. The working prototype used in the user testing consisted of only the first three features mentioned above. The rest of the features where incorporated into the app based on the feedback, suggestions and recommendations given by the participants of the testing. The testing showed that WalkSafe is preferred by the participants more than PSUAlert for the information it conveyed.

Finally, I showed the future work that can be done to make WalkSafe more reliable and safe. With the collaboration with local police, the app can be made applicable to any county, city and state and can serve to visitors who need to know the area so that they can judge for their security and safety. To the best of the my knowledge, no such campus safety app has been developed so far incorporating a wearable technology to safeguard the students, faculty, staff and the college community in general.

Chapter 2

Literature review

To combat the rise in violence reported on university campus, U.S. Department of Education has developed **The Handbook for Campus Safety and Security Reporting handbook.** This handbook presents step-by-step procedures, examples, and references for higher education institutions to follow in meeting the campus safety and security requirements of the Higher Education Act of 1965, as amended [3]. According to this handbook, the college has to notify the campus community upon confirmation of a significant emergency or dangerous situation involving an immediate threat to the health or safety of students or employees occurring on the campus [3]. Examples of significant emergencies or dangerous situations include terrorist incident, approaching tornado, hurricane or other extreme weather conditions, outbreak of meningitis, norovirus or other serious illness among others and also power outage, snow closure, string of larcenies if the college has a policy that requires issuing an emergency alert for such events [3]. The handbook also mentions the mode of communication like a public address system, text messaging, e-mail messaging, electronic signboards, emergency phone lines, phone trees, bulletins posted on building entrances and exits, etc. to notify college community of the emergency and encourages the college institutions to use overlapping means of communication to deliver the notification [3]. Some colleges like East Central University offer safety seminars along with programs on rape, theft, self-defense and safety precautions several times a year to college community [18]. Annually, Penn State publishes a report entitled 'Policies, Safety, &: U." The report contains crime statistics from the previous three years that were reported to local police agencies, or to campus security authorities that occurred at the following locations:

1. On-campus.

2. In certain off-campus buildings, owned, or controlled by Penn State.

3. Public property within, or immediately adjacent to and accessible from the campus.

The statistics in the report reflect the number of criminal incidents reported to the various authorities. The report also includes institutional policies concerning alcohol and drug use, crime prevention, the reporting of crimes, sexual assault, and other matters.

This demonstrates the advent of technology in our day-to-day life and especially during emergency situations. Use of mobile technology to notify and fight the campus crimes has increased in the passing years. Safe lines have been developed for students to address serious problems in their life like bullying to seek relief and counseling from destructive behaviors [16].

Social media has pervaded a vast part of people's lives and has been widely adopted for assisting in the efforts of emergency response and recovery. But it has been underutilized for emergency planning purposes. One study found that the current emergency planning and reporting, in local areas, usually takes a top-down approach that includes local authorities. The paper identified the use of social media such as Twitter and Facebook to inform the local community about the emergencies nearby and inform other community members of the same [14]. The application, Community Incident Report (CIR), identified and developed in this paper is also scalable and can assist in emergency planning of recurring and cyclic events.

Even though social websites like Twitter and Facebook can be used for informing and carrying out emergency response and planning, research has also shown there are overabundant, noisy, inaccurate, and unprofessional information that is rather misleading [13]. This can present a serious challenge for local community members to identify information that is relevant to local incident [13]. To battle this scenario, Shih et al proposed a Community Poll app called Community Incident Chatter that aggregates the information reported by formal news agencies and social media surrounding the local incidents [13]. Results showed that the participants can

have better understanding of the local incident happening around them and can actively interact and participate in helping the local community [13].

Tan, Xia, Joshi and Huang designed a paper prototype of mobile app to increase campus awareness for the college student [17]. They found that the current reporting methods are still cumbersome and include no enhancing social aspect. They conducted a preliminary data analysis of a university's safety report log and the analysis allowed them to detect relevant trends in reporting behavior, specifically pertaining to where, when, and how soon the community would report safety incidents. These findings motivated a design of a mobile app which aimed to enable the spread of crowdsourced public safety information. The app also allowed for immediate mass sharing of a safety incident report: as well as the opportunity for witness reporting [17]. But the app still lacks the notification that the user can provide to police or first responders in general that can come to the help the user.

The use of mobile/wearable technology, in sense of safety, different from aspect of campus crime has been explored in developing Automatic Fall Detection, or Automated Fall Detection for elderly [3]. These systems feature sensors (multiple accelerometers and processors) that can detect between normal activity, and an actual fall and can be worn on waist depending on the waist [1]. Wearable technology has also been used in clothing [8], in the field of medicine for physical medicine and rehabilitation [2], even for fitness as seen with the introduction of Jawbone, Fitbit, Nike Fuelband [12]. It has been estimated that the global wearables market will grow at a compound annual rate of 35% over the next five years and hit 148 million units shipped in 2019 [4]. Wearable smartwatch is introduced since 80's but it gained popularity in 2013 after Pebble, Samsung, Sony, Qualcomm and now Apple and Google introduced smartwatch to market.

As seen from the work that has been done for reducing campus crimes and notifying the college community of immediate emergency situations along with leveraging the technology that

has been utilized for other local and national emergency purposes, I developed an app incorporating wearable technology like Pebble smartwatch to address this challenge and make the college campus safer.

Chapter 3

The WalkSafe App

The WalkSafe app is designed for the campus safety of the college community of The Pennsylvania State University. WalkSafe notifies the user of the emergencies/incidents happening around them based on the updates done to the University Police database. The past incidents are also reported based on the incidents previously reported to the University Police database. The current prototype of the app supports the incidents reported two days prior for the college community and visitors to check and access their safety.

The information architecture of the application is discussed below (refer figure 3-1). The information architecture refers to the organization of content and navigational flow of the application. An application map is presented to visualize the information architecture. As illustrated in the application map, the functions of the application are either Pebble-based or mobile-application based. When opening the application on a mobile device, users first enter a home page, which is a map view of current incidents. They will see their current location as a blue dot and reported local emergencies as red pinpoints. In addition, notifications will pop up if the user is close to an ongoing emergency. There are two landing pages that allow users to navigate from the home page: the past incident map and the text-to-report page. On the past incident map, pinpoints indicates users past incident that occurred nearby. On the text-to-report page, users report an incident to the emergency service via text. They can also take pictures or access to their photo albums if they want attach pictures of an ongoing incident. When the application is closed, push-up notifications will be sent once the users are close to a live incident. If users have a Pebble watch, they will also receive notifications from the application. To report an emergency, users can push a combination of buttons and make a phone call to the emergency service.

