

# Beware: Mobile and Web Application to Prevent Crimes against the Patrimony, Life, Body and Health

Alexa Tataje<sup>1</sup>, Marco Florián<sup>1</sup>

<sup>1</sup>Faculty of Engineering  
Peruvian University of Applied Sciences UPC,  
Lima, Peru  
e-mail: {u201112163, u813651}@upc.edu.pe

David Mauricio<sup>1,2</sup>

<sup>2</sup>Department of Computer Science, FISI  
National University of San Marcos UNMSM,  
Lima, Peru  
e-mail: dmauricios@unmsm.edu.pe

**Abstract**—Faced with the difficulty to know all the dangerous areas and find the latest information to avoid becoming the victim of a crime, this article proposes a mobile application for smartphones and smartwatches called *Beware*, which shows the dangerous zones within a specific geographical area according to the day and time of the week. This application also allows reporting emergencies to the corresponding emergency service entities and communicating events that put at risk the patrimony, life, body and health of other users and yourself. In addition, another Web application is proposed for the emergency service (police station, fire brigade or municipal patrols) responsible for receiving the emergency calls. User tests show that 14 out of 15 citizens consider that the proposed application is useful and very useful for public safety.

**Keywords**—geolocation; mobile computing; crime prevention; smartwatch.

## I. INTRODUCTION

Public safety is promoted worldwide to effectively safeguard the inherent human rights, particularly, the right to life, personal integrity, the inviolability of the home, and freedom of movement; however, over 1.5 billion people all over the world live in countries affected by violence, conflicts and high criminal rates; over 526,000 people are savagely murdered every year, which is slightly more than one person per minute [1].

The fight against citizen insecurity, in general, comes from the different government levels whether local, regional, central or federal, and is executed reactively, aimed to capture delinquents before or after the criminal activity takes place, or in a proactive manner by attacking the root causes of citizen insecurity. In both situations, the information and communication technologies are an essential tool. One way information technology is used for prevention are the so-called crime maps, which show information about the criminal activities within a geographical area. These are used in various countries, such as ‘CrimeReports’ [2] in the USA, ‘InstaGIS’ [3] in Chile, and ‘Onde fui Roubado’ [4] in Brazil. However, most are Web applications, which makes them less used than a mobile app. They do not present information in real time nor the crime intensity like a heat map.

This paper presents a smartphone and smartwatch mobile application that allows citizens to inform, in real time, about

the security level of the area where they are located, and report any crime or possible crimes. It also proposes a Web application to be used by the police so they can see the criminal activities and act. The use of a smartwatch is justified due to its ease of use, low cost and lower theft risk compared to a smartphone. In addition, it is estimated that sales will be of 66.71 million units in 2017 [5] and by 2020 it will become one of the most sold wearables [6].

This article is organized in 5 sections. In Section 2, we present a review of mobile and Web applications related to crime maps. Section 3 describes the proposed mobile and Web applications. The use of these applications in an area of Lima, Peru, and its results are presented in Section 4. Finally, conclusions follow in Section 5.

## II. RELATED WORK

There are four important aspects to consider when developing a crime map mobile application: data collection, data analysis, architecture and related applications.

The data is the most important component for the whole crime map. It must be timely, significant and of quality; however, many times this information is not available or accessible, therefore the work in this context is aimed at building a criminal database from different sources. The collection of data from sources such as websites, news sites, blogs, social media, and Really Simple Syndication (RSS) feeds is presented in [10]. In [12], the data is collected based on the information obtained from interviews with the police, reports and the documentation in the occurrence books. A crowdsourcing based mobile application that allows people to send information about criminal activities is presented in [14]. In *Beware*, we decided to collect crime information from different governmental sources and to use crowdsourcing, allowing users to report crime events into the mobile application.

