WalkSafe: College Campus Safety App

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ABSTRACT

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. We identify weakness of the existing PSUAlert system and address 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. We gathered user perception from 43 survey respondents that informed the design of the WalkSafe app. We use mixed-methods approach to evaluate WalkSafe with PSUAlert system as a baseline. We assess both systems with 22 participants by notifying them of the fake emergencies and asking them to use both systems to understand details regarding the emergency and its location. The pre- and post-surveys are evaluated using content analysis and paired t-test. Participant reported higher perceived convenience, perceived security, willingness to use, and willingness to share when using WalkSafe.

Keywords

Emergency alert; campus safety; real-time and location-based crime report.

INTRODUCTION

Schools and college campuses—where young people spend part or all of their day—are often assumed to be safe places (School and Campus Crime, 2013). Yet substantial increase in the number of mass shooting incidents on college campuses in the United States in recent years would suggest otherwise. In recent times, on April 16, 2007, Seung-Hui Cho shot and killed thirty-two students and faculty and wounded seventeen others on the campus of the Virginia Polytechnic Institute and State University (Virginia Tech) in Blacksburg, Virginia. This was the deadliest school shooting in United States history. Ten months later, on February 14, 2008, Steven Kazmierczak killed five and wounded eighteen in another mass shooting incident on the campus of Northern Illinois University. This was the second-deadliest university shooting in recent decades, and the fourth-deadliest in U.S. history (Kaminski et al., 2010).

Colleges and universities are required to keep records and report crime, particularly VAWA crimes, to the U.S. Department of Education as a result of the Jeanne Clery Act of 1990 (School and Campus Crime, 2018). In 2014, property crimes accounted for more than 50% of all campus crimes reported under the Clery Act. Burglary constituted 42% of crime, motor vehicle theft made up 9%, and arson 2%. Sexual offenses made up 32% (School and Campus Crime, 2018). Data collected by the Clery Act does not encompass all crime experienced by students at colleges and universities. The FBI separately collects reports from campus police as well as local and state law enforcement agencies through its Uniform Crime Reporting Program (UCR) (School and Campus Crime, 2018). Unlike the Clery data, UCR data indicate that violent and property crimes known to law enforcement have remained relatively constant for the past 10 years, with the exception of rape: rape known to law enforcement has increased significantly since 2005 (School and Campus Crime, 2018). Over that same time frame, college campuses have reported a rise in forcible sexual offenses that is 60% greater than the rise demonstrated by UCR data (School and Campus Crime, 2018).

Mass shootings along with violent crimes have led to an increase in perceived sense of fear for crimes. With increase in campus related crime, a lot of studies have been conducted to understand how perceived sense of fear can affect males and females on campus. Study of fear of crime has been gaining prominence since 1960s as shown by Skogan & Maxfield, 1981; Stanko, 1995; Stinchcombe et al., 1980. Research has consistently shown that some groups, especially women and the elderly, are more fearful of crime, despite lower levels of victimization than young males (Clemente & Kleiman, 1977; Dobbs et al., 2009; Ferraro, 1995, 1996;

Fetchenhauer & Buunk, 2005; Fisher & Sloan, 2003; Garofalo, 1979; Parker & Ray, 1990; Parker et al., 1993; Stafford & Galle, 1984; Stanko, 1995; Warr, 1984, 2000). One study showed that while women are significantly more fearful of crime prior to controlling for fear of rape, once fear of rape is considered, women's higher fear of other crimes seems to diminish such that there are either no sex differences in fear or men are more fearful than women (Dobbs et al., 2009). Researchers also identified several personal, contextual, and other factors associated with levels of fear of crime on campus (Kaminski et al., 2010).

With increase in crime and its perceived fear among the males and females of the college community, many campuses have expanded their emergency communication systems using multiple notification routes, such as text, e-mail, and phone alerts (Hamblen, 2008), though a survey of five hundred campuses using a particular emergency alert system found that only about 40 percent of students had registered for the service (Kaminski et al., 2010; Mark, 2008). Nevertheless, a critical question remains: Can technology be used to alleviate the perceived sense of fear for crimes on campus?

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 (Student Safeline, n.d.). Social media such as Twitter and Facebook (Shih et al., 2015) along with apps such as the Crisis Incident Chatter app (Shih et al., 2014a) and other local news apps (Carroll et al., 2015; Han et al., 2014; Shih et al., 2014b) have also been used to inform people of emergencies and incident happening around them.

