Designing a Mobile Crowdsourcing System for Campus Safety

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Abstract

Safety on college campuses remains a dire issue. Current reporting methods are still cumbersome and include no enhancing social aspect. Given the unique opportunity that universities are required to publish their safety reports, we conducted a preliminary data analysis of a university’s safety report log. The analysis allowed us to detect relevant trends in reporting behavior, specifically pertaining to where, when, and how soon the community would report safety incidents. Motivated by these findings as well as literature promoting interactive reporting systems, we then designed a novel mobile app which aims to enable the spread of crowdsourced public safety information. This app allows for immediate mass sharing of a safety incident report, as well as the opportunity for witness reporting. Feedback from a paper prototype interview study indicated that these qualities would facilitate increased interactivity among its user community, and ultimately promote better awareness of campus safety.

Keywords: Mobile Crowdsourcing; Public Safety Reporting; Paper Prototype


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Acknowledgements: We thank our university’s DPS (Department of Public Safety) for providing us the report log data, spending their time, and making efforts in collaborating with us on this research project.

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1 Introduction

Recent crimes occurring on college campuses have significantly escalated the need to focus our attention towards improving campus safety. The recent assault incidents at USC and UNC, which resulted in tragic deaths, serve as reminders for the necessity of a community which is both aware of campus safety issues, and willing to act upon such matters. Prior research has indicated that campus residents have the desire to both receive information regarding safety incidents and report incidents to campus safety. Subjects in a recent online survey conducted in the Syracuse University community reported their safety information needs (Huang, Wang, & White, 2014). These responses included quotes such as: “publish all incidents” and “gather all information and put it in one easy space”. Questions were also asked regarding a public safety mobile app. Responses included quotes such as “include feature allowing you to report a crime quickly”.

Currently, universities are required by Clery Act to log and publish safety incidents. Such a log is readily available for analysis from our university’s Department of Public Safety (DPS). This log contains reportable safety incidents under the Clery Act, as well as important information regarding each safety incident, such as the location, time of occurrence, time of report and incident type. However, the public may find two issues with directly using the DPS as a resource. First, while the log is comprehensive, users have to sift through noisy data in order to obtain their needed information. In addition, the DPS phone number must be called or its web form has to be filled in order to report a safety incident. An intuitive solution is to develop a mobile system utilizing crowdsourcing. Recently, there has been an increasing number of students who use smart phones, and the fastest growing category for mobile content from 2009-2014 is social media. Thus, the public could use this mobile app to receive comprehensive information in a timely manner, as well as to report safety incidents efficiently with the push of a button.

However, challenges arise during the practical implementation of a public safety mobile app in a university area. This area is unlike others in that the majority of the community are temporary residents (students). Limited research has been conducted about the reporting behavior of people temporarily living in a university area. In order to create a more successful public safety mobile app based on crowdsourcing, it is important to learn more about how the public in this location reacts to and reports safety incidents. Questions relevant to the design include: Where and when do the public report? How soon does the public report after the incidents occur? Will the public actually use the reporting feature provided in the proposed
mobile app? When would they use the app? Will the public want to receive historical report information from the app?

In this paper, we contribute to the method of designing a crowd sourced, public safety mobile app which is specifically tailored towards a university area and its residents. In particular, we analyze our university’s DPS log for the year of 2013, using data analysis techniques to detect relevant reporting patterns of the public in our area. Specifically, we analyzed the aggregation of individual safety reports, and present the relevant observations gathered. We discovered that people’s reporting behavior changes significantly depending on where they are and what time of day it is. Certain addresses and streets are also subject to the attention of the public due to a high volume of safety reports. Finally, the reporting speed of people changes depending on both their location and the type of incident they are reporting about. Inspired by the observations acquired from the data analysis process, we developed a paper prototype of mobile crowdsourcing social system. The community can use this S4S (sharing for safety/support) app to both receive and report safety information. Furthermore, we conducted interview studies to evaluate the usability of the design, and to receive feedback on how to improve the design. Finally, we provide discussions on the limitations of the study, and identify future work which can improve our crowdsourced public safety app.

2 Related Work

Our work was informed by different lines of literature. We mainly present under-reporting issues and mobile crowdsourcing systems for improving public services.

2.1 Reporting Behavior

A variety of factors are believed to influence a victim’s decision to report a safety incident. (Bowles, Reyes, & Garoupa, 2009) analyzed the crime reporting process with a cost-benefit analysis, and argued that victims would weigh between several costs and benefits when deciding to report a safety incident.

