E-mergency

Towards an Uberized Emergency Medical Service

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***Abstract*—This work presents E-mergency, a cloud-based software solution designed to respond most recurrent issues of Emergency Medical Services (EMS). The solution is being designed and used by means of cooperation with a public EMS responsible to answer emergency call from a one million inhabitants population and the first main functionalities have been deployed to use.**

Keywords-Emergency Medical Services (EMS); mobile application; uberized services; SAMU.

I. INTRODUCTION

Medical Emergency Services (EMS), commonly referred to as Ambulance Service, date from the 19th century [1]. In this secular history, this service became part of day-by-day routine of people and healthcare professions in multiple countries and continents. During this time, considerable improvements have also been adopted applying innovative technologies and medical procedures to pursue higher effectiveness of the service, expressed in numbers of patient life savings and cost-effectiveness of the service provisioning.

Despite the enormous differences from the first EMSs and the current high-technology vehicles and advanced trained healthcare team, some serious issues remain challenging healthcare managers and professionals to deliver a fast, efficient and cost-effective service to thousands, hundred thousand and some cases millions of requiring citizens.

In this work, we focus on four of the most recurrent issues of EMS provisioning and propose an innovative technology–centered solution to address them. E-mergency is designed to re-engineer the current EMS classical provisioning model so as to overcome critical issues and improve its service cost-effectiveness.

Section II presents a broad scenario of EMS in Brazil and the current technology resources in use. In Section III, the problem addressed in this work is stated, while in Section IV the proposed solution is detailed. In Section V the first results reached are discussed, followed by a brief conclusion and future works on them in Section VI. References can be found in the end of the paper.

II. CONTEXT

EMS in Brazil is named *SAMU* – Mobile Urgency Assistance Service - and is a public and free service, nationally funded by the Ministry of Healthcare and locally operated by thousands of municipalities all over the country.

SAMU's assistance follows well-known [2][3][4] international standards and medical protocols, in which an ambulance is required by a citizen to a call center, commonly by means of a phone call to a widely publicized phone number, where the assistance starts from the moment the operator answers the call and ends, in the worst case, when the patient is transferred to the attention of a hospital emergency team.

In the last decade, the SAMU coverage has increased and most recent official data show that since 2017 the service is available to nearly 80% of Brazilian population [5] in their home municipality (see Table 1).

TABLE I. EVOLUTION OF SAMU POPULATION COVERAGE

Population Coverage		
Year	***Population***	***Percentage***
2012	***135.703.665***	***70.53%***
2013	***141.089.175***	***72.73%***
2014	***150.487.160***	***74.84%***
2015	***155.983.958***	***76.91%***
2016	***157.299.697***	***76.92%***
2017	***163.590.587***	79.36%

According to Brazilian healthcare legal definition [6] the service is available when the following components are provided to the municipality inhabitants as depicted in Figure 1:

- A call center to answer emergency healthcare assistance phone requisitions;
- Ambulance/s vehicle/s and healthcare professionals to answer the requisition;
- Hospital/s to receive the patients assisted by SAMU.

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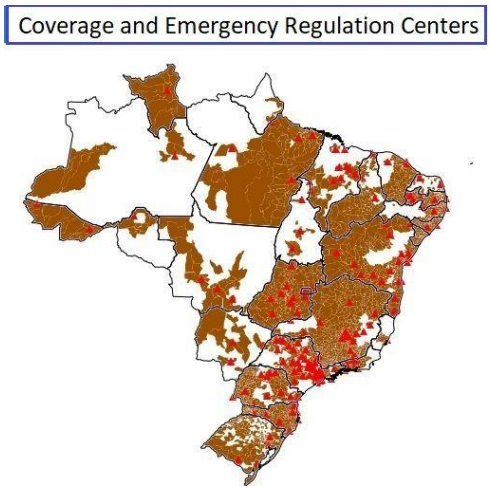

Figure 1. SAMU geographic coverage.

The typical assistance flow goes through the three components above, and starts with call center answering an assistance requisition, to which an ambulance + healthcare team is assigned to assist. When a hospital intervention is needed, a hospital bed must be reserved to receive the patient during and after the emergency room assistance.

Intense information production and exchange occurs during the assistance protocol. The mean, the time frame and the precision in which such critical information is generated, recorded and passed on can make great difference to both the patient wellbeing and the emergency service cost efficiency

Currently, phone, radio devices, desktop computers and paper forms are the dominant instruments used by citizens and SAMU professionals to produce, to record and to exchange information throughout the assistance protocol.