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 (Campus Security, 2014). 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 (Automatic Fall Detection for Seniors, n.d.). Wearable technology has also been used in clothing (Mattmann et al., 2007) in the field of medicine for physical medicine and rehabilitation (Bonato, 2005) even for fitness as seen with the introduction of Jawbone, Fitbit, Nike Fuelband (Shaking up the wearables, 2014). 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 (Danova, 2015). 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. Keeping the past research in mind, we decided to survey 43 participants about their perception of safety. The survey and its result showed that there was definitely a room for improvement when it came to relaying type of crime information, its location, whether or not they should be informed about the crimes happening near their loved ones, etc. This requirement gathering helped in creating 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, car 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 this paper we strive to investigate the following research questions:

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

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

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

RQ: *In comparison with the PSU Alert system, will WalkSafe 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:

- We identify situations that lead PSUAlert to not perform up to the user standards of safety and we propose solutions with respect to these problems that is solved by our app:

- *Location based alert system:* We 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:* Our 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.

- We conducted usability testing with 22 users to compare PSUAlert and WalkSafe. The testing showed that WalkSafe is preferred by the participants more than PSUAlert for the information it conveyed.

Finally, we show 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 our 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.

REQUIREMENTS GATHERING

We started out first by sending a digital survey in which 43 participants responded. The survey included questions such as participant demographics, their frequency in viewing statistics related to crime, their preference in being notified about crime, their preference for filtering crime related information, some features they would like to see in safety apps, etc. 17 said that they never viewed crime related statistics, 19 participants expressed to be notified of the crime/s immediately once it happened, 24 participants mentioned that they would like to filter the crime/s in their proximity and 15 participants said that they would like to customize the radius of the crime to their location. Based on these results, we developed the app WalkSafe. WalkSafe incorporated the insights from the survey results and to understand if the app met the safety needs of the college community, we user tested the app against PSUAlert-The Pennsylvania State University's emergency notification system.

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. Wearable devices like Pebble smartwatches are taken into consideration when designing functions but it is secondary to the mobile app and interaction.

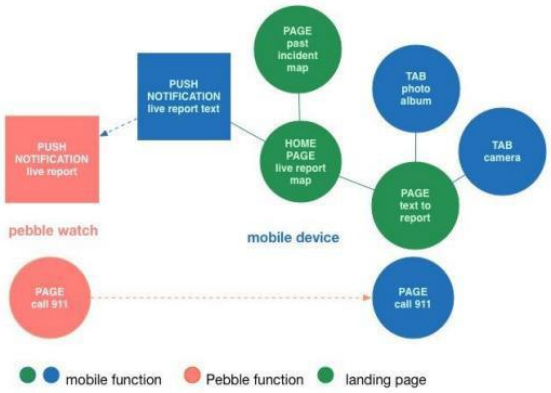

Figure 1. The application map of the app

The information architecture of the application is discussed below (see Figure 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. The past incident map indicates 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.

The RQs, 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 is 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. Low-fidelity mock-ups are developed using paper prototypes. High-fidelity mockups are developed in Balsamiq (see Figure 2 and Figure 3). The working prototype is developed on iOS platform. The app is coded for iOS platform and is currently available on iOS.

Figure 2. Notification sent to Pebble and Cellphone main screen

Figure 3. 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)

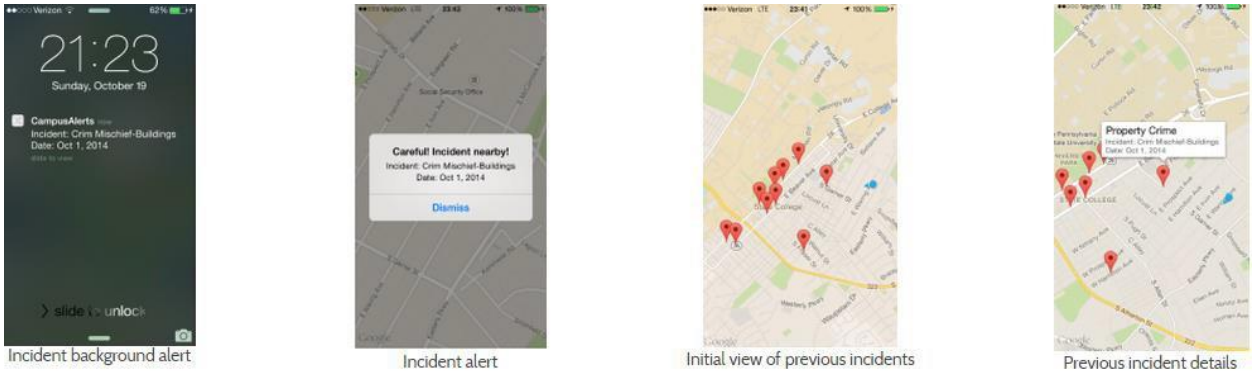

Figure 4. WalkSafe App: (a) Incident background alert, (b) Incident alert, (c) Initial View, (d) Previous incidents

When the WalkSafe app initially loads (see Figure 4c), 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 4d). 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 4a.