Significant costs the victim will consider are the time and effort to assemble evidence and contact the police. Potential costs include situations when the victim feels shame or embarrassment filing a sensitive safety report, or when the victim fears retaliation by the offender. Significant benefits the victim will consider consist of both intrinsic benefits and extrinsic benefits. Intrinsic benefits include the solidarity effect, the incapacitation effect, and psychic benefits. The solidarity effect is derived from victim’s altruistic motives. The incapacitation effect is derived from the victim’s belief that his or her reporting will prevent future offenses. The psychic benefits are derived from the victim’s feeling of retribution to offenders who can be punished in the future by the police. All three effects will promote a victim’s reporting frequency. Examples of extrinsic benefits include getting an insurance claim on stolen property, or qualifying for compensation through a criminal victim support scheme (Bowles et al., 2009). Geographic and racial factors can also impact on victim’s reporting decision (Xie & Lauritsen, 2011). If victims live in neighborhoods with higher crime rates, they will be less likely to report safety incidents to the police (Wagner, 1992).

Other theories have also been proposed to help explain the difference in crime reporting behavior among individuals. (Black, 1976) proposed a stratification hypothesis, which argues that the uneven distribution of social resources would result in varied crime reporting behaviors among different groups. (Goudriaan, Lynch, & Nieuwbeerta, 2004) suggested that the normative reporting behavior is affected by the victim’s perception of appropriateness to report in a particular situation. Finally, (Singer, 1998) explained that victims who are rational would opt to maximize their utility based upon their expected costs and benefits when deciding to report.

2.2 Related Systems

The method which victims use to report safety incidents also affects reporting behavior. Interactivity seems to be an important factor to enhance the reporting efficiency. (Lasley & Palombo, 1995) found that crime report frequency increased significantly when reporting was done using a computer interactive system rather than the traditional telephonic mode. Additionally, an Internet based crime reporting system “i-recall”, which emulates a police officer conducting a cognitive interview to enhance victim’s memorization of the offense, proved to be more effective than the non-interactive textbox recording system (Iriberri & Navarrete, 2010).
There are very few systems designed for enabling crowdsourcing public safety information. Most existing systems only have basic functionality, partly because several challenges remain on how to design a system that effectively and efficiently gathers and shares safety information to improve the public safety. Relevant issues include, but are not limited to, motivating people to share potentially sensitive public safety information, user privacy (to avoid inadvertent leak of their identities), quality or accuracy of the crowd-contributed data, data collection (passively by way of sensors or actively contributed) and data dissemination methods.

Some existing systems address some of the aforementioned challenges. For instance, the WikiCrimes system built a web tool that allows people to report public safety issues and uses a reputation model to address the tension between user participation and quality of contributed information (Furtado, Ayres, de Oliveira, Eurico Vasconcelos, & Belchior, 2010). To enable quick responses to emergent safety incidents, it would be very useful to have real-time or near-real-time information about these incidents that are happening or about to happen. Given the ubiquity, mobility and Internet connection of mobile devices, they are a powerful platform to support real-time searching and reporting public safety information. Yet, very few existing systems were built for mobile devices. One example is the CROWDSAFE system which enables both crowdsourcing of crime incidents and provides safe routing suggestions to avoid public safety issues on people’s mobile devices (Shah, Bao, Lu, & Chen, 2011). Even fewer such mobile systems were actually deployed for real-world use. In addition to academic prototypes (Yin, Lampert, Cameron, Robinson, & Power, 2012), we researched relevant apps from the iOS and Android app markets. We found about 20 safety notification or reporting apps. Some of them incorporated only push safety related notifications (Alyacom Emergency, 2014; Mobile UW, 2014; Ready TN, 2014), while others allow users to send reports to law enforcement agencies (AlertID, 2014; Emergency AUS, 2014; Crisis Emergency Alerts, 2014). A few apps use social networks (e.g. Facebook) for reporting (Crime Watch San Diego, 2014; Social Alert, 2014) or enable their friends or family to track specified locations in an emergency (Fightback, 2014). Georgetown University recently released EmergenSee, a mobile app, for university residents to report safety issues (EmergenSee, 2014). The EmergenSee app allows users to stream live video or audio or to share GPS locations when they need help. However, we could not find any information about whether and how their target population uses the app.

