# Smart Services: A Case Study on Smarter Public Safety by a Mobile App for University of São Paulo

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***Abstract*—The University of São Paulo has faced public safety issues a long the years. Due to its size preventive surveillance by the campus security guard cannot be effective all the times. In order to bring a safer environment to its public of more than 60,000 daily users, a smart public safety system is being developed. This is a complex system, spread throughout all the University's campuses. It is composed of a smart surveillance cameras system, a back office system with a workflow engine and a mobile application within a collaborative concept. The smart cameras system is being deployed and the mobile application together with the back office system is being used this past year with satisfactory results. The mobile application is the user entry point to report several security and campus maintenance related issues that are automatically directed to the responder team for immediate action in the case of security or enters an automated workflow engine in the case of campus maintenance. This paper presents the structure created towards achieving a smarter public safety environment, details of the implementation, presents statistical data collected by the system showing its effectiveness and concludes showing the improvements introduced in the university community safety and welfare.**

***Index Terms*—smart service, public safety, campus maintenance, mobile application, collaborative community.**

## I. Introduction

The University of São Paulo is the largest university in Brazil spread throughout eleven campuses, including four museums, two hospitals, with a total area exceeding 76 million $m^2$, has nearly 90,000 students in undergraduate and graduate courses, around than 6,000 professors and 14,000 technical-administrative staff. The USP campus at São Paulo, the capital of the state, alone has an area of 7.5 million $m^2$. It is called "University City", or more formally "Cidade Universitária Armando Salles de Oliveira" (CUASO), and is responsible by itself for most of the campus maintenance services independent from the city where it belongs. Each campus has its own Security Guard Team that has a 24 by 7 dispatch center. Their routine includes preventive rounds in the campus grounds, answering to traffic accidents inside the campus, response to the USP community in case of emergencies. Due to the dimensions of some of the campuses immediate response to user's emergencies are not always possible.

In an effort to create a smart public safety system in all the university campuses, a smart surveillance cameras system is being developed and deployed. This system, aided by advanced image processing algorithms embedded in analytical software packages, allows the Campus Security Guard to be virtually present in every corner of the whole area of the university 11 campuses.

Another component of the smart public safety system is a mobile application that is a way of connecting the community of users (students, faculty and staff) of each campus to the university care teams. The mobile application collected information provided by the users is displayed together with the cameras system images in the Security Guard Dispatch Center to help the response team to narrow down potential problems and take immediate actions, reducing false alarms, response time and costs associated.

Using a mobile application in smartphones in this context brings some benefits in the interaction with the response teams:

- user current location by GPS;
- current time of the report;
- send visual information using camera;
- send audio and text information;
- directly contact security dispatch center by telephone.

The creation of a mobile device application that can be used by every member of the university community that has an University ID was a solution found to improve the users safety and bring them a better environment through a collaborative action. Using the mobile application the user can expect immediate response from the Campus Security Guard and also can report problems such as damages in the streets, water leakage and illumination faults, that are schedule for maintenance in a back office workflow system.

The mobile application main objectives are:

- Improve communication between the user and the university response teams;
- bring *de facto* sense of safety to the users;
- assist university's security team to shorten response time during user emergency;

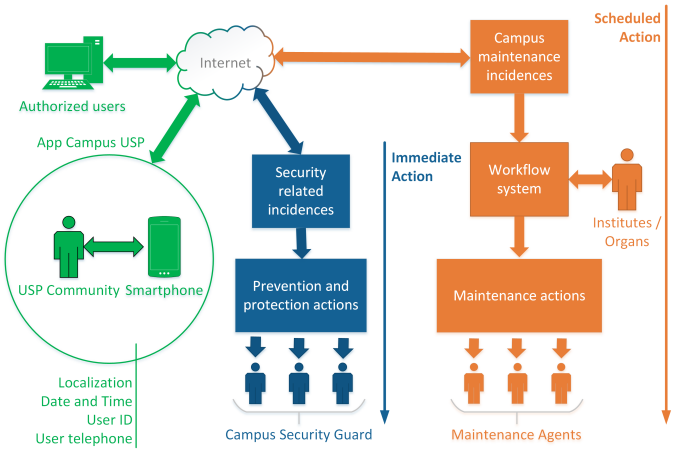



Figure 1: Campus System structure

- create a collaborative community inside the campuses to maintain users safety and care for university's property.

## II. System Structure and Particularities

The mobile application, called "Campus USP", brings to the University of São Paulo community a point of entry for reporting security related incidents for the local Campus Security Guard, including emergencies, and for reporting damages in the campus property to the local maintenance office. this application, together with the back office system is being called "Campus System", which schematic diagram is shown in Figure 1. The Campus System is being integrated with the smart surveillance cameras system, called "USP/EMS", that together provide a complete solution for a smart public safety system for the University of São Paulo.

