Open Platform Within the Smart Health Framework to Support the Development of Recreational Bike Path Applications

Smart Bike Path in the Context of the VAS Strategy in Colombia

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Abstract. This article describes the design and development of an open data platform that was implemented as part of the Smart Health framework and aimed at supporting the development of Recreational Bike Path applications. Recreational Bike Path programs follow the guidelines of the World Health Organization and seek to reduce the appearance of Chronic Noncommunicable Diseases; these programs, although having great potential, do not have a source of data to investigate their impact or motivate public investment. This paper presents the design of a platform for integrating data through a service REST API by considering Smart Cities architectures as a reference. The final product features an extensible platform that supports basic functionalities, has the capability to integrate other APIs and has the ability to generate open data datasets while following the "Guidelines for the implementation of open data in Colombia".

Keywords: Smart Cities (S-Cities) · Smart Cities architecture · Smart Health (S-Health) · Mobile health (m-health) · Well being · Open data · REST API · Vías Activas y Saludables (VAS) · Ciclovía Recreativa (CR) · Open bike

1 Introduction

Smart Health (S-Health) is the tendency, within the concept of Smart Cities (S-Cities), which aims to improve health services by making them more secure, efficient, equitable and centered on patient comfort; through innovation in computer science, information science and engineering. This research addresses the development of an extensible platform, framed within the S-Health tendency, that provides various functionalities for Recreational Bike Path applications in the context of Colombia's Active and Healthy Paths. The latter are inexpensive public programs to encourage physical activity in a community in order to reduce Chronic Noncommunicable Diseases (NCDs) [1].

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1.1 Conceptual Framework

Smart Cities: The XXI century will be the century of smart cities; in this research, the concept of Smart City refers to the following: "A city that is instrumented, interconnected and people-oriented". Instrumentation enables the real time capture and integration of world data through the use of sensors, smartphones and the web. Interconnection involves the integration of data on a computer platform and the communication of such information among various city services. Intelligent refers to the inclusion of complex analysis, modeling, and the visualization of operational processes for making decisions. Although it is clear that a city's dynamic has its roots in the community, the concept of being people-oriented emphasizes that services should be provided in order to improve the living conditions of its inhabitants.

Smart Health: Medical and public health practice supported on smart mobile devices, with the ability to interconnect devices to applications and other emerging technologies, thus seeking that the health system and the synergy of its components behave more intelligently [2, 3].

Open Data: The philosophy of open data states that some data should be available without the restriction of copyright, patent rights, and other management mechanisms. These data are open to society and anyone can publish and freely use them for any purpose they want [4]. Open data are an opportunity to create value and enhance the creation of new services and economic and social opportunities, when the data and knowledge from all levels of government and business are integrated into applications [5]. In Colombia, the Ministry of Information Technologies and Communications defined the "Guidelines for the implementation of open data in Colombia" [6].

Vías Activas y Saludables (VAS): 63 % of deaths worldwide are caused by NCDs. The World Health Organization has defined a set of guidelines for nations to address this issue. In Colombia, a project called Vías Activas y Saludables [7]—Active and Healthy Paths in English—supports this initiative by temporarily closing some roads for vehicles so that citizens have a safe free space for the practice of physical activity, recreation and healthy use of leisure time. This event takes place on one or more fixed days a week and lasts four hours on average [8].

In the study carried out in [9], 38 bikeways from 11 countries were analyzed and the results showed that Bogotá-Colombia has the world's largest circuit, of 121 km, and a range of 600,000 to 1,400,000 participants per event. VAS are a beneficial cost because, for every dollar invested in Bogota's Ciclovía Recreativa program (CR)—Recreational Bike Paths in English—, US$3 to US$4 are saved on the direct costs of health care associated with physical activity. Furthermore, the study concludes that the VAS have other benefits such as the following: helping decrease pollution and noise levels, generating social capital, promoting equity and creating economic opportunities.