3 DPS Safety Report Log

The Daily Incident Log was obtained for the year of 2013 from our university’s DPS. Each safety report was provided by values in the following fields: Incident, Address, Occurred from Date, Occurred Through Date, Status and Document Text. Incident describes the incident type of the report. Examples include Burglary, Larceny and Criminal Mischief. Address describes where the safety incident took place. Occurred from Date describes when the incident took place, or “time of occurrence”. Occurred Through Date describes when the victim reports the incident to the DPS, or “time of report”. Status shows whether the case is open or closed. Document Text describes the reported incident briefly.

3.1 Analysis Method

Data was analyzed using functions provided by Excel and RStudio. Histograms, tables and additional line charts were generated in R.

Previous literature indicated that there is a difference in willingness to report and reporting speed depending on whether the person is located at work or home. Inspired by this difference, we decided that it would be informative to classify the safety incidents into the locational categories of residential and commercial. Residential is defined as a location where persons are at home. Commercial is defined as a location where persons are away from home, and are at work, at a restaurant, in the park, etc. As a result, the log can be subsectioned based upon location and further analyzed. Given the address of each safety incident, we could determine whether the incident occurred in a residential, commercial or unknown area using smarystreets.com. Smartystreets.com is described as a service which provides “free street address validation and geocoding”. The unknown locations are a limitation of this study.

Previous literature also indicated that time of day affects people’s sharing decisions. As a result, two aspects of time were investigated: the seasonal trend of daily safety report volume and the hourly trend of
safety report volume.

To determine how soon the public will report after safety incidents occur, the reporting speed should be quantified. In order to calculate reporting speed, we created the variable Elapsed Time. Elapsed Time is defined as Occurred Through Date - Occurred from Date, and is in the units of hours. Elapsed Time is investigated in relation to location and incident type.

3.2 Results

![Figure 1](image1.png)

Figure 1: (A1) Aggregated counts of safety reports during 2013. Year is subsectioned into three time periods, and slopes (m) from linear regressions are calculated for residential and commercial areas during each time period. (A2) Daily counts of safety reports during 2013. (B1) Histogram of hourly occurrence times over 24 hours from safety incidents located in a residential area (B2) Histogram of hourly occurrence times over 24 hours from safety incidents located in a commercial area (C1) CDF of safety report volume for unique addresses. (C2) CDF of safety report volume for unique streets.

3.2.1 Reporting Behaviors Vary Based on Time and Location

Seasonal Trends of Reporting Behavior based on Location

We investigated the volume of safety reports per day based on location. One vector was acquired by counting the number of safety reports for each unique day of 2013. This vector was further sub sectioned into three separate vectors using smartystreets.com, based upon location of each safety report (Residential, Commercial, Unknown).

Three observations were significant to us. First, more crime occurred in Residential than Commercial areas, indicated by a higher count of reports on day 365 on Figure (A1). From Figure (A2), we see that Residential areas generally have a higher volume of safety reports per day than Commercial areas. At times, Residential areas even reached 16 reports per day. Additionally, while there are several days where more safety reports were from the Commercial area, the majority of days occurred such that the more of safety reports were from the Residential area.

Second, the volume of safety reports follows a similar trend in both Residential and Commercial areas. In general, there is a growth of safety reports from day 0 to day 126, a slower growth rate of reports from day 126 to day 237, and then the original (or greater) growth rate of reports resumes from day 126 to day 237. Day 126 is the first day of summer for students, and day 237 is the first day of school for students. Therefore, we considered days 0-125 to approximately reflect the spring semester, days 126-236 to approximately reflect
the summer, and days 237-365 to approximately reflect the fall semester. Linear regressions were conducted for both Residential and Commercial data points for each of the three sectioned time periods as shown in Figure (A1). The R squared values were > 0.97 for all regressions, and the calculated slopes (m) are also shown on Figure (A1). According to the slope values, the Commercial safety report volume grows faster than the Residential safety report volume during the summer, and the Residential safety report volume grows faster than the Commercial safety report volume during the fall and spring semester. However, the general trend of safety report volume remains and is evident.

Third, the depression in the volume of safety reports in the summer can perhaps be attributed to the leaving of temporary residents (students). Also, more crime occurred in the Commercial area than the Residential area, as indicated by Figure (A2). As a result, it seems as though persons filing safety reports in the Commercial areas and the persons filing safety reports in the Residential areas could be composed of various proportions of two demographics (temporary vs. permanent residents).