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 (see Figure 4b).

In summary, we are trying 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, we specifically strive 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.

USER STUDY

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, we designed and conducted a user study with 22 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 11 males and 11 females. The average age was 27 years ranging from 22 – 34 years.

The participants are first given a consent form to sign before the test is administered. The consent form includes the name of the investigators and the summary of the project. It also mentions that the participant is audio recorded for future reference but their identity will be kept private. The first section of the test is a pre-experiment survey. Following the survey is a controlled experiment. Then, a post-experiment survey is conducted. Last, the participants are interviewed. Post-surveys employees 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 present 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 questions are used as potential control variables.

Controlled Experiment

We conducted a within-subject experiment. To compare the usage of PSU Alert and our 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 is randomized. The route starts 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 are sent. For the designed application condition, test data obtained from the university police is used.

Post-Survey

At the end of the experiment, the participants fill in a post-survey. The post-survey consists 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 are included at the end of 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-survey, a semi-structured interview is conducted. First, participants are 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, the researcher asks them to provide feedback regarding potential needs for customization function within the application. The last question focuses on gathering general feedback/recommendations towards the app. The interviews were audio-recorded and transcribed for analysis.

Measures

The interviews that were taken were transcribed and coded based on the metrics given by the stakeholders 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 are 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 identifies the trust that the user puts 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.

RESULTS AND ANALYSIS

A paired sample T-test is performed to analyze the survey data to see if 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.

Perceived sense of security: Participants reported that WalkSafe ($M = 5.5$, $SD = 1.3$) provides higher perceived sense of security than the PSU Alert system ($M = 4.7$, $SD = 1.64$; $t(8) = -2.1$, $p = < 0.05$).

> *"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: Participants perceived higher sense of convenience when using Alert ($M = 6.2$, $SD = 0.6$) than when using the PSU Alert system ($M = 4.8$, $SD = 1.6$; $t(8) = -3.5$, $p < 0.01$).

> *"It's probably more convenient because I will only be notified 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: Participants reported that they were more willing to use WalkSafe (M = 6.3, SD = 0.8) than the PSU Alert system (M = 4.7, SD = 1.5; t(8) = -3.5, p < 0.01).

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

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: Participants reported higher level of willingness to share using WalkSafe (M = 6.33, SD = 0.7) than the PSU Alert system (M = 5.1, SD = 1.8; t(8) = -2.2, p < 0.05).

From the user study new features were added to the application and a mockup design was used for the second survey (see Figure 5). The features included in the improved version are filtered by crime, sharing the alert, setting up location range and adding multiple location.

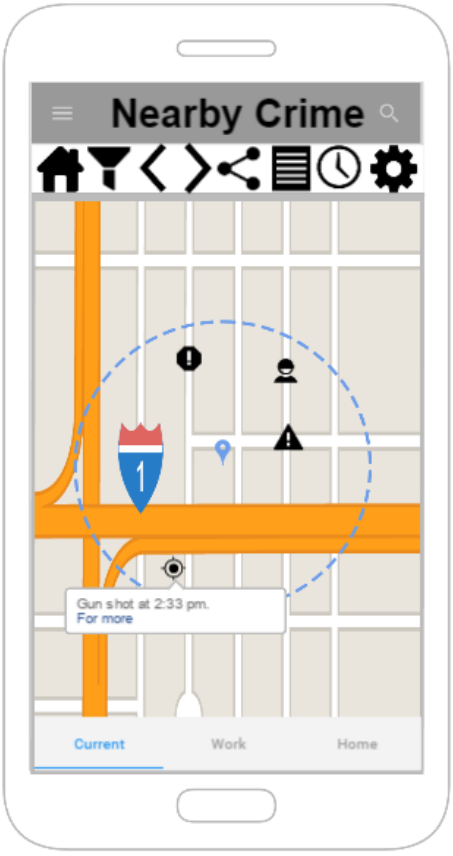

Figure 5 Improved design of WalkSafe app

A survey was conducted to evaluate the user perception of the improved design. There were 43 responses from different ethnographic. The survey was completed by 86% Asian with 51.2% male and 48.8% female. The survey questions included about their neighborhood safety their concern about neighborhood safety, application review and demographic questions. From the survey we learnt that less than 50% of people recorded that neighborhood is safety. However, on the other side highest percentage of people among all categories are concerned about their neighborhood safety. This shows the need of neighborhood safety application. This application has feature advanced feature to help users to learn how safety is their neighborhood. Almost no user has explored the safety places since only very limited doors available to reach out the resources. WalkSafe

makes this information handy and readily available. The survey helped to envision future roadmap for this application. Users came up with diversity of requirement as add on feature.