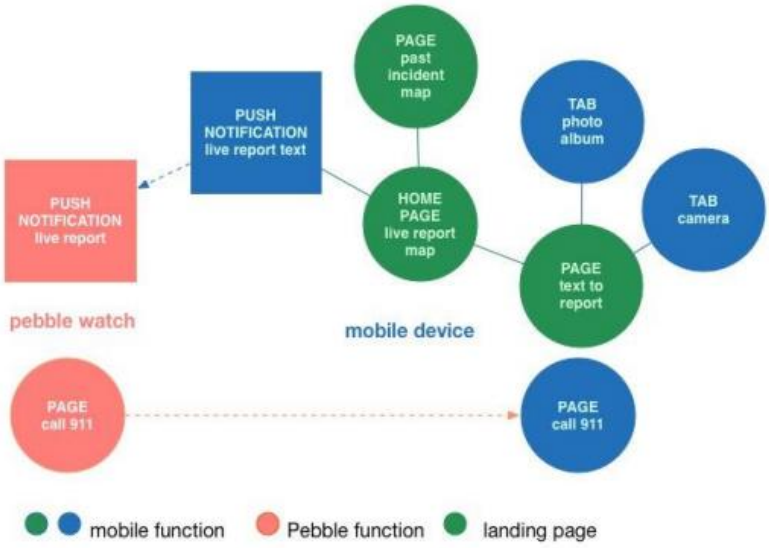

Figure 3-1. The application map of the app

The hypotheses, mentioned in the introduction, led to development of the information architecture of the app which in turn took shape of the app, WalkSafe. The purpose of the personas and storyboard was to provide a basis for the development of the app and its integration with wearable technology like Pebble smartwatch and its specific use case scenarios. The personas identified 4 main users of the app at The Pennsylvania State University: undergraduate student/s, graduate student/s, faculty and staff. Example of one such persona and the corresponding storyboard is given in figures 3-2 and 3-3 respectively (other personas and their corresponding storyboards are mentioned in Appendix A):

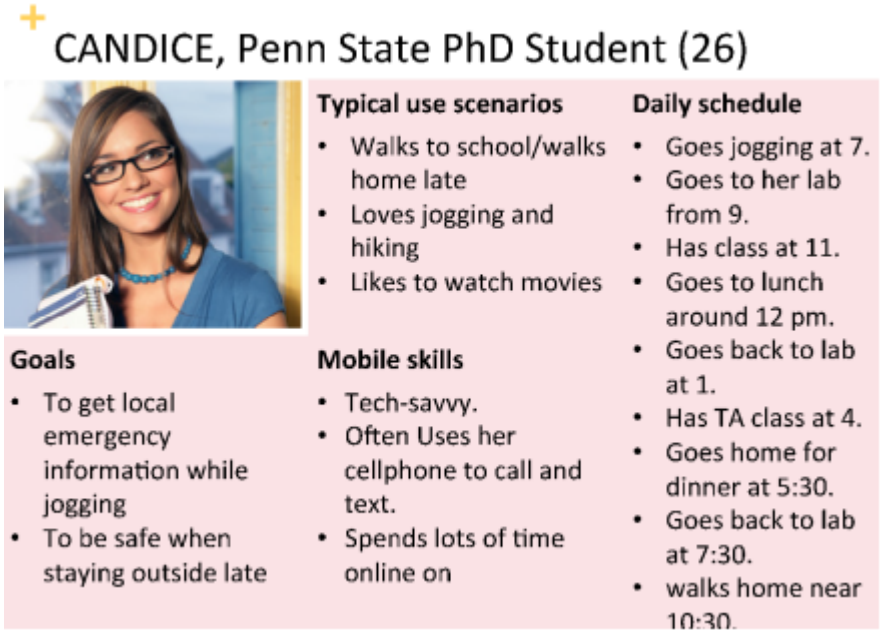

Figure 3-2. Persona for Candice: A graduate student at Penn State

Figure 3-3. Storyboard and use case scenario for Candice justifying the use of the app

Low-fidelity mock-ups were developed using paper prototypes. High-fidelity mockups were developed in Balsamiq (figure 3-4 and figure 3-5). The working prototype was developed on iOS platform. The app is coded for iOS platform and is currently available on iOS.

Figure 3-4. Notification sent to Pebble and Cellphone main screen

Figure 3-5. High fidelity prototypes; Left: Landing page of app showing the emergency (red dot) with respect to user's position (blue dot); Right: Page showing past incidents (green dots)

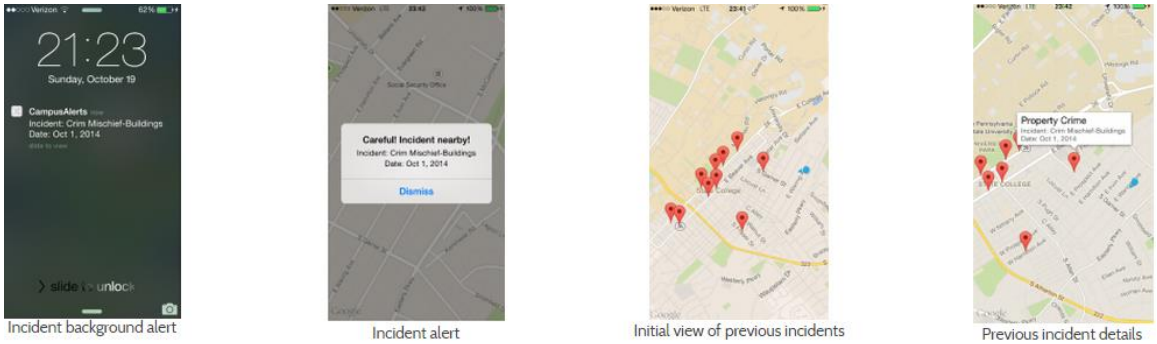

Figure 3-6. WalkSafe App: (a) Incident background alert, (b) Incident alert, (c) Initial View, (d) Previous incidents.

When the WalkSafe app initially loads (refer figure 3-6c), the user's location is calculated. Once found, a map view is displayed which shows the user's location as a blue marker. Also plotted on the map are locally reported police incidents, denoted by red markers and plotted according to their own location data (figure 3-6d). The user is able to interact with the map by zooming in and out, panning on the map, and selecting individual incidents. When the user moves location, the user's location marker is updated to reflect this change.