The Mann-Whitney test was used to determine whether there was a significant difference between the volume of crime per day in Residential areas (n = 978) vs. Commercial areas (n = 729). The Mann-Whitney test was chosen to determine statistical significance because the following assumptions were fulfilled: two different groups of participants performed both conditions of our study (report vs. not report), data was not normally distributed, and sample size was larger than n = 7 for both groups. In the remainder of the Results section, the same assumptions were fulfilled each time the Mann-Whitney test was used. The function wilcox.test() was used in RStudio for the Mann-Whitney test. We considered results statistically significant if the p value was < 0.05. As a result, there was no significant difference between the volume of crime per day in Residential areas vs. Commercial areas.

**Design Suggestion(DS) #1:** There is an evident increase in the rate of safety reports being filed when the students are present compared to when the students are not present. At least for the year of 2013, we can infer that students are the demographic which are filing a significant portion of safety reports to the SU DPS. As a result, we believe it is beneficial to understand students’ reporting behavior. For this reason, we decided to recruit students to interview for feedback regarding the paper prototype.

**Hourly Trends of Reporting Behavior Based on Location**

To obtain a general snapshot of the occurrence time of safety-related incidents, a histogram was generated showing the total volume of safety-related incidents throughout a 24 hour day using all reports from the SU DPS log. A distinct increase in incident occurrence can be seen at around midnight, and there is a clear decrease in incident occurrence from the hours of 4am to 9am. Because of these peaks and depressions in the histogram, we became interested in whether some hours of the day had a higher volume of safety reports than others.

First, a vector was obtained counting the number of safety reports for each unique day of 2013. The vector was further sub sectioned based upon time of day in intervals of 15 minutes. As a result, 96 different vectors were generated for each interval of 15 minutes throughout the day. Each sub sectioned vector contained the volume of safety reports for each unique day of 2013 for the specified 15 minute interval. The mean report volume per day and median report volume per day was generated for each 15 minute interval. We defined a high volume period as a 15 minute time interval with a relatively high mean report volume per day. Most of the high volume time periods occurred between the hours of 11pm - 3am, as well as 2pm - 5:45pm.

Because the high volume 15 minute intervals took place during two different time periods (11pm - 3am and 2pm - 5:45pm), we wondered whether there was a difference in these high volume intervals due to the location of the safety report.

Histograms of occurrence time of safety-related incidents in the Residential area (Figure (B1) and in the Commercial area (Figure (B2)) were generated. These two snapshots showed a similar depression in report volume from 4am - noon, however the peaks of report volume occurred in different time intervals. The mean report volume per day and median report volume per day was generated for each 30 minute interval for both Residential and Commercial areas. Most high volume time periods for the Commercial area occurred during the interval of 1:30pm - 3:30 pm, and most high volume time periods for the Residential area occurred during the interval of 11:00pm - 3:30am.

The Mann-Whitney test was used to compare each 30 minute interval to every other 30 minute
interval to determine if there was a statistical difference \((p < 0.05)\) between the volume of crime per day during these intervals. We kept track of how many times a certain 30 minute interval had a statistically greater volume of crime per day than another 30 minute interval. This count will be referenced as “statistically greater counts”. We then ordered the intervals based on this count. Statistically greater counts were generated for each 30 minute interval for both the Residential and Commercial areas. Similar results were found. According to the statistically greater counts, the high volume time periods for the Commercial area occurred during the interval of 1:30pm - 5:30pm, and the high volume time periods for Residential occurred during the interval of 11:00pm - 3:30am.

These results are significant for both the public and the DPS. The public can be made aware of when the high volume time periods are according to their general location. This may help with under-reporting issues, because the public know that other crimes are occurring during these time periods, and could feel more comfortable reporting a safety incident. Additionally, after identifying these high volume periods for the university area, the DPS can potentially optimize their allocation of resources according to time of day.

**DS #2:** Based on historical data, the public are informed of which time periods they should be the most cautious and aware of their safety. They can also observe the different trends in incident occurrence times based on their location. As a result, people are more likely to make safer choices about their travels if they are armed with information about these high volume time periods and incident occurrence time trends.

### 3.2.2 Flagging The Essential Addresses and Incident Types

We can immediately flag several addresses and streets for Public Safety by exploring the relationship between safety report volume and location. Figure (C1) and Figure (C2) show cumulative density functions of report counts for the addresses and streets from the SU DPS log.

The skewed distribution from Figure (C1) and (C2) shows that while most addresses and streets have a low volume of safety reports, several addresses and streets have a high volume of safety reports relative to other locations. The top ten addresses account for 30.16% of all crime, while the top ten streets account for 50.51% of all crime. A similar pattern exists for incident types as well. The top three incident types of Personal Injury/Injury, Larceny, and Intoxicated Person account for 44.57% of total crime.