III. PROBLEM STATEMENT

Different studies [7][8][9] indicate that each step of the assistance protocol previously described faces difficulties to be properly executed. Some of these difficulties are expressive to Brazilian SAMU, some are equally found in emergency services from different countries and continents. Throughout the assistance protocol steps the following issues are highlights [10]:

1. High rates of fake calls;
2. Too long time interval from the emergency call to the care scene;
3. Imprecision/incompleteness of patients' healthcare records;
4. Ill ambulance-hospital communication.

Information and Communication Technologies (ICT) solutions have been placed in use to address the issues above [11][12]. Emergency support software systems have made important steps to reinforce the quality and agility of emergency services, such as EHR (Electronic Healthcare Record) data integration to access patient's medical data during the assistance protocol [13].

Although existent ICT solutions that EMS have reached some consistent outcomes, they have not been enough to effectively address the issues 1-4 (section III) and, therefore, such services still lack of technology support to make the expected quality shift.

In section IV, E-mergency is presented. An Uber-inspired ambulance ICT solution that aims to contribute to a new service model redesigned to best respond to current challenges of emergency healthcare services.

IV. E-MERGENCY

Emergency is a cloud-centered ICT solution, composed by three modules, plus a web service standard interface, which supports the different actors who require and provide EMS. wo of the component modules are mobile applications (apps), one to be used by the citizens, the other to be used by the ambulance team. The third and core module is in charge of service management and is operated in the local emergency healthcare service headquarter. Further details on each module are provided next (Figure 2).

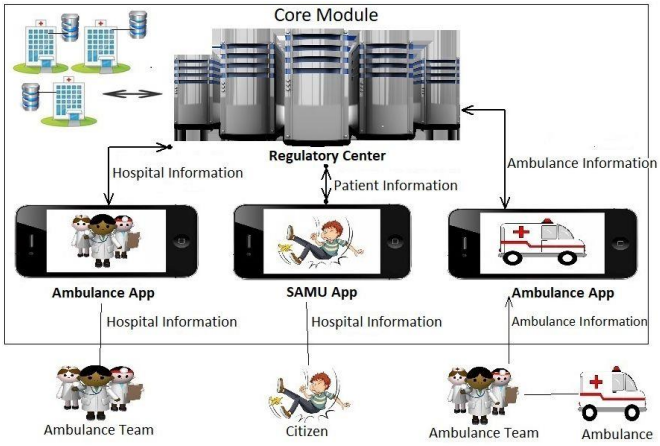

Figure 2. Emergency overview.

A. *The SAMU App*

Instead of memorizing an emergency number, citizens are now supposed to have the SAMU app installed in their mobile devices so as to make an one touch call to an ambulance, in the presence of a critical situation.

Through a simple interface (a single tap, a single button) as shown in Figure 3, the ambulance call is made and the user can then begin to interact with the emergency service.. Voice, audio messages, text and videoconference are available options to the citizen interact with the EMS call center. After this first contact, when an ambulance is assigned to the request, the same citizen can then interact with the ambulance team and forward precious information to the an agile response in the care scene. The citizen can also trace the ambulance path, which provides geographic position and expected time wait.

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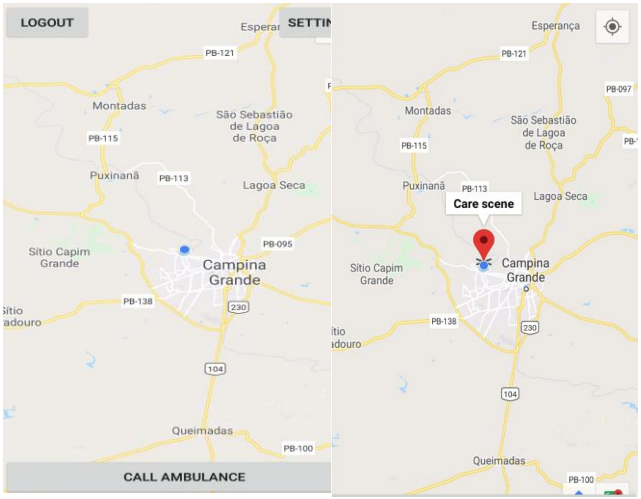

Figure 3. SAMU and Ambulance apps.

When installing SAMU app the citizen is required do provide personal information, photo, a valid official document and telephone numbers. When calling an ambulance, the app informs the EMS the citizen's GPS location. During the interaction citizen-ambulance team real time picture and video of the citizen can also be required. This set of identification and authentication functionalities addresses and is expected to strongly discourage fake calls to the emergency service (issue 1, section III).

B. The Ambulance app

The ambulance team makes use of an app to first respond to a broadcast or specific and directed request sent by the emergency service headquarter.

From the moment the ambulance answers the request, the ambulance app access all the information related to the citizen call. The type of emergency, GPS positioning of the care scene and citizen contact (in case interaction is necessary) are made available to the ambulance team (Figure 2).