Once the crime information is obtained, it is analyzed to make decisions. The analysis could be about the criminal activity spatial (geographical) behavior, criminal records, crime trend, or urban infrastructure, among others. In [7], it is explained that a factor that could help reduce citizen insecurity is the analysis of the spatial behavior of the delinquents known within their activity space (Crime

Theory), since it can determine the likelihood of possible crime places. In [8], Sathyadeyan et al, include criminal records for the delinquents, the causes for crime occurrence, and every day crime factors. An emergency management system for public transport, based on a Geographic Information System (GIS), is proposed in [9], which includes the crime trend, and guides police officers might use to capture the delinquents. An analysis of the urban aspects related to criminal activities is studied in [15], where it is concluded that there is a correlation between the streets width, the number of construction floors, the type of facilities and neighborhood, and the criminal activities. In our approach, we not only count the occurrences of crime events in an area, but also take into consideration the aspects of the streets in that area that might represent a risk for people. This could be, for example, if the area has been abandoned or it has drug addicts rounding the streets (Table III).

Several architectures have been proposed for systems related to public safety. A client-server software architecture to determine more accurately the police location is presented in [11]; this considers that the mobile device should have an Assisted Global Positioning System (A-GPS) and be compatible with a HyperText Markup Language version 5 (HTML5) geolocation so it can connect with Google Maps API and the data center through JavaScript Object Notation (JSON). In [14], the architecture is designed around cloud development with the integration of GPS functions. In the same manner, in [13], the use of GPS is incorporated in the software architecture, and this consists of five layers: information knowledge layer, business support layer, data layer, business application layer, and user level. For our application, we considered to use GPS functionalities to capture, in real time, the user's current location, and use the Google Maps API to show him/her current map positions as well as the dangerous zones and crime events reported around.

There are several mobile applications related to public safety that take into consideration a crime map and allow reporting criminal activities. In [12], the authors added a search functionality for information about arrested people, the display of a map with the crime zones, and it also accepts alerts about new crime zones. [10] allows the police to receive information about the citizen's location – by GPS – and for him/her to receive information about the closest police station. In [13], six crowdsourcing mobile applications were evaluated, among which we mention: CrimeWatch Mobile, which displays the crimes reported within a 1-mile radius around the user current position; Community Against Crime, which sends email or Short Message Service (SMS) notifications about crimes reported by a registered or an anonymous user; CommunityAlert that includes reporting floods or fires, which are sent to the closest police station; and MyDistress, from where the closest police stations can

be located. The application proposed in [14] also includes sending a report through short messages, and phone calls to all emergency contacts and institutions. A HTML5 based application that allows police officers to register a crime according to the GPS location at that very moment, attach pictures or videos related to the incident, and display on a map or chart the crimes reported, is proposed in [10]. In the Beware mobile application, it is not only possible to report a fixed type of event, as shown in Table II, but also any other incident or emergency as, for example, a land slide or flood. We added a type "other", which can be further explained by the user and viewable by others in the wall of events. Another useful feature added to the application is when a crime event (e.g. a house robbery or a fire incident) is reported close to a favorite location (e.g. your home, your university or your work) and a notification is sent to the user, so him/her can be timely informed.

Three mobile applications were selected to analyze their features. These applications were downloaded and installed on mobile phones that supported Android. Table I shows the summary of each criteria we used for this analysis.

Y = if the application complies with the feature.

TABLE I. SUMMARY OF ANALYSIS

Feature	Applications		
	<i>Community Against Crime</i>	<i>Community Alert</i>	<i>MyDistress</i>
View crime list	Y		
Share GPS coordinate to local authority	Y	Y	Y
View nearest police station		Y	Y
Send email/SMS about crimes	Y		
Share crime with others	Y	Y	Y
Share crime incident through social media	Y		
Send help alert to local authority		Y	Y
Send report to emergency contacts		Y	
Capture and share photo	Y		
Capture and share video	Y		
Integrate with a Web application	Y		
Coverage area	Malaysia Singapore	Australia	Malaysia Singapore

Based on the evaluation of the applications, it was observed that the three applications do not show the reports of crimes on a map. Only one of them allows to show them in a list (Community Against Crime). In the case of the Community Alert, it allows to notify the user's emergency contacts and shows the crime events, but in a general way

and without evaluating if they are close to the user. Two of the applications have not been updated in 4 and 5 years, and none of the three applications perform an analysis of the information shared by their users. In comparison to Beware, the crime reports users share are used to create dangerous zones, as well as official police records. This way, it is possible to provide more reliable information, since there is a risk that they will register non-real crimes. In addition, hazards that exist on the streets (Table III) and the possibility of notifying emergency contacts are included to create dangerous areas. Additionally, the application notifies the user when entering a dangerous area, sends the location and report information to a local authority and the emergency contacts if requested, displays a map with the crimes closest to the user's location and a wall with the list of crimes that includes photographs.