**DS #3:** The public should be informed about these specific addresses and streets because of the relatively high amount of safety report traffic at these locations. Aggregation on the street level can help warn students of certain street safety qualities. The proposed app design can potentially aid user navigation by helping them avoid these addresses and use safer streets for travel. It is also necessary for the public to be aware of the aforementioned incident types, since they are the most common incident types in our area in 2013. Individuals can potentially prepare themselves for these incidents.

### 3.2.3 Elapsed Time Varies Based on Location and Incident Type

Elapsed Time (ET) was calculated for all safety reports. This data was collected in a single vector, and then further sub sectioned based upon location and incident type.

An overview of ET was obtained by generating a CDF of ET for all cases from the SU DPS log from 2013. The majority of elapsed time values are equal to 0, and very few elapsed times last more than 24 hours. A histogram of the elapsed time values showed a heavily right skewed distribution.

The ET for safety reports were compared between Residential and Commercial areas. For the Residential area, the mean ET = 15.33 hours and the median ET = 0 hours. For the Commercial area, the mean ET = 15.02 hours and the median ET = 0.01667 hours. The median ET is a better statistical measure because the ET histogram for both Residential and Commercial areas are heavily right skewed.

A Mann Whitney test indicated that the Residential ET was statistically less than Commercial ET, which suggests that the reporting speed is faster in residential areas than in commercial areas. We believe that the public in residential areas may have more urgent safety related issues to report, and are more willing to immediately call for help. Because the median ET in a commercial area is greater than zero, persons in a commercial area are more likely to report a crime some time after it has occurred. As a result, we believe that potential underreporting has taken place in the commercial area because of the slower reporting speed, or the incident types which occur in commercial areas are less urgent than those in residential areas.

The ET for safety reports were also compared between all incident type. The mean and median ET
were calculated for each incident type. The top 5 incident types with the highest median ET with n > 7 are Property Damage Hit and Run, Burglary, Lost Property, Larceny and Criminal Mischief. These results may reflect how sensitive the public is to certain incident types. For example, an incident like Burglary will cause an individual to report immediately because the situation is urgent and they are unashamed to do so. However, an incident such as Loud Noise Complaint may be more sensitive for an individual to report, because they are aware of the potential social repercussions present after making such a report. As a result, elapsed time will be nonzero, and potentially high as well. In theory, a DPS can then allocate the proper resources and prepare a tailored response to a more sensitive report as well.

**DS #4:** The proposed app design should accommodate for immediate as well as longer ET reports, since ET varies based on location and the incident type which is reported. This would allow equal opportunity to report cases of varying sensitivity levels, and hopefully aid the issue of underreporting in sensitive incident types. As a result, the app design should include both a “call immediately” button to accommodate for immediate elapsed times, as well as a “report” button to accommodate for longer elapsed times.

## 4 S4S Paper Prototype

In this section, we present the design goals and current features of S4S, and explain how and why we designed these features. Overall, the design of S4S was informed by the relevant literature we reviewed previously as well as our data analysis results of the report logs.

### 4.1 Design

![Home screen of the S4S app](image)

Figure 2: Home screen of the S4S app

In general, we defined the following design goals of the S4S system. S4S should collect safety related reports with more context information, enable sharing of these reports easily, notify users with new reports in a timely manner without overwhelming the users, and allow users to access historical reports. In order to achieve the above design goals, we developed a set of major features. Figure 2 shows the home screen of the S4S. The three buttons on the top left are one-click functions for users to look up the university’s DPS’s social media feed and to call DPS directly. The text box in the middle of the screen is used to report a safety incident. The inclusion of both a call button and a report text box is motivated by DS #4.

We will focus on user interaction design when clicking the buttons that are annotated with red callouts. In essence, they present 4 groups of functions and brief summaries are provided in the figures. Each time users tap on the buttons, the system will direct them to a new screen. The major followup screens are presented in Figure 3.

For example, clicking R button in Figure 2 will promote users to the R1 view in Figure 3, which allows users to provide details of a report. When the user wants to change the location where the event happens, they can click the location on R2, continue reporting more details, and choose to share it publicly or anonymously in screen R3. In addition to the incident time, location and a brief description, users can also choose the incident type. Concerning the privacy issues, users can also share privately, and anonymously by checking the two boxes shown in R3.