If a user taps on the screen where an incident marker is located, a text box pops up above the marker. This text box gives the user some details related to the incident, including the general category, the specific incident recorded, and the date in which it occurred. This is shown in figure 3-6a.

As stated before, as a user moves their location information is updated. Every time their location information updates the distance between the user's location and all reported incidents is calculated. If this distance falls within the threshold for danger set in WalkSafe, the user is presented with an alert of the incident that the user is close to. Once a user dismisses this alert, they will not be alerted of it again (refer figure 3-6b).

In summary, I tried to design an app for college community safety that can provide the necessary and pertinent information without compromising user's safety. WalkSafe strives to provide the location of the emergencies/incidents to the depending on user's location along with the type of the incident, its date and time. It also provides the details of the past incidents depending on the user's location so that user can prioritize their safety. The salient feature of the WalkSafe is that it gives the user all the relevant details about the incident with respect to their position on the map which makes it easier for the user to understand the danger surrounding them.

From the user study, I specifically strived to understand which system (PSUAlert or WalkSafe) do the college students, staff and faculty prefer based on their perceived sense of security, perceived sense of convenience, willingness to use and willingness to share the app.

The participants were also asked to recommend and/or suggest the features that would help them feel more comfortable using the app. Some features that were suggested and incorporated in the future design of the app includes: calling 911 with the help of designated combination of button on the cell-phone, incident on/off icon which helps the user switch off or on particular types of crimes reported which are included in the app so that they can receive the notifications of the incidents that they consider is of value to them, location of the nearest emergency pole on campus which can help the user draw attention to the crime/incident happening in the vicinity. The mockups of the features suggested above were created but were not tested.

Chapter 4

Methodology & User Study

Participants

To better understand which system the college community prefers and how they will perceive both the systems in terms of security, convenience, willingness to use and willingness to share, I designed and conducted a user study with 9 college members consisting of students, staff and faculty The Pennsylvania State University with approximately 45,000 students, and a total of 1,000 faculty and staff. All the participants were recruited through snowball sampling. The participants were 3 males and 6 females. The average age was 32 years ranging from 20 - 63 years.

The participants were first given a consent form to sign before the test was administered. The consent form included the name of the investigators and the summary of the project. It also mentioned that the participant will be audio recorded for future reference but their identity will be kept private. The first section of the test was a pre-experiment survey. Following the survey was a controlled experiment. Then, a post-experiment survey is conducted. Last, the participants were interviewed. Post-surveys employed 7-point Likert scale questions (where 1= *Strongly disagree* and 7 = *Strongly agree*). Open-ended questions regarding their choices in the post-survey were asked in the interviews where the participants presented their views about each system in terms of security, convenience, willingness to use and willingness to share both systems. The details of each test section of the study are discussed in the following paragraphs.

Pre-Survey

The pre-experiment survey asked the participants regarding their current phone brand, the operation system of their phone, and their prior knowledge with a smart watch. These question were used as potential control variables.

Controlled Experiment

I conducted a within-subject experiment. To compare the usage of PSU Alert and my app, the participants are asked to walk along a route on campus using one system first and switch to another at the midpoint. The order of the two systems was randomized. The route started from the HUB, the central building of the campus passing intersection of Pollock Road and the Pattee Mall, and ending at the endpoint at Information Sciences and Technology Building (IST). Note that in the PSU Alert system condition, fake The Pennsylvania State University Alert texts simulating real text messages were sent. For the designed application condition, test data obtained from the university police was used.

Post-Survey

At the end of the experiment, the participants filled a post--experiment survey. The post-experiment survey consisted of questions such as probing the users to rate both systems according perceived sense of security, convenience, enjoyment, willingness to use, and willingness to share. In addition, demographics section was included at the end of the survey. Post-surveys employed 7-point Likert scale questions (where 1= *Strongly disagree* and 7 = *Strongly agree*).The demographics survey included questions about their age, educational qualifications, gender, ethnicity and first language.

Interview

After the post--experiment survey, a semi-structured interview was conducted. First, participants were asked to explain the reason behind their ratings for each dependent variable: perceived sense of security, perceived convenience and enjoyment toward both the PSU alert and

the application. Afterwards, I asked them to provide feedback regarding potential needs for customization function within the application. The last question focused on gathering general feedback/recommendations towards the app. The interviews were audiotaped.

Measures

The interviews that were taken were transcribed and coded based on the metrics pre-determined at the start of the project. These metrics formed the basis of the coding process and allowed the app to be rated with respect to its counterpart PSUAlert and realize its potential strengths and weakness. The four metrics that were used for coding the interviews are defined and discussed below:

Perceived sense of security: Perceived sense of security is defined as the attitude of the users towards the app in keeping them safe by providing timely and correct information when needed. This refers to how fast and correctly the user can recognize the emergency jeopardizing their safety and act accordingly to prioritize their safety.

Perceived sense of convenience: Perceived sense of convenience is defined as the ease with which the users can assimilate the information regarding the emergency such as the type of emergency like weather conditions, sexual assaults, accidents, etc. along with their date and time. This information pertains not only for the current emergency but also for the incidents that have happened in the past that user wants to grasp.

Willingness to use: Willingness to use the app refers to attitude of the users to use the app given that they feel secure using the app and also find the information regarding the threat/incident in the time of emergency as well as past incidents. This metric identified the trust that the user put in the app for delivering the right information so that they can prioritize their safety.

Willingness to share: Willingness to share describes the user's willingness to recommend the app to their friends and family while on campus for emergency purposes. This metric takes into account user's perceived safety and convenience using the app along with their willingness to use it.

Chapter 5

Result & Analysis

A paired sample T-test was performed to analyze the survey data. Hypothesis 1 to 4, mentioned in chapter 1, predicted that WalkSafe would lead to higher level of perceived sense of security, perceived convenience, willingness to use, and willingness to share than the PSUAlert system respectively. The individual results are discussed in the next section:

Perceived sense of security: In terms of perceived sense of security, 1 participant strongly agreed that PSUAlert was secure while 2 participants strongly agreed that WalkSafe was more secure. For PSUAlert, 3 participants rated 6 for security, 1 participant rated 5, 2 participants rated 4 and 1 participant rated 3 and 2 each. For WalkSafe, 4 participants rated 6 for security, 1 participants rated 5, 4 and 3. WalkSafe ($M = 5.5$, $SD = 1.3$) provides higher perceived sense of security than the PSU Alert system ($M = 4.7$, $SD = 1.64$), $t(8) = -2.1$, $p = <.05$.