1.2 Problem Under Study

Some research highlights the importance of CR programs but indicates situations such as the following: "Although Ciclovía Recreativa programs are promising, the evidence of their effectiveness is limited to cross-sectional studies that have provided limited data to create a framework for future research and monitoring. …" [9].

Regarding CR, the following was found: lack of data concerning the characteristics of participants; limited data available to other stakeholders interested in their dynamic such as the academic, governmental and business communities; outdated information on the mobile applications that promote them; and unarticulated data unknown by the managers of the program because it was gathered by third-party mobile applications.

As a solution, we proposed implementing an open support platform for health applications development in order to prevent NCDs in the context of CR.

2 Smart Bike Path Platform

2.1 Platform Architecture

The design of the Smart Bike Path platform architecture is based on the architecture proposed for S-Cities in [10, 11] because the scheme is aimed at data management. Figure 1 shows the layers that comprise this architecture. The application layer refers to the applications that consume support services; applications interact directly with citizens and offer them their expertise regarding intelligent cities. Inside this layer there is a sublayer of data acquisition which, in this platform, consists of the sensors of mobile devices such as the following: accelerometers, proximity sensor, GPS, etc.; the collected data are available to the other layers through the application layer.

The data layer comprises data networks and Internet infrastructure that enable communication between applications and the platform, and support the delivery of data to the storage layer. The layer of support services is responsible for arranging data for applications; in smart cities a variety of services must be provided to governments, businesses and citizens. The development of this project has been focused on this layer through the implementation of the API, which represents CR resources.

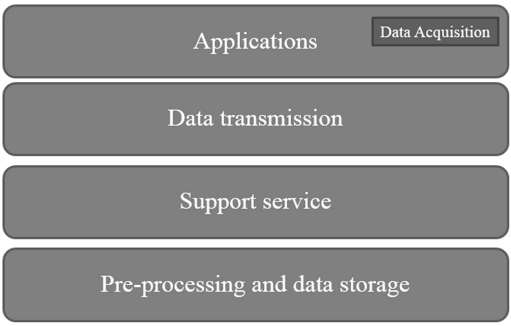

Fig. 1. Platform architecture for information integration.

In the layer of pre-processing and data storage, pre-processing helps detecting and correcting problems related to the quality of data while storage involves the ability to support large-scale complex data with high reliability and scalability; this is achieved through cloud services.

2.2 REST API Services

The REST API (Fig. 2) is a service that uses an HTTP request to provide and consume information from the CR. The pillars of its design were: usefulness, simplicity and value. Usefulness for the end user; simplicity given by the accessibility, ease, speed of implementation and functionality that it provides for developers; and value concerning the benefit generated to the management entities.

The API provides the following services: User represents anyone who attends and uses the spaces and services of the CR to practice recreational activities and sports; Service manages participant information such as age, gender, health risk, disability and activity; Location represents the whereabouts of the user at any given time.

Happen manages information about incidents or events of various types that occur simultaneously to the CR event, such as mobility, security, services or otherwise; events are reported to the platform by users. Via represents the stretch of road that is temporarily open. Place provides information about the location, name, description and pictures of sites that may be of interest to CR users such as parks, tourist sites, hospitals and police, among others; this information is categorized into different types such as art, Bike Path, security, etc.

Benefit includes additional services that can be found on the Bike Path; those offered by the managing entity or the community are included and categorized as art, Bike Path, culture, science, security, sports, technology, tourism and trade. Some CR services may include the following: aerobics, restrooms, bicycle, hydration spot, veterinary service, Physical Activity Recommendations spot—RAFI in Spanish—or bike-school.

Notification contains data from messages aimed at showing users an event, news, service or risk that happens in a path on which the participant is located; these data can be classified according to priority. Service Manager works as a proxy between API services and the services of other REST APIs that are registered on the platform; its purpose is to facilitate the integration of other functionalities.