The diagram shown in Figure 1 represents the components of the Campus System structure where the university community, represented by students, professors and technical – administrative workers, uses its own device to connect through the Internet to the specific system. A web browser interface is also provided to the users, not only for reporting incidences but also for checking statuses of on going actions and statistics of the campus wide past and closed cases. The two back office systems have different structures. The part of the system that receives security related incidences is designed for immediate action, practically displaying the reporting user information in real time in the Security Dispatch Center that coordinate actions of the security agents in the field. The other part of the system that receives campus maintenance incidences is designed as a workflow engine that allows the follow up of the complete process that can take longer periods of time to be completed depending on the services required.

One important feature of using a mobile application in a smartphone is the user current locations can be detected. This information is used to configure some features automatically:

- Constrain the use of the application to a certain radius inside each campus, so that an off-campus user cannot report security nor maintenance incidences.
- Select the appropriate Security Guard local telephone number to the campus where the user is in at the moment of the report. Using this feature the user do not have to know any Security Guard telephone so he or she can always reach the nearest dispatch center.
- In the case the user is unable to to talk to the phone or is in a severe situation, the Security Guard Dispatch Center can use the user's location to send a vehicle without any further delay.

### A. Integrating the Campus System in the USP/EMS

The Campus System is an important module that integrates the monitoring environment for security purposes, a smart surveillance cameras system, called "Sistema de Monitoramento Eletrônico" (Electronic Monitoring System) and is abbreviated as USP/EMS, or simply "camera network". The USP/EMS system will generate significant video data (hundreds of TB every month) for a variety of public safety and transportation applications. The USP campus security guard department is the main operator of these applications, but the Office of Information Technology (STI – Superintendência de Tecnologia de Informação) manage the entire USP/EMS system as well the data centers that store and process the video data.

The implementation of USP/EMS is divided into two phases. The first phase is the installation of a fiber network called GPON (Gigabit Passive Optical Network), augmented by high speed wireless coverage. The main trunk of GPON consists of a 144-fiber bundle in a ring configuration that run alongside the main campus roads, plus all entrances and exits. In addition, high speed wireless networks that cover strategically sensitive areas, e.g., bank agencies have been connected to GPON. The first phase has been substantially completed by the end of 2016. Further plans are in place to add 4G LTE coverage for the entire campus. The second phase consists of the installation of video cameras and their connection to GPON and USP data centers. The budget for the second phase has been approved and allocated; the bidding process is about to be completed (as of March 2017), with the completion of actual camera installation expected by July 2017.

*1) USP/EMS System Architecture:* The USP/EMS covers the entire Campus of São Paulo (CUASO). The video cameras are connected an optical fiber network, which has high-bandwidth connection to the InterNuvem USP (a network of data centers operated by the STI) and the rest of USP through an existing network called USPnet. The application command center is connected to USPnet, and the rest of the USP/EMS system. The EACH campus, which stands for "Escola de Artes, Ciências, e Humanidades" (School of Arts, Sciences, and Humanities), located on the East side of City of São Paulo, also known as "USP Leste" is also integrated in the USP/EMS. Further references to EACH will be omitted since operationally it will be a smaller scale mirror installation of CUASO, in hardware, software, and applications. On the positive side, EACH will contribute additional data for research

when it is completed (in approximately two years). Beyond CUASO, this network is linked to the Brazilian National Network for Research and Education (RNP) and the several data centers that serve all 11 USP campuses spread through various cities in the state of Sao Paulo.

The second phase of USP/EMS installation consists of an initial deployment of 222 cameras covering the gray areas. The optical network runs underground. The cameras are mounted on poles, with wired connections to splitters (in two levels) located in underground boxes of GPON.

*2) Data Produced and Stored:* The initial deployment is expected to generate about 0.5PB of video data (H264) per month. This estimated value is based on the following assumptions: (1) motion detection and same-image removal will reduce the data volume by 50%; (2) image resolution of full HD at 720p to 1080p, at 30 fps. Although the USP InterNuvem total storage capacity is rated at 8PB, it will be too expensive to store 0.5PB/month. The managerial (cost-based) allocation for storage is 100TB for the most recent month data (likely implemented by a reduced frame rate of 8 fps) and 150TB per year (at reduced resolution of VGA and frame rate of 4 fps).