Clicking L button or P button in Figure 2, it will lead users to L1 and L2 view or P1 and P2 view in Figure 3 respectively. Users can identify the areas and paths where they are interested in receiving new report alerts. The interactions for both user customizations are almost the same. Given space limitation, we do not show every individual screen for each function. They all start off by selecting the type of path or
area users interested in. On the other hand, users can also make changes to the paths and areas that they had before. In addition, when users draw the path, they will be asked to identify a time they care the most about. Inspired by DS #3, the behind-the-scenes purpose of this design is by specifying users’ paths/areas of interests, they will have alerts instantaneously when criminal events happen near that path/area, and notifications about the road condition following the time they provided.

A sample notification message is presented by A1 in Figure 2. When a reported event happens within the identified area of a particular user, the report will be shown on this user’s map, and after clicking the pin on the map, A2 shows the detailed report message. Users can comment on the report using A3. This notification allows users to receive real-time event notification timely, but not all the events, such that users won’t be overwhelmed by other locations’ reports where they may not care about. Users can also provide more details to the events by clicking on the “I am a witness” button, the system will direct them to the quick report, and the proof and/or details that they added will be pass right to the Police Department.

Inspired by DS #2, clicking the S button in Figure 2 allows users to look up historical reports around the areas or the streets they identified. The map on the top showing areas and paths that users have selected, and the window on the bottom showing users data that the Department of Public Safety collected (including the diagram presenting dates and events frequencies within a certain time range that users selected). The system will go through the historical reports area by area and path by path once users click the left or right arrows at the bottom of the screen. In between the arrows, the name of the areas or paths which the users cropped is shown. The focus of this feature is to provide users the comprehensive data about areas and paths they care the most.

![Figure 3: Selected screens of the S4S (Sharing for Safety/Support) system paper design.](image)

### 4.2 Paper Prototype Study

We recruited university students as our participants and the recruitment was done by emailing lists and poster advertising. We focused on recruiting students because of DS #1. In total, ten students participated in our study; six were male and four were female.

#### 4.2.1 Interview

We followed a typical procedure of paper prototype test. At the beginning of the study, we introduced to the participants the purpose and the status quo of our project. Then, we explained to the participants
the meaning of paper prototype test. After obtaining participant’s consent form and permission to audio recording, we initiated the interview. Initially, we asked some ice breaking questions e.g., how long they have been in the university, and how they commute to our university every day. Then, we presented the five sets (R, L, P, S and A) of complete S4S mock up screens. Note that Figure 3 only shows major steps in each set. The mock up screens in each set were put in a logical sequence, e.g., from the display of the quick send button on home page, until the final send and share page. Based on literature review on public incidents reporting and paper prototype testing, as well as the mock up screens, we devised the interview questions.

In each screen set, participants were asked to imagine a pre-defined task and imagine the effect of the function. For instance, in the “quick report” scenario, participants were initially situated in an emergency and then asked about their behavior to deal with it, whether to report to police, or share the situation to other people. Afterward, participants were presented with the “quick report” set of mock up screen, from the very beginning home page with a “quick report” button. They would be encouraged to think aloud how this function will work, and potentially what the next page would be. During this process, we would gather participants’ ideas and confusions of the “quick report” function. Then, we showed the next mock up screen in the set to illustrate the proceedings of how the function would work. Along the way, participants would make their evaluations on the pros and cons of the app. At the end of a set of mock up screens, we let participants make a summary of their viewpoints on the function.

After going through all the five sets of mock up screens, we presented the System Usability Scale (SUS) form to participants and let them evaluate the usability of our app. SUS named the System Usability Scale (SUS) (Brooke, J. (1996)) is a widely cited usability test scale. It is regarded as reliable, cost efficient, and could be implemented globally for system usability assessments (Brooke, 1996). Before scoring the scales, participants were reminded to be honest in assessment and only based on the current mock up screens of our app, instead of future vision. Once participants finished all the scoring, we would check the result and ask for participants’ explanations on their scores. Finally, we would wrap up our interview by asking participants to make a general perception of our app, and provide advices for its future development.

We also audio recorded the interview for transcription and reference. One interview study takes about 1 hour to finish, and the participant received $5 for participating the interview.

In terms of interview data analysis, we used a two-phase strategy. First, we coded the transcriptions from the audio recordings and generated categories based on participants’ general perceptions on the app, and their specific evaluations of the five set of mock up screens as five primary functions of our map; Second, we did a simple calculation on participants’ scores on SUS and referred to the transcriptions again to double confirm their evaluations. The study was approved by our university office beforehand.