### III. BEWARE

#### A. Background

A mobile application called *Beware* has been developed. Its main objective is to warn citizens when they enter a dangerous area, report any crimes or risk events, and request assistance from an entity or emergency contact. To respond quickly to a criminal activity, the application has been designed to be used also by the security staff, police stations and fire stations. Also, with the information gathered, it is possible to generate a report of the crimes that are not reported to the police station and, in this way, create action plans.

Figure 1 shows the interaction between the citizen and the functionalities that Beware offers.

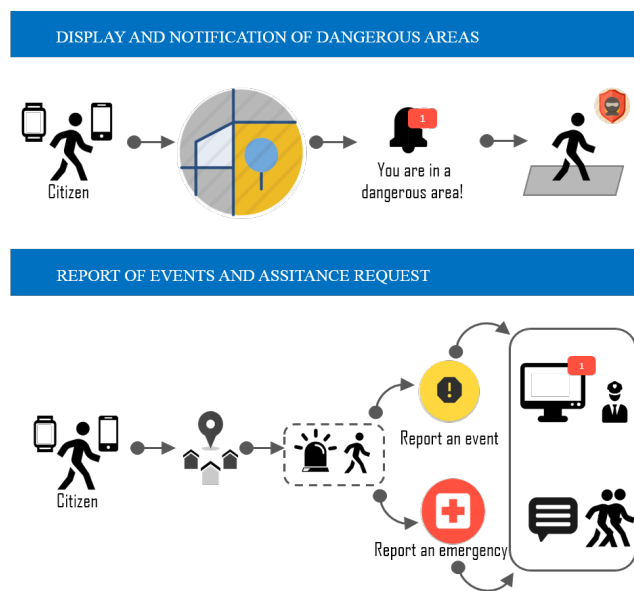


Figure 1. Beware flowchart.

#### B. Development

##### Data Analysis

The five steps for unstructured data analysis proposed in [8] and the criminal activities grouping given in [9] were considered. To collect data for the first time, public information sources were chosen, which are shown in Table II. After implementing the mobile applications for smartphones and smartwatches, these will be included as information sources for documenting new crimes.

TABLE II. PUBLIC INFORMATION SOURCES USED

Information source	Information used
Public Safety Local Plan	Crime map, Risk map, Critical points, Incidence detail about the crimes occurred
Surveillance staff opinion	Occurrences during their shift

The Public Safety Local Plans were reviewed to obtain a standard of the variables. We choose the most important variables that affect the citizen's patrimony, life, body and health. There were also interviews to obtain information, opinions and suggestions from the surveillance staff.

Regarding the data analysis, the most relevant crimes and risks were taken into consideration; these are listed in Table III. To identify delinquency patterns and trends within a specific place, the collected database was analyzed, which was spread according to the day of the week (7 days), hour range (every 6 hours), the amount of crime events (3 crimes or more) and how close these events are between each other (50 meters or less). The result of the analysis while identifying the pattern showed the places with the highest concentration of reported crimes, which, when manually grouped in polygons, form the areas with a delinquency index. The type of risks occurring in those polygons was also identified.

TABLE III. TYPE OF CRIME AND RISK

Type of crime	Type of risk
Burglary	Scarce lighting
Robbery of an establishment	Concentration of drug addicts
Personal theft	Abandoned area
Car parts theft	Concentration of alcoholics
Vehicle theft	Construction area
Scam	Street vendors
Micro drug trafficking	Informal bus stop
Clandestine prostitution	Frequent fights
Pernicious gang activities	

To obtain the areas prone to crime, we first identify the crime type level (Table IV), then the risk type level (Table V), and finally the crime percentage level that the created area contains. The crime type level refers to the occurrence degree and the crime priority at national level. The risk type level represents the degree it would harm a person while

being near to a risk type, where the highest number is what would cause the most harm.