"Because it applies to me and where I am as opposed to the PSU campus in general." (P9)

"If there's something going on right now you want to know where it's at so you can know to avoid that area." (P6)

The above statements by participants imply that incident location with respect to their own location played a major role in increasing the participant feeling more secure. The location of the danger on map near them showed them the exact location instead of taking for granted that users already know where the given location on campus is as is the case with PSUAlert.

Perceived sense of convenience: In terms of perceived sense of convenience, 1 participant strongly agreed that PSUAlert was convenient while 3 participants strongly agreed

that WalkSafe was more convenient. For PSUAlert, 3 participants rated 6 for security, 2 participants rated 5, 1 participant rated 4, 3 and 2 each. For WalkSafe, 5 participants rated 6 for security, 1 participant rated 5. The results also supported Hypothesis 2, users perceived higher sense of convenience when using WalkSafe (M = 6.2, SD = 0.6) than when using the PSU Alert system (M = 4.8, SD = 1.6), $t(8) = -3.5$, $p < .01$.

"It's probably more convenient because I will only be notify if the thing is closer to me" (P9)

"With watch being just an added complimenting because you can see it more quickly than to remove phone from the pocket." (P4)

Participants like the use of Pebble as they can feel the vibration of Pebble on their wrist that draws their attention to the emergency around them. They don't have to remove the cellphone from their pockets or purses as the notification about the incident is sent on the Pebble. The implication here might that not a lot of participants had used a smartwatch before though they had certainly heard about smartwatches.

Willingness to use: 1 participant expressed their willingness to use PSUAlert whereas 5 participants expressed their desire to use WalkSafe. 2 participants each expressed their willingness to use WalkSafe by rating it 6 and 5 each. For PSUAlert, 2 participants rated it 6, 3 participants rated it 5 and 1 participant rated it 3, 2 and 1 each for their willingness to use. Using WalkSafe also lead to higher willingness to use (M = 6.3, SD = 0.8) than using the PSU Alert system (M = 4.7, SD = 1.5), $t(8) = -3.5$, $p < .01$, indicating that Hypothesis 3 is supported.

"It gives me a visual aspect as to what location is the alert from…." (P2)

"I do feel that one [the app and watch] is a little bit more enjoyable [than the text alerts] even just because it does give more information as to what is going on." (P8)

WalkSafe gives a visual aspect of the incident whereas PSUAlert just mentions the location of the incident in text. Both the systems give similar information but utilize different

means of communicating the information the users. Participants feel that WalkSafe is more interactive than PSUAlert because of the app's visual feature of showing location of incident/s and user.

Willingness to share: Furthermore, in terms of willingness to share PSUAlert 3 participants rated it 7 with 2 participants rating it 6, 1 participant 4 and 3 participants rating it 3. For WalkSafe, 4 participants expressed their willingness to share it and rated it 7. 4 participants rated WalkSafe 6 and 1 participant rated it 5 and the expressed their willingness to share the app (WalkSafe). The results supported Hypothesis 4, which stated that WalkSafe would provide higher level of willingness to share ($M = 6.33$, $SD = 0.7$) than the PSU Alert system ($M = 5.1$, $SD = 1.8$), $t(8) = -2.2$, $p < .05$

"Umm..I guess again I would go with the one on the watch just because it's pretty cool." (P6)

Though the participants found the WalkSafe 'cool' as a combined system because of the Pebble smartwatch, there is no denying the fact that Pebble also played an important role in notifying the participants of the emergency around them.

Chapter 6

Discussion

The overall results clearly show that the participants prefer WalkSafe in comparison to PSUAlert system. This may be due to Location-based system that is provided by Alert and the instant notification that is supported by Pebble smartwatch.

Measures

Perceived sense of security: One of the reasons participants felt more secure in using WalkSafe as compared to PSUAlert was because that it gave them the location of the incident with respect to their own location. Also WalkSafe gave the information of the incident as and when it happened which helped them to access their safety in much better way. This information allowed the participants to realize the true magnitude of the incident and prioritize their safety. It also gave them an exhaustive list of all the incidents that happened in the nearby area that allowed them to judge the safety of the area.

Perceived sense of convenience: In terms of convenience, participants felt that having Pebble made a difference as they did not have to pull out their cellphones to check the notification. Since the Pebble showed them all the basic information regarding the incident on the watch itself, the participant need not remove his/her cellphone from the pocket to check the notification. Unlike PSUAlert where all the students, faculty and staff are notified of the incident when it takes places, the participants are notified of the system only if they are near the incidents. This helped them as the notification made them aware of the danger that is close to them as opposed to the incident that might not be related to them.

Willingness to use and Willingness to share: The reason the participants were more willing to share and use the app can be attributed to their feeling more secure and convenient in using the app. Another reason as to why participants were willing to share and use the app is because of the display feature of the app. Also they found the app much more enjoyable in terms of the information that the app could give them as compared to PSUAlert system.

Limitations

There are limitations to the testing design and experiment in general. First, the setting of my usability testing can be more realistic. To improve the naturalness of the setting, I allowed participants to use their own phone during the test. In addition, the content and frequency of the alerts can be more realistic by having access to real-life data such as the incidents used in the study, from the police department. In this study, I conducted surveys, interviews, and experiments partly due to the limitation of time. If feasible, it might be more appropriate to perform a diary study. In my study, I received mixed opinions on smartwatch. Therefore, researchers can gain more insight by looking into the user experience of smartwatch and the phone application separately.

Second, a more representative sample can help me increase the generalizability of my results. Though I tried to keep the sample as diverse as possible, external validity of this study can also be higher if I recruited more participants from more diverse backgrounds.

Third, though I tried to keep the interview questions consistent across all participants, there might still be bias coming from different wordings of the questions. By having a more clear instruction, potential bias of the participants can be reduced.

Last, a more detailed prototype might be helpful. The working prototype of the app used for the user testing consisted of current incident location with respect to participant's location,

record of past incidents and incorporation of Pebble smartwatch with the app. The features discussed in chapter 7, if incorporated into the app prior testing, could have affected the participants' response. It seems intuitive that by allowing users to interact with more functions, more insights can be received.