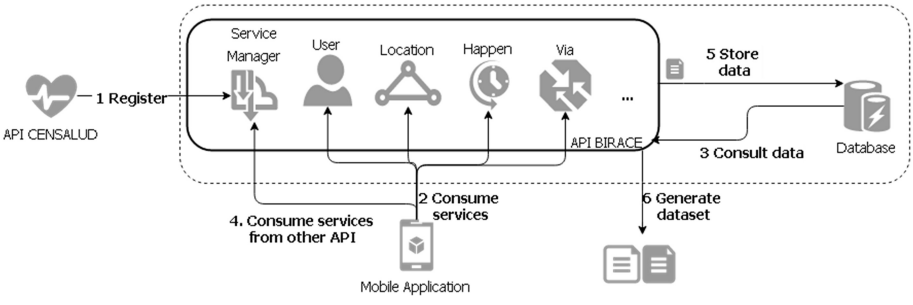

Fig. 2. REST API services and operation.

3 Validation

3.1 Validation Regarding Assessment Criteria of Recreational Bike Paths

In order to estimate the completeness and the value of the potential benefit generated from the platform for the entities responsible of managing the CR in Bogotá, such as the IDRD [12], the sufficiency of the platform regarding the calculation of the assessment measures defined in [13] is estimated. A sufficiency of 70.45 % was obtained in relation with the APIs coverage for calculating the evaluation criteria of bike paths, thus leading to the conclusion that the data collected by the API are relevant and are currently gathered in a non-automated manner by the entities running and investigating CR days.

3.2 Validation of a Case Study

To analyze the platform in terms of its usability for the developer interested in consuming REST API services, a software developer, who was not involved in the design of the platform and does not know the dynamics of bike paths, was selected; these conditions were intentionally sought assuming that other developers do not know these issues in depth. The developer was asked to design an application using the API to analyze the Bike Path Route that is enabled every Sunday from 7:00 a.m. to 2:00 p.m. on the 9th Avenue, between streets 117 and 147, in Bogotá; the simulation of the arrival of users takes a small Bike Path described in "A discrete event simulation model to estimate the number of participants in the ciclovía programs" [14] as a reference.

Figure 3 shows the resulting application. Statistics include: Total participants, Participants by activity, Average time spent on the route, Average time per activity and Participants by health risk. In addition, the following filters are included: age range, range of dates and times, activities, health risks and gender. The use of the API also shows that all the information collected from participants can be published in an open data repository to make it available for further analysis. Particularly, it is possible to use this open data to understand smart cities behavior based on the information obtained from the VAS.

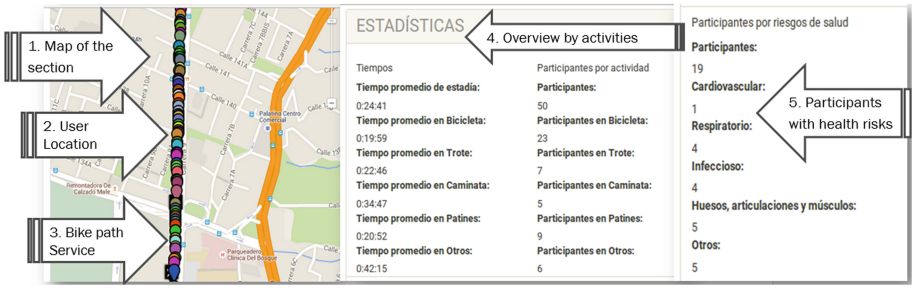

Fig. 3. Overview of the application including event reporting and general statistics.

4 Conclusions and Future Work

The design of the architecture for the information integration platform was developed taking architectures for S-Cities as reference, and is focused on data management and service integration. The module for generating open datasets enables the use of information collected by other parties interested in studying the dynamics of CRs. The platform is extensible in functionality, and experimentation leads to the conclusion that it abstracts the processes of the object of study. Furthermore, the adequacy of the data is evidenced by comparing the services regarding the evaluation criteria of the CR.

The possibilities for future work consider the following three areas: development of applications that use the services of the platform and extend its functionality through integration with other platforms. Integration and support for Internet of Things through the development of services that enable connection with and data collection from devices located on any object such as bicycles or pathways. And ultimately, the analysis of information to be performed using Big Data techniques on future datasets.

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