TABLE IV. CRIME TYPE LEVEL

Degree	Crime Type Level
5	Drugs and murder
4	Personal theft
3	Burglary, car parts or car theft
2	Robbery of an establishment, scams
1	Other (pernicious gang activities, clandestine prostitution, injuries)

TABLE V. RISK TYPE LEVEL

Degree	Risk Type Level
6	Concentration of drug addicts
5	Scarce lighting
4	Abandoned area
3	Concentration of alcoholics
2	Construction area
1	Other (street vendors, informal bus stop, frequent fights)
0	No risk

To qualify and visualize the crime level, the following concepts were taken into consideration. The crime percentage level within an area is the percentage that the criminal activities grouping represent compared to the total number of crimes that occurred within a day of the week and time range in that area. The danger value represents the amount of danger that exists in that area, and the danger level is the danger category to which each area belongs (Table VI). The danger value has been created from the International Standards Organization (ISO) 31000 risk management concepts, where the risk and type of impact are identified [16]. The risk represents the crimes and risks from Table III, and the type of impact are the levels in Tables IV and V.

TABLE VI. DANGER LEVELS

Classification	Lower Limit	Upper Limit
Very high	7.01	10
High	5.01	7
Medium	3.01	5
Low	1.01	3
Very low	0.00	1

The classification in Table VI is related to the ISO 31000, while the lower and upper limit ranges of the danger levels have been determined first by the maximum upper limit mean; from there, the areas with values higher than the midpoint were divided to be classified as “High” or “Very High”. Meanwhile, values lower than the midpoint were established with a 2-difference-value interval for “Medium” and “Low”, and finally, “Very Low” for values no greater than 1.

Equation (1) determines the danger value:





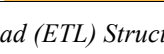
$$\text{Danger value} = \frac{(d + NPDP)}{2} + \frac{(NTD + NTR)}{2} \tag{1}$$

Where:

- **d**: Total crimes grouped in the area.
- **NPDP**: Percentage level of crimes within that area.
- **NTD**: Crime type level.
- **NTR**: Risk type level.

Each danger level is associated with a color, which can be seen when painting each dangerous area in the map of the mobile and Web applications (Table VII).

TABLE VII. DANGER LEVELS ACCORDING TO COLOR

Classification	Color	Value
Very high		c62828
High		d84315
Medium		ef6c00
Low		ff8f00
Very low		f9a825

*Extract, Transform, Load (ETL) Structure*

Aside from the information gathered, an ETL structure had to be done to elaborate the database. The data stored in the flat files and Web Services is extracted, then the transformation of the types of data from the corresponding fields takes place, and these are loaded into the database tables. For this, the quality of the data collected was verified wherever inconsistent terms were found, blank spaces and street names written backwards (e.g., Chavez Jorge instead of Jorge Chavez). The latter made it difficult to obtain the coordinates. To find the address where a crime occurred, it was necessary to make a connection with the Google Maps API to obtain the latitude and longitude through JSON, which were stored as spatial data in the database. The risks and crimes were associated to the geographical location (latitude and longitude), time, date, type and address where it occurred.

*Software Architecture*

The software architecture focuses on Model, View, and Controller (MVC), the geolocation services in the Google Maps API and the use of a cloud platform for the Web Services that the applications consume, as well as the PostgreSQL database with a PostGIS extension [17]. Next, the logical and physical architecture diagrams are shown.

*Logical Architecture Diagram*

In Figure 2, the logical architecture diagram describes the breakdown in the software architecture layer, which goes down to the level of the server containing them.