Chapter 7

Recommended Features

The participants of the user testing suggested some features that they thought could be incorporated within the app and make it more useful. Participants suggested a lot of features that could potentially be incorporated into the app but depending on the frequency of the number of people that suggested the same feature, I included the features that ranked the most.

1. *Calling 911:*

Out of the 9 participants that were tested, 7 participants expressed that calling 911 directly from the app would be a very useful feature in times of distress and/or emergency. Participants felt that in times of need when a victim might not have time to open the dialer and dial 911 for help, having the app call 911 by pressing buttons on cell-phone or Pebble smartwatch can actually be helpful.

Keeping this in mind, a method was devised to call 911 and notify the authorities by pressing designated combination of button the cell-phone. To make such a call, the only requirement is that the app be running in the background. This does not mean that the user will have to go to the app to make that call but only that app be running in the internal memory of the cell-phone since the app will be utilizing the internet to make that call. This can be achieved by coding this step in the main code while designing the app. The mockup of how the screen will look like when such a call is placed can be seen below in figure 7-1:

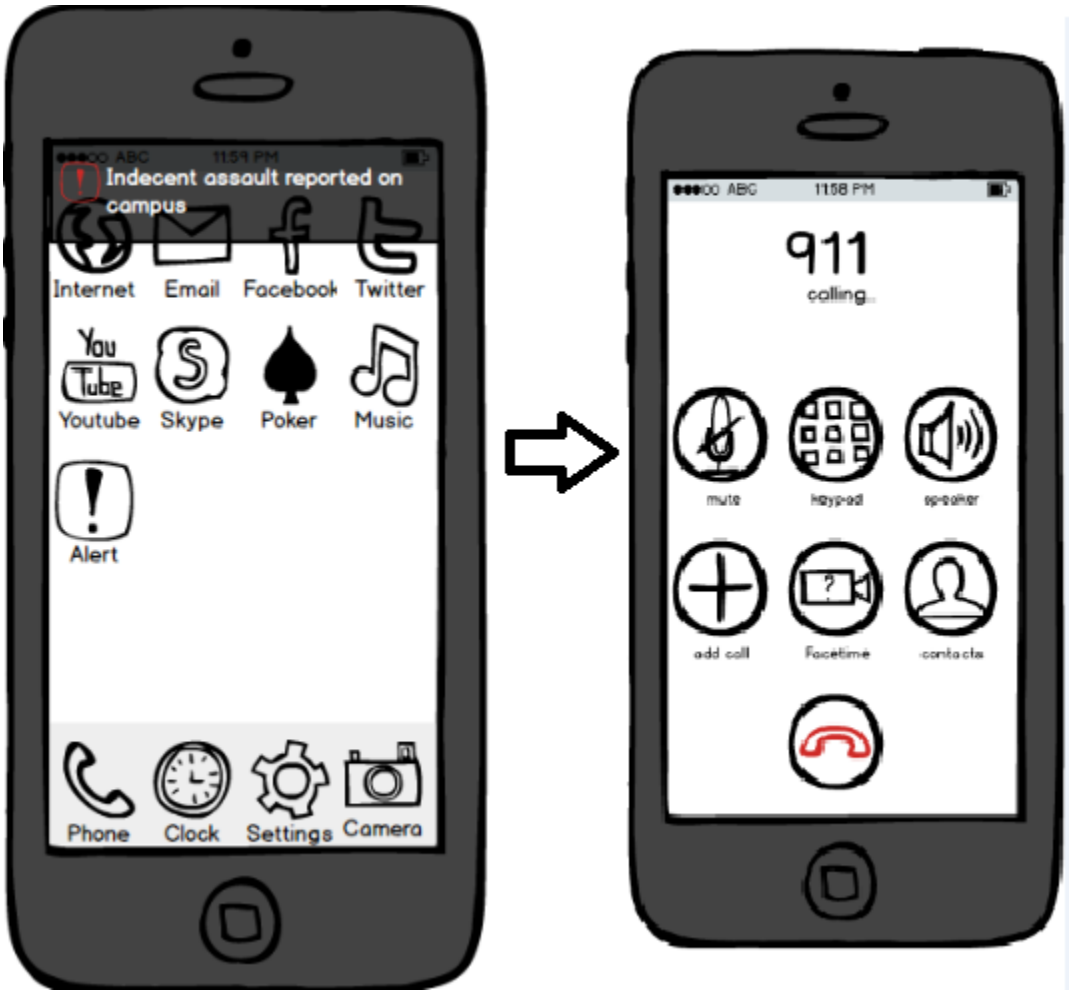

Figure 7-1. Notification on the top of the screen shot 1 shows app is running in the background and pressing the home button directs a call to 911 as shown in screen shot mockup 2

Since the working prototype of the app has been developed for iPhone and has been tested on it, the mockup has been designed for iPhone only. The notification on the top of the screen shot 1 shows that the app is running in the background. This allows the user to call 911 by simply pressing the home button twice/thrice. Mockup 2 shows how the screen will look like once the home button has been pressed. The user need not open the app to call 911. The only two criteria are that the screen has to be unlocked and the app be running in the background.

2. *Incident on/off icon:*

The app is meant to notify and report all the various kinds of crimes that are reported across the Penn State University Park campus. Since, there are a lot of crimes that are reported to the university police, participants recommended that they be able to turn on/off certain kind of crimes that may or may not helpful to them. 3 participants out of 9 felt that such a system will help them give succinct information of what is going around them and let them know the pertinent information.

"Maybe you can target specific audiences: for the girls, like, who are going out after 9:00pm. Maybe you can make it more specific to them, so it will automatically turn the application on when they are going out in certain areas after 9:00pm." (P10)

With the help of Annual Security and Fire Safety Report (2014), a list of crimes was prepared which included all the crimes that were reported to the university police or local authorities in the years 2011, 2012 and 2013 that took place in the University Park campus (http://www.police.psu.edu/clery/security-reports/upload/UP14-3.pdf). The table of the crimes is given below:

Table 7-1. The Table of Campus Crimes as reported in 2014

Offences	**2013 Crime Rate**
Criminal Homicide	-
Forcible Rape	15
Robbery	-
Assault	33
Burglary	68
Larceny – Theft (Exc. Motor Vehicles)	769
Arson	6
Assaults – Non-aggravated	105
Forgery and Counterfeiting	25
Fraud	53
Embezzlement	-
Stolen Prop., Rec., Possess., etc.	10
Vandalism	331
Weapons, Carrying, Possess., etc.	2

Prostitution & Commercialized Vice	-
Sex Offenses (Exc. Prostitution and Rape)	10
Drug Abuse Violations	813
Gambling	-
Offences Against Family & Children	0
Driving Under the Influence	73
Liquor Laws	975
Drunkenness	265
Disorderly Conduct	-
Vagrancy	481
All Other Offenses (Exc. Traffic)	117
Total	**4169**

The crime rate reported in the table above is calculated per 100,000 population and for year 2013 only. Population is calculated using full-time equivalent students, staff and faculty.