4.2.2 General Feedback

All the participants regarded this app project will potentially be very interesting and helpful. Some of them expressed their desire to participate into the developing process of this app. We received valuable comments and suggestions from the participants.

Regarding the set of R (reporting) designs in Figure 3, in general, participants thought it important and innovative to integrate phone call and text messaging together in the app. They also talked about when they would prefer to call and when to use the quick report function. For example, P2 said “If someone is stabbed, I would definitely call the police directly; whereas if I am a bit away from the incident and it is not an immediate danger, I will choose to type a quick message.” P3 said “I prefer typing message than making a call. P4 said “Now everybody uses text message. Making a call is kind of slow.” Most participants want to use this app not only to report the public safety incidents to DPS, but also share and comment the situation to their family or friends. For instance, P1 mentioned “I would post the accident not only to DPS but also to my friends so that more people may come and help me”; P5 affirmed that “I will definitely share the incident information to my friends, so that I could alert them as well”.

Regarding the set of L (Location) & P (Path) designs in Figure 3, all the participants were impressed by the design and the proposed functions. For instance, P7 said “I like this (adding area for notification) function and it makes a lot of sense to me because I can know what is happening at my family or friends areas and that is important to me.” P9 said “I would like to share the area information to my friends, so that in case I am not at my home and something happen at my parents’ or kids’ places, my friends nearby could help them.” P5 said “I hope that the paths function could recommend me the safest path, not necessarily the
shortest one based on historical stats. Then the app will be very helpful”. P6 also mentioned “I imagine that I would also share the path information with my friends or family.”

Regarding the set of S (Stats) designs in Figure 3, the participants expressed their particular favor to check the stats when they come to a new area and when they are find a route to some place. P5 said “I hope that the app could recommend me the safest path, not necessarily the shortest one based on historical stats. Then the app will be very helpful.” P2 also expressed the S designs can be simplified by removing the line chart.

Regarding the set of A (Alert) designs in Figure 3, participants are willing to share and comment on event notification. Most of our participants regarded the share and comments features very useful when they imagined themselves receiving public safety notifications. They further emphasized their willingness to spread out the notification to let more people know the incidents, and to make comments and read from others. For instance, P7 and P9 made the similar comments “I would like to make comments, particularly to my friends, and read other people’s comments on the incident as well.” P5 said “I will definitely share the incident information to my friends, so that I could alert them as well.”

4.2.3 SUS Scores

There are ten questions used in SUS. Those in the white boxes are positive ones and those in the gray boxes are negative ones. To calculate the SUS score, we first sum the score contributions from each item. Each item’s score contribution will range from 0 to 4. For item 1,3,5,7 and 9, the score contribution is the scale position minus 1. For item 2,4,6,8 and 10, the contribution is 5 minus the scale position. Multiple the sum of the scores by 2.5, we can obtain the overall value of SUS.

According to Figure 4, P3 gave the lowest score, and he explained that “I think this app should be separated into several independent apps. I like an app with only one function. I like the app to be as simple as possible”. However, all other participants like to have different features integrated into one app, and many of them gave our design high scores.

<table>
<thead>
<tr>
<th>Question</th>
<th>AVERAGE</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
<th>P6</th>
<th>P7</th>
<th>P8</th>
<th>P9</th>
<th>P10</th>
</tr>
</thead>
<tbody>
<tr>
<td>I think that I would like to use this system frequently</td>
<td>4.1</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>I found the system unnecessarily complex</td>
<td>2.9</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I thought the system was easy to use</td>
<td>2.9</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>I think that I would need the support of a technical person to be able to use this system</td>
<td>1.8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>I found the various functions in this system well integrated</td>
<td>3.9</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>I thought there was too much inconsistency in this system</td>
<td>1.9</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>I would imagine that most people would learn to use this system very quickly</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>I found the system very cumbersome to use</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>I felt very confident using the system</td>
<td>3.7</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>I needed to learn a lot of things before I could get going with this system</td>
<td>2.3</td>
<td>3</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

**Figure 4: SUS Scores**

5 Discussion

5.1 Design Implications

We were inspired by three major observations obtained after studying the log data. (1) People report more from where they live. We developed the features allowing people to receive notifications within their interested areas. In the interview results, the top two places are their own home, and their family’s homes. (2) The uneven distribution of the reports at different streets or living areas highlights the needs of informing residents with the accuracy image of the local safety. In the interview results, people express the needs of path recommendation. (3) Around half of the reports are sent right after the incidents happened (ET = 0 hours).
We suspected people would still prefer to call the DPS even when they have the feature of reporting using text or phone. However, in the interview, some participants mentioned that they would still like texting, because they think it is more efficient, and a phone call could take more time. Also participants mentioned they would prefer to report instead of calling if the incidents are not urgent, or they are witness of the incident. Under-reporting could happen because after the incidents occur and some time elapsed, people may feel less likely to call the DPS or using the website form to fill out a report. Having the mobile app at hand, might encourage people to report the incidents any time. The process for witnesses to report is also made easier and efficient with the incorporation of an accessible report button in the mobile app.