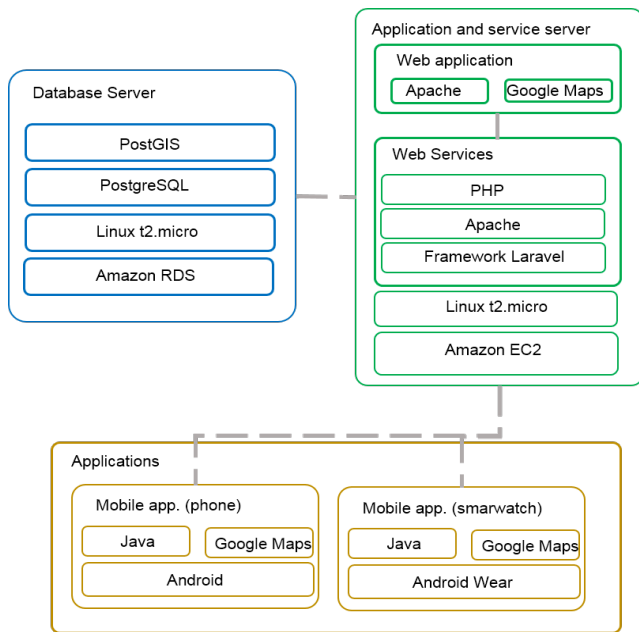


Figure 2. Logical architecture.

*Physical Architecture Diagram*

In Figure 3, the physical architecture diagram shows the Web Services and the Web application stored in the same Amazon Web Services Elastic Compute Cloud (Amazon EC2) instance. The Web application, Web Services and smartphone application require Internet to work, while the smartwatch application requires to be connected to the Internet via Bluetooth to the smartphone.

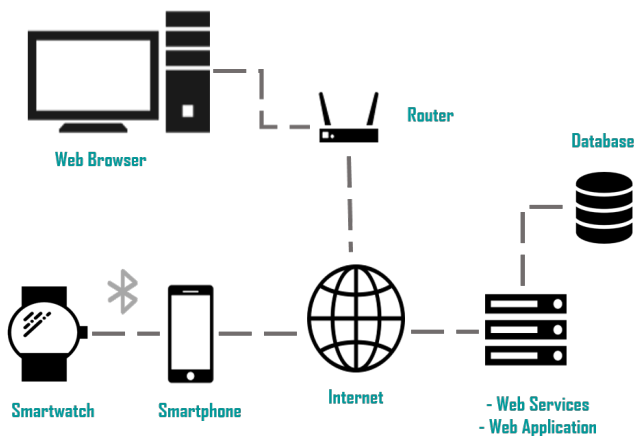


Figure 3. Physical architecture.

*C. Final product "Beware"*

*Mobile Application*

In the mobile application for smartphones (Figure 4), the users can see the areas with a security index and receive a

notification when they are in one of them, register their emergency contacts, add their favorite places, enter relevant personal information that would be used in case they require medical assistance (blood type, allergies, medication), and report events according to their type. The users can also send their information and location automatically when requesting assistance through the alarm button. Aside from all this, they can view the reports from other users on a wall.

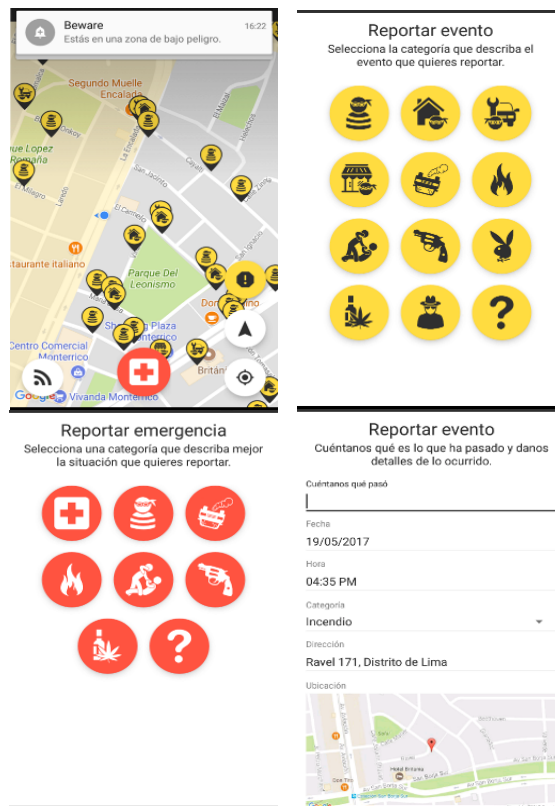


Figure 4. Mobile application interfaces for smartphones.

In the smartwatch application (Figure 5), users can see the map with a security index and receive a notification when they are in one of them, as well as request assistance quickly so the command center can obtain their location and personal information, and send a SMS to his/her emergency contacts.