The survey broadly classified into three sections which focus on background of client, neighborhood safety and feedback on neighborhood safety applications. The questions under background section focus on people from diversity region. The research was interested in finding out how many percentage of people are aware of any neighborhood safety applications. It could be appropriate to state that only around 37% of the people are aware of such advanced technology applications. On the other side, more than 50% of the neighborhood is not safe to travel and live.

The participants reside in different country such as India, UK and USA. Over half said that they never get to know the safety of their neighborhood safety. Almost no one receives or make utilizes of any applications to learn safety of their neighborhood. So this depicts, the participants are not aware of any existing applications that facilitates such services. It could be either users' unawareness towards safety or the application limitation to attract enough number of audiences. Survey such as WalkSafe survey will help the participants learn about the application and how that would be very useful in our day today life.

Few questions focus on features that the participants are envisioning in any neighborhood safety applications. The list of questions begin with what type of filter will help participants to get most informative data. More than half of them preferred to have the search filter set to proximity near me. This will sort the results of crime activity that has happened closer to last known location. This filter helps any user to know how safe their current location is. Equally same percentage of participants opted to have another filter which sorts any crime activity which has happened near their loved ones. This option indicates, the participants are equally interested to know the safety of their loved ones as much their safety. Questions like this will take neighborhood safety applications to next level by knowing loved ones in family are safe as well. Sort by date and time option are the least preferred options among all other options. This option is more like informative to know the crime activity by date and time.

The survey included questions like how the user would like to get notified. All participants are very interested to get notified by some means. This shows how much all participants are very active participants for any practicing safety neighborhood applications. More than half of the participants likes to get notified as soon as any crime activity occurs irrespective of location. This will help to create awareness of known active criminal activity that has recently happened in any location. The second largest option preferred is criminal activity happening within defined range of region. The preferred option is have push notifications for every defined set of regular intervals.

Participants are very active in defining the features of applications that makes the application very active and engaged. Most of the users likes to know more information about any active criminal activity. Participants are interested to learn more about criminal activity, so they prefer to get any external reference such as news feeds, articles or quick feed that provides more detailed information about the crime. Any social media reference or related articles are very least preferred option. Most of the social media news feed are user controlled which deceives any information.

User has almost equal range of vote for all features that are listed to as upcoming features. Participants are very interested to have safety neighborhood application as crime-free route options as well. It is equally important to know take safe route as to know any active crime activity. This will not only help the users to learn crime activity but also to react to any crime activity. This feature will help users to find out safe zone and reach safely to any safe zone. User are also interested to learn how safety is any destination that the user has planned to journey. This is very important feature which prepares the user for any upcoming or active criminal activity. The options include display nearest safe zone along with distance from user last known activity. User suggest other features such as notify family members on safety, call feature to alert family on any active criminal activity and report any know incident. The last option may trigger false alarm which may lead to some serious consequences. If any such option has to be implement in any neighborhood safety applications, this has to be verified from different resources. On the other hand, waiting to confirm or validate any reported crime activity may take time which will delay pushing notifications to active users.

More than half of the participants agreed that safety neighborhood applications will definitely enhance personal safety. Almost all users also recommend such applications to their friends and family members. This will create awareness on locating safety neighborhood. All features and responses are very much aligned in involving family members and know safeties of beloved ones. Users' response include suggestion which allows application not only to notify neighborhood safety but also to help users to learn and navigate to safe zone in a safe route.

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.

Perceived sense of security: One of the reasons participants felt more secure in using WalkSafe as compared to PSUAlert may be 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 is 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 are 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 are 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.

There are limitations to the testing design and experiment in general. First, the setting of our usability testing can be more realistic. To improve the naturalness of the setting, we can allow 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 these from the police department. In this study, we 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 our study, we 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 us increase the generalizability of our results. External validity of this study can also be higher if we recruit more participants from more diverse backgrounds.

Third, though we try to keep the interview questions consistent across all participants, there might still be bias coming from different wordings of the questions as well as different interviewers. By having a more clear instruction, we can reduce potential bias.

Last, a more detailed prototype might be helpful. It seems intuitive that by allowing users to interact with more functions, the more insights we can receive.

CONCLUSION AND FUTURE WORK

We 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 using wearable technology for safety purposes.

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. Another thing can be looked into is adding the on/off notification systems for various incidents that the users can prioritize according to their requirements. This can eliminate the notifications from all the emergency incidents happening near-by them and will focus on the incidents that the user has turned on. The app can also be used as a standalone system. The app can be tied to the local police department of any town or city and this can act as an emergency notification system to the residents as well as the visitors of the place. Furthermore, the records of past incidents can also provide a glimpse to the visitor of the safety of the nearby places that can help them decide about their safety.

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