*3) Operational and Analytical Uses of Video Data:* For USP security guard department operational use, the USP/EMS video data will be displayed in a video wall at the command center, plus individual screens for the operators. The operators examine the video images manually and detect any anomalous behavior such as a robbery, or problems such as traffic jams due to an accident. Another way to examine the video data is using analytical software that is integrated with operational use. The Campus System has a fundamental contribution for automatic identification of anomalous behavior. Based on annotations captured by Campus System and reported by analytical software, the camera network helps operators to identify automatically anomalous behavior. This is the main functionality of the Campus System to the USP/EMS.

## III. Mobile Application Implementation

The mobile application was implemented to iOS and Android platforms. When the mobile application is used for the first time a text explaining how the application works and what user information is being sent is presented to the user. Once the users accepts the terms of usage, information share and logs into the system, he or she has access to the application functions. The application visual arrangement and user interface where designed to be simple a use a minimum number of touches to execute the desired function. The primary interface has only 4 buttons: Report Incidence; Emergency Call; Security Map and Enter "Watch Over Me" state. Figure 2a shows the Android version screen with the buttons covering most of the screen area so that the user is able to touch any of them even in stress moments.

### A. Report Incidence

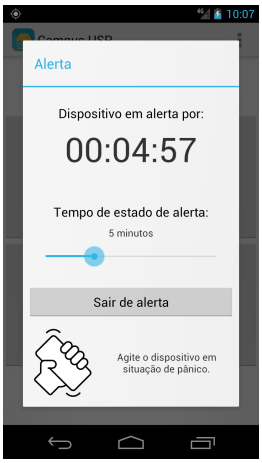
The Report Incidence button leads to the second screen, shown in Figure 2b, where the user can chose the type of incidence to report. The user does not have to know beforehand whether the incidence to be reported is related to personal or campus security or campus maintenance, least of all to which part of the back office system it is going to be sent to.

By choosing one of the incidence types the user is directed to the screen where he or she can input information about the specific incidence type that is to be reported. The incidence can be something that is happening to the user at that moment, something that he or she is witnessing or something that the user saw in his or her path and wants to report later. Usually, the first two cases can be related to both security incidents


(a) Main screen of the Android version of the mobile application. Buttons are in Portuguese, in a clockwise order from top left: Report Incidence, Emergency Call, Security Map, Enter "Watch Over Me" state.


(b) Incidence type selection screen. Buttons are in Portuguese, from top left to bottom right order: Theft or Robbery, Kidnapping, Suspicious Activity, Vandalism, Traffic Problems, Pavement Damage, Public Lightening, Water Leakage, Animals in the Campus, Fire, Medical Emergency, Violence Against Women.


(c) Example of Theft or Robbery report screen




(d) "Watch Over Me" state control screen

Figure 2: Screens of the Android version of the mobile application "Campus USP"

and campus maintenance and the last one is related to campus maintenance only. In the screen example, shown in Figure 2c, the user can attach a camera or album photo, a piece of audio, in the case of emergency related incidence only, a text description, that is optional, call the security dispatch center directly and type a reference about the locale of the incidence, mandatory in the case of campus maintenance incidences only as the user can be in another place different form where the incidence is.

In the case of security related incidences reports, as soon as the user touches the button to send the report, a map in the security dispatch center computer screen displays an icon related to the type of incidence in the user location and also the user's name and phone number. Also, and audible alarm goes off. By clicking in the map icon, the operator have access to the incidence related information: photo, audio and text description. The operator can then take the appropriate action required by the type of incidence and the user provided information. The same process applies if the user calls directly. In this case, the operator will know in what type of situation the user is in by the icon type in the map even if the user did not provide more detailed information.

### *B. Emergency Call*

When the Emergency Call button is touched the local campus security dispatch center is called from the users phone and, in the same way as in the incidence report, an icon is displayed in a map showing that an emergency situation is in progress. Immediate action can be taken including sending a vehicle to the user location. This type of call is handled with much higher priority than the call originated form the incidence report case.

One important feature when using smartphones is that the application, through the user location, dials the correct campus local number without any knowledge of the dialed number by the user.

### *C. Security Map*

The Security Map button, when touched, shows a map with past security incidences for a selected period of time. This is a statistic data that is presented to the user as a feedback of the Campus Security Team work and so the user can avoid certain areas at certain times.

### *D. Enter "Watch Over Me" state*

The university campuses are wide areas where the users usually walk from one building to another. The Enter "Watch Over Me" state button was created so the user can alert the Security Dispatch Center that he is going to be walking around the campus and if he needs assistance due to a risk situation, he is going to alert the dispatch center by shaking his phone. So when the user enter the "Watch Over Me" state, his location and selected time period is sent to the dispatch center. If within the defined period of time, the user shakes his phone and sends an alert to the dispatch center, a vehicle is immediately sent to the user location. If the defined period of time expires, the alert condition for this user ends and is erased form the list of users under "Watch Over Me" state. This feature is particularly of interest of people walking alone during the evening period.