During and after the assistance in the care scene, the patient healthcare information is input by the ambulance team using the app. This information will be transferred to the hospital emergency service, in the cases that the patient condition requires hospital assistance. Because the patient information is input in the app according to the assistance medical protocol and the healthcare professional mostly selects options in a clean app interface, instead of handwriting, the patient information records tend to be more detailed and precise (issue 3, section III).

The app is also the contact link between the ambulance team and hospital emergency service. From the moment that the EMS decides that hospital assistance is required.

C. The Core Module

The core and most complex E-mergency module is a cloud accessed application that manages the ambulance and hospital resources so as to best respond the citizens' ambulance request.

Answering the citizens' calls is the most use-intense function of the core module. This function puts the citizen in contact with an attendant and records all the information the citizen first provides on the emergency situation.

Is by means of the core module that the EMS headquarter transmits a request to the ambulance/s in order to assign one of these vehicles to the citizen request. The transmission can be a one-to-one call directed to a specific ambulance selected by the emergency service by means of any rationale, such as location or equipment compliance. The transmission can also go broadcast to be answered by a group of ambulances in similar conditions to answer a request.

The third and fundamental function of the core model is the interaction with hospital/s. When either the call center attendant in the first contact or later the ambulance team during local or remote assistance decides that the situation requires hospital care, the core model consults among the chain of hospitals associated to the EMS, which has the most appropriate condition to receive the patient currently assisted by the emergency service. Most appropriate here refers to the hospital medical capabilities and the estimated transfer time from the care scene to the hospital emergency room. Consults means an automated contact between the E-mergency core model and the hospitals internal ICT solution used to offer and allocate hospital bed and medical teams.

The combination of the SAMU app immediate contact with the emergency service, the Uber-similar mechanism to assign an ambulance to the citizen request and e prompt and automated interaction with the hospital is expected to efficiently respond to the (issue 2 and issue 4 , section III).

D. The Hospital Interface

E-mergency is designed to interact with hospitals in two moments. The first when a hospital bed and emergency team is allocated to receive the patient initially assisted by the emergency ambulance professionals. The second during the ambulance team assistance and patient transfer, when patient medical records are transmitted by the ambulance staff to the hospital.

Both interactions mentioned above are meant to be automated and do not entail human communication. The information on hospital availability to receive the patient and the bed and team allocation is 'negotiated' between E-mergency core module and a hospital software (ICT solution), while transmission of patient medical records to the hospital software is an interaction between the Ambulance app and the hospital software.

To make automated communication between E-mergency and hospital possible and scalable to a large number of hospitals and ambulances, one standard interface is defined by E-mergency.

Each hospital is required to implement and make available the hospital-E-mergency interface in order to become associated to the EMS The interface is a set of functions that allows to the necessary data exchange and software interoperability involved during the automated interaction between the hospitals and the emergency service.

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V. FIRST RESULTS

The design and implementation efforts to produce E-mergency have great part of partnership articulation, to get in touch with end-users and management levels in the EMS and hospital. Currently it is established a solid cooperation involving E-mergency development team, the local emergency service, and one of the associated hospital. Such partnership has been critical to design the solution, to execute test scenarios and collect feedback on the modules deployed.

The SAMU app, the ambulance app and some of the core module have been delivered, with the following functionalities

The SAMU app

- Call function;
- Ambulance tracing;
- Text interaction with the ambulance.

The Ambulance app

- Answer to an ambulance call;
- Text interaction with the citizen.

The Core Module

- Answer to an emergency call;
- Ambulance requisition (one-to-one and broadcast)
- Hospital bed request.

Hospital interface

- Fully defined;
- Answer to bed request implemented.

VI. CONCLUSION AND FUTURE WORK

Ambulance/Emergency is a challenging healthcare service required and provided all over the world. Some classical issues remain unsolved despite the constant improvement through ICT use in different activities of the service.

In this work an innovative approach and solution was presented aiming to apply well established technology and service provisioning model to address EMS recurrent issues.

E-mergency has its first functionalities delivered and is expected to be in full operation in the first quarter of 2019 in a one million inhabitants real use scenario. The service will be put in experimental operation coexisting with the Campina Grande SAMU regular service, with the purpose to collect comparative data on the assistance provided by the different approaches.

In the second round of development, a more innovative service model is proposed. An E-Mergency two modules only solution will be tested, in which there is no core Module in operation and the citizen SAMU request is captured directly by the ambulance located closer to the care scene. In this model the citizen SAMU App interacts directly to the Ambulance App (and team). The objective is to save costs of an EMS call center and the time to respond the request, while not jeopardizing the assistance quality standards.

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