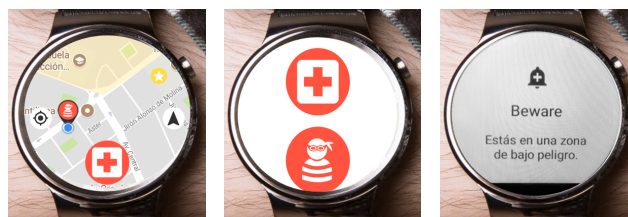


Figure 5. Smartwatch application interfaces.

*Web Application*

In the Web application (Figure 6), called Command Center, all the notifications that the users have made can be seen in real time. This platform is meant for the municipality patrols, where they register their security members. They are granted access through a Quick Response (QR) code generated by the mobile application. Inside the application, they can obtain all the information of an emergency event, such as the address, map location and information of the user who reported this emergency.

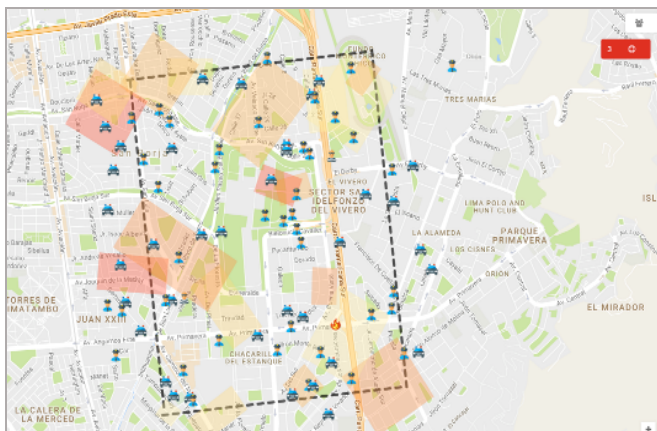


Figure 6. Web application interface (command center).

The access to this platform will be only for authorized security staff, since it shows the location of all the security staff that is on foot or inside a vehicle.

IV. VALIDATION

For the validation, we performed some tests and a survey about the usability, functionality and input from mobile and Web applications related to public safety.

A. Design

We performed a test to obtain the satisfaction level of the citizens from the Santiago de Surco district in Lima, Peru. In the first part, each participant would replicate the applications functionalities. For the second part, they had to answer questions about “Beware” after their experience with the application.

The sample area, in the Santiago de Surco district, was from the Primavera Bridge until the Peruvian University of Applied Sciences (UPC), from 13:00 to 18:00 hrs. on a Monday. Figure 7 shows the dangerous area and its danger level within the selected hour range and day of the week.

Prior to the test, the participants should have installed the mobile application “Beware” on their smartphones and two of them should have configured and installed it on their smartwatches. For the Web application, it was only necessary to have access to the URL, and the test user name and password.

Table VIII shows the characteristics of the participants who did the test.

Sex: F= Female, M= Male

TABLE VIII. CHARACTERISTICS OF THE PARTICIPANTS

Cod.	Age	Sex	Type of visit	Frequency (days of the week)	Type of device
P01	24	M	Health	Monday, Wednesday, Friday and Saturday	Smartphone
P02	28	F	Leisure	Friday, Saturday and Sunday.	Smartphone
P03	26	F	Studies	Friday, Saturday and Sunday.	Smartphone, smartwatch, Web
P04	30	F	Leisure	Monday, Tuesday, Friday, Saturday and Sunday	Smartphone
P05	18	F	Lives in the district	Everyday	Smartphone
P06	18	M	Studies	Monday to Thursday	Smartphone
P07	26	F	Lives in the district	Everyday	Smartphone
P08	18	F	Leisure	Friday	Smartphone
P09	24	F	Lives in the district	Everyday	Smartphone
P10	19	F	Leisure	Friday and Saturday	Smartphone
P11	28	M	Work	Monday, Tuesday and Thursday	Smartphone
P12	33	M	Studies	Tuesday and Thursday	Smartphone
P13	26	M	Work	Monday to Friday	Smartphone
P14	27	M	Work and lives in the district	Everyday	Smartphone
P15	28	F	Work	Monday to Friday	Smartphone