Figure 2d shows the Enter "Watch Over Me" state configuration and control screen where the user can set the time interval to be in the "Watch Over Me" state from 1 minute to 15 minutes. The user also can control entering in and exiting from the "Watch Over Me" state. While in the "Watch Over Me" state, the phone monitors its movement. For a user privacy reason, the user location is not sent continuously to the dispatch center. Only the user initial location when enter in the "Watch Over Me" state is sent and in the case of phone shaking.

## IV. Case Study

The Campus USP mobile application has been in use for almost a year now, with around 12,000 installs in iOS and Android versions. Table I shows the security related incidences reported by the application by campus and type of request for the last 6 months. The numbers shown in the Table represents processes that where opened through the application, demanded an action form the security guard and where closed after solved. As the university campus at São Paulo is the largest, as expected, security problems are more numerous.

In the campus at São Paulo, the Security Guard response time before the introduction of the mobile application was between 8 and 10 minutes. After the app introduction, it was reduced to 5 to 7 minutes. This reduction was possible because when the user uses the application his location and identification is displayed in the Dispatch Center so the operator can skip some questions to the user and dispatch the nearest vehicle to the incident location almost immediately.

## V. Conclusion

The Smarter Public Safety Service described in this paper for the University of São Paulo's campuses is undergoing continuous improvements and expansion. The two major components (Electronic Monitoring System – EMS – and Campus USP mobile app) have evolved from state-of-the-art, but manual services. The EMS (to be installed during 2017) builds on, and replaces, an existing CCTV (closed circuit TV) monitoring system entirely based on human monitors. The EMS will incorporate smart and automated recognition capabilities, including license plate reading, motion-sensing, crowd recognition (group of people or vehicles). These new recognition capabilities will facilitate the construction of next generation smart public safety services by incorporating faster incident recognition and response.

Mobile applications solutions for campus safety is definitely growing [1], [2], [3]. Some of them put the user in direct contact with the campus security guard, such as CampusSafe [4] and EmergenSee [5] and others put friends in contact to each other, such as "Circle of 6" [6] and Guardly [7]. Those applications are in use in several Universities today. Providing campus security guard with situation description, photos and user location are among the features shared by

Table I: Security related incidences reported by the application by campus and type of request

| Campus | Animals | Suspicious Activity | Theft or Robbery | Kidnapping | Traffic Problem | Vandalism | Emergency Call | Violence Against Women | Medical Emergency | Fire | "Watch Over Me" state | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| USP at Bauru | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 4 |
| USP at Piracicaba | 7 | 2 | 3 | 0 | 2 | 0 | 10 | 0 | 0 | 0 | 8 | 32 |
| USP at Ribeirão Preto | 7 | 22 | 5 | 0 | 7 | 2 | 47 | 0 | 0 | 0 | 14 | 104 |
| USP at São Carlos – Campus 1 | 2 | 11 | 4 | 0 | 4 | 0 | 29 | 0 | 0 | 0 | 14 | 64 |
| USP at São Carlos – Campus 2 | 4 | 3 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 10 |
| USP at São Paulo | 16 | 15 | 22 | 0 | 25 | 3 | 107 | 1 | 3 | 2 | 52 | 246 |
| USP at São Paulo – East Campus | 3 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 11 |
| USP at São Paulo – Health and Law Campuses | 0 | 0 | 1 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 1 | 8 |
| USP at Pirassununga | 1 | 2 | 0 | 0 | 6 | 3 | 6 | 0 | 0 | 0 | 3 | 21 |
| USP at Lorena – Campus 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 17 |
| USP at Lorena – Campus 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 41 | 56 | 37 | 0 | 44 | 8 | 220 | 1 | 3 | 2 | 105 | 517 |

most of the applications. The first version of Campus USP has been in operation for almost one year. The Android version has received 4.5 stars rating. We are considering several ideas for the Campus USP 2.0 release towards the goal of encouraging users to adopt it.

The next step of the Smarter Public Safety Service will become operational once the EMS cameras are installed and appropriate data management and analytics software come online. While the system bears some resemblance in goals to commercial offerings such as Motorola Smart Public Safety Solutions [8] and airport security monitoring, our service aims for higher degrees of automation for a large area with relative low crime rate (compared to the rest of the City of São Paulo), and citizen volunteers who are eager to cooperate with campus safety officers.

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