The mockup of how the incident on/off icon screen will look like is given below in figure 7-2:

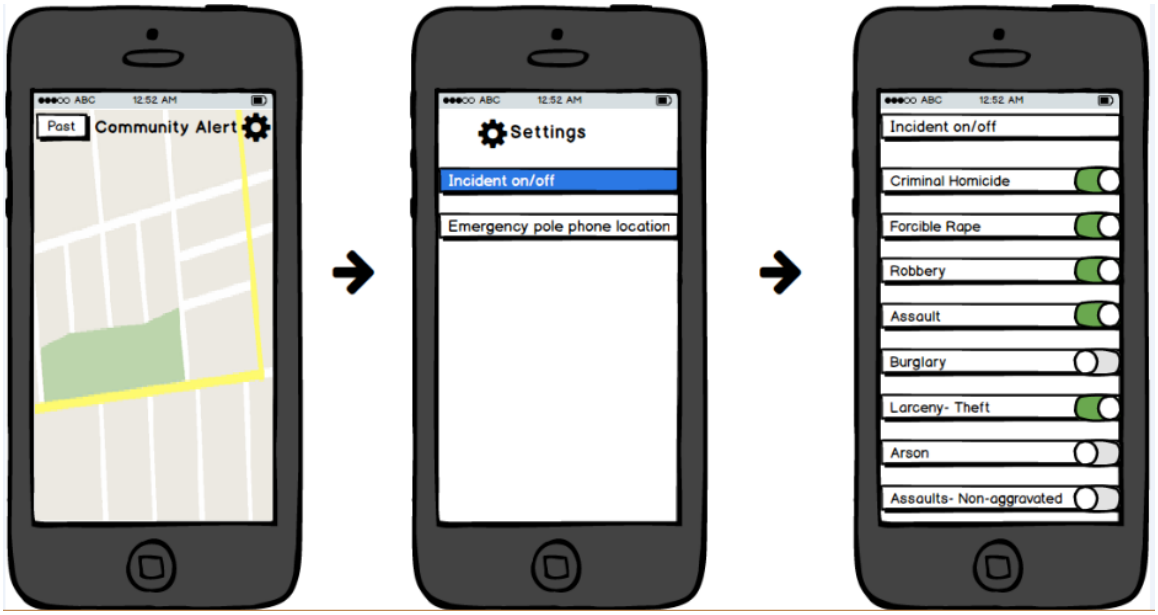

Figure 7-2. Incident on/off mockup

3. *Location of on-campus emergency pole phones:*

Pole phones are the newest style of emergency phones and can be easily located by the blue lights above them. These phones have no receiver, but instead contain a built-in speaker. To activate the phone:

- Push the red button to immediately call University Police or push the button marked "on" and you will hear a dial tone.
- The phone will automatically disconnect after approximately three minutes.

Out of 9 participants, 3 participants felt that having the location on these poles on the map can help them run to the pole and report the crime to the university authorities. The campus has 80 such pole phones located all across the University Park campus. The mockup of how the location of nearest poles in the vicinity of the user on the screen will look as shown below in the figure 7-3:

Figure 7-3. Emergency pole phone location nearest to the user

Chapter 8

Conclusion and Future Work

I showed in the study that the app, WalkSafe is preferred by the users because of the safety features it incorporates. The main features of the app namely: location based interface, record of past incidents, type of emergency along with the WalkSafe's integration of Pebble smartwatch for the safety of the users led to users giving preference to WalkSafe over PSUAlert system. Preliminary results of this study are encouraging as the study shows the potential of use wearable technology for safety purposes.

Summary

Campus crimes can have debilitating effect on the technological growth and success of the university. WalkSafe tries to address this challenge and provides a proactive way to of being notified of the emergency situations happening around the user. It also helps the user by providing pertinent information of the previous incidents so that the user can stay vigilant all the time. With the rise in wearable technology and the functionalities it covers, a future is not far off where wearable technology will be the order of the day. Incorporating Pebble smartwatch into the design of the app shows that the use of wearable technology can be made not only for commercial purposes but for personal and safety purposes also. The results of testing clearly suggest that the participants feel that PSUAlert has some limitations and that WalkSafe provides a way around those limitations without compromising their safety. Their recommendations also played an important role in further improving the app and making it more reliable.

Conclusion

This paper presents a concise and easy-to-use location based notification and public safety app which is specifically tailored towards the Penn State University area. Relevant observations have been recorded from the data analysis procedure, and three design suggestions are developed from the user testing for the mobile app design. The mockup of the app has been updated to incorporate these design suggestions. Feedback from an interview study regarding the paper prototype is promising, including comments which suggested that the system was safe and convenient to use. The participants also showed willingness to use the app and share it with their friends and family for their safety. In future work, I plan to enhance the working prototype according to the interview respondent's suggestions, and deploy the system into the real world. Thus in all, an ingenious solution to the prevalent problem of rise in campus crimes and their effective reporting and notification system has been developed with novel features.

Future Work

There is still vast amount of work to be done to use wearable technology for safety purposes. Future work done in this field can look into how emergency number like 911 can be called directly from the wearable technology as opposed to calling it from cellphone when in emergency situation. The wearable technology like smartwatch can be hardwired to make a phone call to emergency services when a certain combination of the buttons are pressed on the smartwatch.

Future work can also include testing the working prototype of the app incorporating the features which were recommended by the participants of the user testing. The testing of the

updated app can lead to some interesting conclusions and insights which can help in further improving the app and making the safety of the user more proactive.

Another thing can be looked into is including crowdsourcing the information of the various places, streets, areas, etc. within and around campus with respect to their safety and crime rates. This can help the new resident of the area or the tourist or a visitor to gauge their safety and prioritize it.