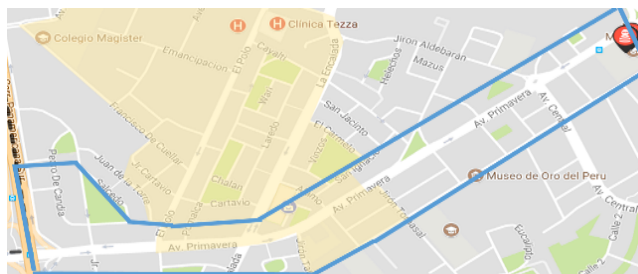


Figure 7. Area chosen for the test.

Table IX shows the questions the participants were asked once the mobile and web application test concluded.

TABLE IX. QUESTIONS ASKED

Cod.	Question
Q01	How much did the application help you to identify the dangerous areas?
Q02	How easy was it for you to use the application?
Q03	How useful do you consider the “Beware” application is?
Q04	How often would you use the application to report an emergency or event?
Q05	Would you recommend this application to identify which are the dangerous areas?

The scale used to measure the answers is in Table X.

TABLE X. MEASUREMENT SCALE

Scale	Score
Not at all	0
Very little	1
A little	2
Moderately	3
Very/Much	4
Extremely	5

### B. Results

Table XI presents the results obtained per each respondent and the questions average. These results are interpreted in a qualitative way, matching the scores to the defined scales in Table X.

TABLE XI. SURVEY RESULTS

Cod.	Q01	Q02	Q03	Q04	Q05
P01	4	4	4	3	5
P02	4	3	4	4	4
P03	5	5	5	5	5
P04	5	5	5	4	5
P05	5	5	5	4	5
P06	5	5	5	5	5
P07	3	4	2	1	3
P08	4	0	5	3	5
P09	4	5	5	5	5
P10	5	5	5	5	5
P11	5	5	4	4	5
P12	4	5	4	2	4
P13	5	4	5	4	5
P14	4	5	5	5	5
P15	5	5	5	4	5
<b>Average</b>	4.47	4.33	4.53	3.87	4.73
<b>Sample Standard Deviation</b>	0.64	1.35	0.83	1.19	0.59

According to the survey results, in question 3, 90% of the participants consider the applications to be “Very useful” and “Extremely useful”. Question 4 shows that 77% of the participants would frequently report events or emergencies. Questions 1 and 2 show how easy is to use the applications and that they help them “Much” to identify the dangerous areas.

It can also be observed that for participant P07, who lives in the district, the application helps him “Moderately” to identify the dangerous areas, while for most who visit the area a few days a week it helps them “Much”.

In summary, it could be concluded that there is a favorable acceptance for applications that identify dangerous areas and their ease of use.

### V. CONCLUSION AND FUTURE WORK

In this paper, a mobile application for smartphones and smartwatches was implemented. It displays and notifies which are the dangerous zones within a geographical area, and allows reporting emergencies and/or events. There is also a Web application to receive the emergency alerts from the users and manage the security staff who oversee these emergencies.

Public safety requires constant citizen participation since there is a lack of reporting in the police stations. Therefore, the use of GIS technologies helps to locate the exact place of a crime, analyze various factors that influence the reduction of citizen insecurity, and detect new places prone to crime. Another requirement is that all the criminal information should be stored in a single place to avoid losing data, and that at the same time it is presented in a friendly and updated manner.

The mobile application “Beware” for smartphones and smartwatches, allows citizens to be alert and take the necessary measures when entering into an unsafe area, so they can avoid becoming victims of a crime against their patrimony, life, body and health, as well as to participate in the reporting of criminal events that are not documented in the police stations, and safeguard their lives by sending an emergency report. The “Beware” Command Center allows the Municipality to know the crimes that occur during the day, detect new areas with a security index, know the location of their security staff so they can attend immediately to emergency alerts and, from the information gathered, create new action plans to reduce citizen insecurity.