The current safety reporting mechanism is point-to-point, which means one person can only report or inform the incident to one other person at a time. This seems to be very inefficient if the person’s desire is to be more social with his or her reporting. The S4S app would enable its users to share the incident information to many people at once, and allow users to write comments and read other people’s comments about the situation. This increased collaboration and interactivity can potentially promote a more engaged and safer community.

5.2 Privacy Concerns

We also expected people would have a lot of privacy concerns when reporting safety related issues. However, most of the students expressed that they would like to share their reports especially with their friends and they also would like to comment on incident reports and see others’ comments.

Accountability and reliability can also be a great attribute this app can be considered for. Accountability issues raise the potential risk of the public receiving false and malicious information through the mobile app’s social community.

We can target these situations from a design perspective by introducing a layer where users are required to sign up through the app, or sign up using a particular social networking site like Google, Facebook, Twitter. In such situations, DPS will have information of all the users and their information using this app. Therefore, in the case of anonymity, while other general users may not be able to find someone’s identity, the DPS can track the user through his/her post.

5.3 Community Perception

When we about talked the idea to some university staff, some expressed the concerns about showing the reports may not make the community look good. So there is a trade off between reporting transparency and community image. We asked our participants if they wanted to see data, and they all thought that they would like to see the data. However, we expect permanent residents who are very familiar with the community may prefer a more “friendly” way of delivering the information. P2 gave a good suggestion on balancing the tradeoff. We plan to study different design options of information delivery. Option 1: instead of showing all the stats, we may only show the real-time alert; Option 2: showing the major incidents within a time window; Option 3: giving prediction based on history reports, but not showing the exact reports. In the future, we will run survey studies to acquire people’s feedback and input on which option is preferable and why.

5.4 Challenges and Limitations on Data Analysis

The data analysis aspect of this study was exploratory. Using aggregation methods, snapshots of the public’s crowdsourced safety reports helped provide insights about how both the public and a DPS can help produce a safer community. Aggregated information regarding the time, location and type of incident can produce a more self-aware public, which will potentially decrease the overall volume of safety report filings.

However, there are several limitations and challenges in this data analysis. More years of data are needed to make a statistically based conclusion about the seasonal trend of safety report rate. Specifically, we were unable to quantify the student impact in safety reporting rate due to only having one year’s worth of data.

We also aimed to provide more information about how dangerous a specific street is. While the numerical volume of safety reports is known for each street, there was no way to quantify how dangerous the
specific volume of safety reports were. If there were a way to easily categorize incident types into ranked system of danger, then each specific volume of safety reports could receive a ranking as well. This would be very informative to include in the paper prototype as well.

There is also a limitation in the identification of an address as “Unknown” by smartystreets.com. Since we do not know whether the address of a report is in a Residential or Commercial area, these reports were not included in our location analysis. The number of these reports were small (n = 7).

6 Conclusion

The purpose of this paper is to design a mobile crowdsourcing, public safety app which is specifically tailored towards a university area. Relevant observations have been recorded from the data analysis procedure, and four design suggestions are developed for the mobile app design. The paper prototype has incorporated these design suggestions, and also included two additional features: (1) the ability to mass share an incident report, and (2) the enabling of witnesses to easily report incidents. Feedback from an interview study regarding the paper prototype is promising, including comments which suggested that the system was practical and informative. In future work, we plan to enhance the system according to the interview respondent’s suggestions, and deploy the system into the real world.

References

Table of Figures

Figure 1  (A1) Aggregated counts of safety reports during 2013. Year is subsectioned into three time periods, and slopes (m) from linear regressions are calculated for residential and commercial areas during each time period. (A2) Daily counts of safety reports during 2013. (B1) Histogram of hourly occurrence times over 24 hours from safety incidents located in a residential area (B2) Histogram of hourly occurrence times over 24 hours from safety incidents located in a commercial area (C1) CDF of safety report volume for unique addresses. (C2) CDF of safety report volume for unique streets. .......................... 4

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