Tan et al. mentioned in the paper that the research has shown that people weight a variety of factors while reporting any incident of which time and effort to assemble the evidence and contact police plays a major role. To help eliminate this cost, WalkSafe can include a feature that can help the witness directly report the crime via the app in form of images, text, location, etc. while still keeping their identity anonymous if need be. Since the crime is being reported right away, no significant details are left out and will help expedite the process of finding the person/s responsible for the crimes.

Furthermore the records of past incidents can also provide a glimpse to the visitor of the safety of the nearby places that can help him decide about his safety. This systems can especially be helpful in cities like New York City, Chicago, Los Angeles that have a major tourist attraction and crime reported is high. This system has a lot of potential and can help in saving innocent lives.

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Appendix A

Personas and Storyboards

The various personas and their corresponding storyboards are shown below:

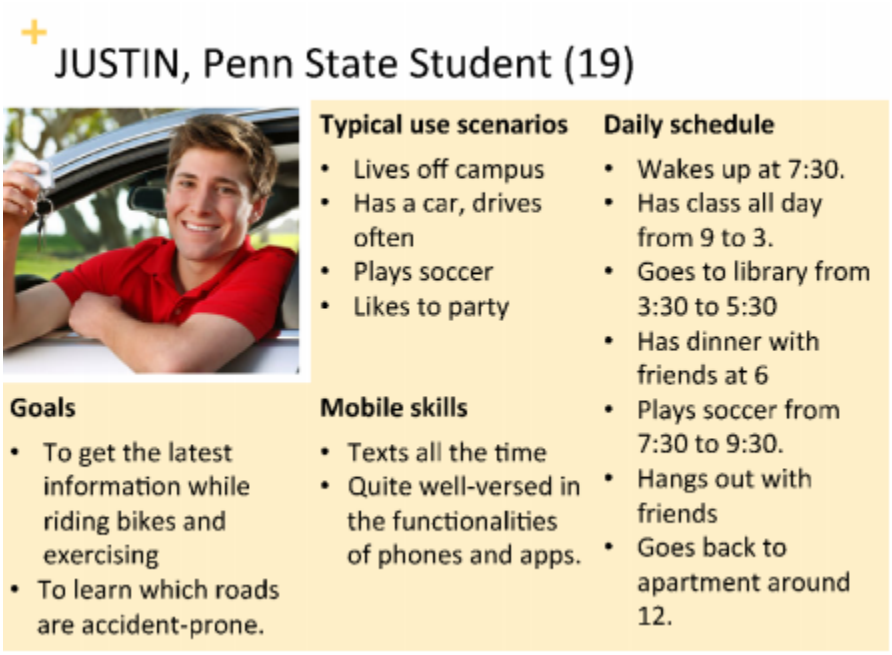

Figure 1. Persona for Justin: An undergraduate student at Penn State

▲*Storyboard for Justin*

Figure 2. Storyboard and use case scenario for Justin justifying the use of the app