The validation of the usability, functionality and security perspective of these applications is through a user experience test, which ended with a survey. It showed that the applications comply with the functionalities mentioned and that are easy to use. Also, the survey showed that the application helped to identify new dangerous areas that the participants were not aware of despite that they visit the place regularly. Thus, 14 out of 15 citizens consider that the proposed application is useful and very useful for public safety.

As for future work, we intend to develop an algorithm that generates automatically the dangerous areas from spatial data. This would decrease their creation and storage time. Likewise, we are also interested to use crowdsourcing.

### REFERENCES

- [1] UNDP: Issue Brief: Citizen Security Crisis Prevention and Recovery. United Nations Development Programme (2012). [http://www.undp.org/content/dam/undp/library/crisis%20prevention/30012013\\_citizen\\_security\\_issue\\_brief\(English\).pdf?download](http://www.undp.org/content/dam/undp/library/crisis%20prevention/30012013_citizen_security_issue_brief(English).pdf?download), [retrieved: 2017, 08]
- [2] <http://www.crimereports.com/>, [retrieved: 2017, 08].
- [3] <http://www.mapadelito.cl/>, [retrieved: 2017, 08].

- [4] <http://www.ondefuiroubado.com>, [retrieved: 2017, 08].
- [5] Garnet, "Gartner says Worldwide Wearable Devices sales to grow 18.4 percent in 2016", Febrero 2016. <http://www.gartner.com/newsroom/id/3198018>, [retrieved: 2017, 09]
- [6] CCS Insight, "Wearables Momentum Continues", 2016. <http://www.ccsinsight.com/press/company-news/2516-wearables-momentum-continues>, [retrieved: 2017, 09]
- [7] M. A. Tayebi, M. Ester, U. Glasser, and P. L. Brantingham, "CRIMETRACER: Activity Space Based Crime Location Prediction", ASONAM 2014 - Proceedings of the 2014 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining, pp. 472 – 480, 2014.
- [8] S. Sathyadayan, S. Gangadharan, and D. M. S., "Crime Analysis and Prediction Using Data Mining". 1st International Conference on Networks and Soft Computing, ICNSC 2014 – Proceedings, pp. 406 – 412, 2014.
- [9] R. Liu, G. Su, W. Tang, and H. Su, "PTEMS: A Novel Public Transportation Emergency Management System Based on GIS", Proceedings of the 1st ACM SIGSPATIAL International Workshop on the Use of GIS in Emergency Management, 2015.
- [10] W. Jakkhupan and P. Klaypaksee, "A Web-based Criminal Record System Using Mobile Device: A Case Study of Hat Yai Municipality", Proceedings - APWiMob 2014: IEEE Asia Pacific Conference on Wireless and Mobile 2014, pp. 243-246, 2014.
- [11] T. Mantoro, Feriadi, N. Agani, M. A. Ayu, and D. Jatikusmo, "Location - Aware Mobile Crime Information Framework for Fast Tracking Response to Accidents and Crimes in Big Cities", Proceedings - 3rd International Conference on Advanced Computer Science Applications and Technologies, ACSAT, pp. 192-197, 2015.
- [12] C. Oduor, F. Acosta, and E. Makhanu, "The Adoption of Mobile Technology as a Tool for Situational Crime Prevention in Kenya", IST-Africa Conference Proceedings, pp. 7 – 9, 2014.
- [13] I. Ariffin, B. Solemon, and W. M. Luqman Wan Abu Bakar, "An Evaluative Study on Mobile Crowdsourcing Applications for Crime Watch", 2014 International Conference on Information Technology and Multimedia (ICIMU), pp. 335 – 340, 2014.
- [14] S. T. Zeng and C. M Lee., "Personal Emergency Notification Application Design for Mobile Devices", 2014 International Symposium on Next-Generation Electronics, ISNE 2014.
- [15] K. Leong and S. C. F. Chan, "A content analysis of web-based crime mapping in the world's top 100 highest GDP cities. Crime Prevention and Community Safety", pp. 1-22, 2013.
- [16] <http://www.poder-judicial.go.cr/controlinterno/index.php/informacion-general-gestion-de-riesgos?download=99:resumen-iso-31000-gestion-de-riesgos>, [retrieved: 2017, 08].
- [17] <https://postgis.net>, [retrieved: 2017, 08].