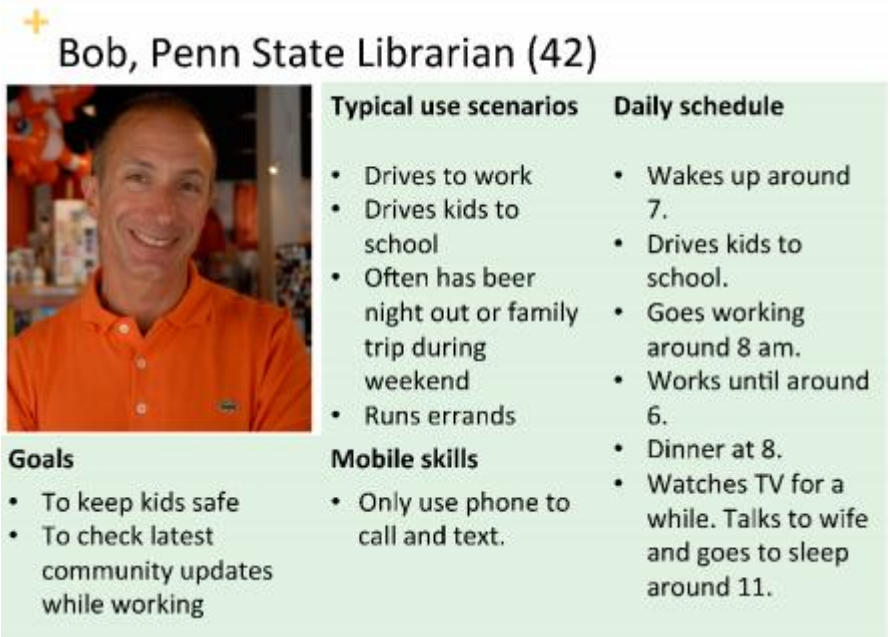

Figure 3. Persona for Bob: Staff member at Penn State

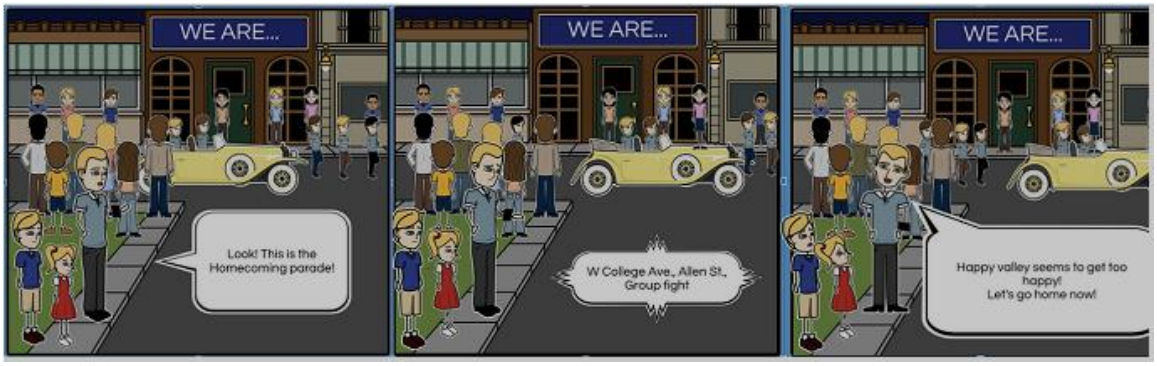

Figure 4. Storyboard and use case scenario for Bob justifying the use of the app

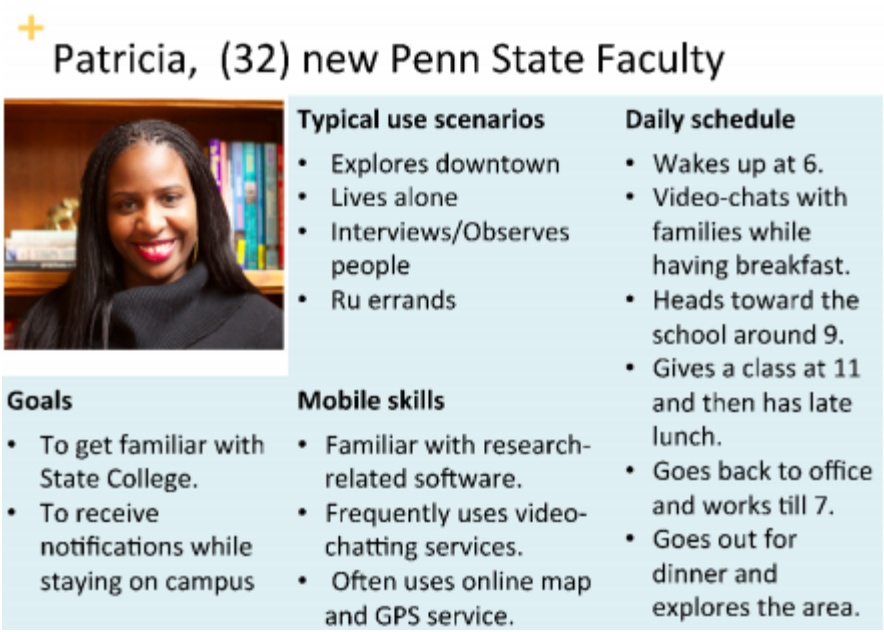

Figure 5. Persona for Patricia: Faculty at Penn State

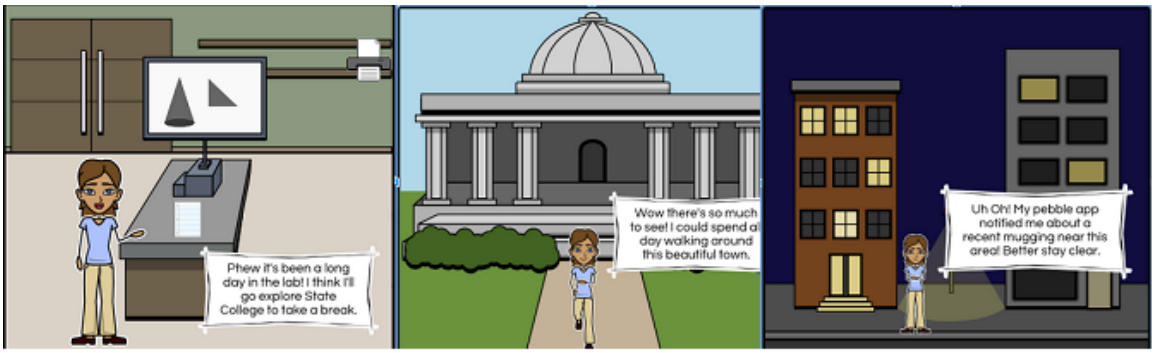

Figure 6. Storyboard and use case scenario for Patricia justifying the use of the app

Appendix B

Pre-Surveys and Post-Surverys

Pre-experiment survey

The pre-experiment survey was a paper-and-pencil survey. The questionnaire is as follows:

1.	The phone I am currently using….	☐ is a smartphone ☐ is NOT a smartphone (please go to question 3)
2.	The operating system of my phone is	☐ iOS ☐ Android ☐ Windows Phone ☐ Others
3.	Have you heard about smart watches?	☐ Yes ☐ No
4.	Have you ever used a smart watch?	☐ Yes ☐ No

Post-experiment survey

The post-experiment surveys was a paper-and-pencil survey. All dependent variables were measured using a 7-point, Likert type scales. Perceived sense of security and convenience were respectively measured with one question. Perceived satisfaction was measured using two questions. In addition, demographic information was asked at the end of the survey. The questionnaire is as the follows:

1.	Please rate your agreement with the following statements.

	Strongly disagree						Strongly agree
When using the PSU Alert system, I feel secure.	☐	☐	☐	☐	☐	☐	☐
I feel the PSU Alert system is convenient.	☐	☐	☐	☐	☐	☐	☐
I would like to keep using the PSU Alert system.	☐	☐	☐	☐	☐	☐	☐
I would like share the PSU Alert system with those who have never used it before.	☐	☐	☐	☐	☐	☐	☐
When using the tested application, I feel secure.	☐	☐	☐	☐	☐	☐	☐

I feel the tested application is convenient.	☐	☐	☐	☐	☐	☐	☐
I would like to use the tested application.	☐	☐	☐	☐	☐	☐	☐

I would like share the tested application with those who have never used it before.		☐ ☐ ☐ ☐ ☐ ☐ ☐	
2.	What is your age?		
3.	What is your first language		
4.	Please list your sex	☐ Male	☐ Female
5.	Please indicate your ethnicity	☐ White ☐ African American ☐ American Indian and Alaska native ☐ Asian ☐ Native Hawaiian and other Pacific islander ☐ Others	
6.	Which is your level of education?	☐ High school or equivalent ☐ Some college ☐ Bachelor's degree ☐ Master's degree ☐ Doctoral degree ☐ Professional degree	

Appendix C

Interview Guidelines

The action plan of the interview is as follows:

"Welcome to the last section of the study and thank you for coming today. Now, please either turn off your cell phones or set them to vibrate instead of ring. Thank you.

This interview will be rather short. I would like to remind you that your opinions are very important. For the purpose of the research, the interview will be videotaped. Also, you have the right to refuse to answer or leave in the middle of the interview.

Probe:

1a: During the experiment, when did you have the feeling that the application makes you feel [secured/unsecured]?

To begin with, let's talk about the survey you just completed. Please tell me why, in comparison with using the PSU Alert system, you feel [more/less/equally] secured when using the application?

Probe:

2a: During the experiment, when did you have the feeling that the application is [convenient /inconvenient]?

Next, why do you think the application is [more/less/equally] enjoyable than the PSU Alert system?

3a: During the experiment, when did you think the application is [enjoyable/ not enjoyable]?

Do you think the application will be better to use if you can add personal settings to the application? Can you give me some examples?

Do you have other comments on the application? Can you me some examples?

Thank you so much for your participation today. Please feel free to ask me if you have any questions. Have a nice day!