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Cloud-Based Realtime Emergency Medical Service Platform

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Abstract— In emergencies such as accidents, natural disasters and epidemics, immediate medical treatment in necessary, where patients need to be transported to the hospital from their location. In such situations, Emergency Medical Services (EMSs) as well as ambulances play an important role in saving people's precious lives. Presently, there are several systems in Sri Lanka to direct ambulance drivers to reach the patient's location in minimal time and to send the patient to the nearest hospital as soon as possible. But there are some limitations in these systems, such as the nearest hospital may not have the facilities to treat the patient, limited number of ambulances available for each of these systems, hospitals' difficulties in tracking ambulances and the fact that existing systems do not maintain patient health records. Therefore, the need for a Cloud-based Real-time Emergency medical service Platform that can be used across the country is essential to address the said issues. The aim of this research is to provide a mechanism to reduce the latency of finding a suitable hospital for an emergency patient. The proposed platform is built using a Web application and an Android application that serve as the admin panel and user panel respectively. MySQL database hosted by a web server is utilized as a database connector between the Android application and the Web application. This paper presents design and implementation details of the proposed system and offers a comparative study on existing systems in Sri Lanka to understand the significance of the new system.

Keywords: ***emergencies, emergency medical services, ambulance, latency, realtime, cloud-based, platform***

I. INTRODUCTION

A. Background of the study

An emergency is a situation that poses an immediate threat to personal health, life, property, or the environment. The statistics of emergency cases are being rapidly increased, putting people's lives in danger. This can comprise single-person emergencies including heart attacks, strokes, cardiac arrest, and physical injuries, as well as large-scale occurrences like tornadoes, hurricanes, flooding, earthquakes, mudslides, and epidemics like coronavirus, cholera, Ebola, and malaria. Moreover, the number of road accidents have increased in the city day by day and it is even more crucial to prevent the loss of life due to such accidents. Therefore, in case of any of the above emergencies, immediate medical treatment is required to transport the patient from the place of incident to the hospital. The necessity of transporting a patient to the hospital can be judged from the fact that if an ambulance arrives late due to any reason, it can deteriorate the patients' medical condition and even lead to death. In such cases, Emergency Medical Services (EMSs) play a key role in saving the precious lives of innocent people. Indeed, improving efficiency in healthcare sector is one of the hardest and most challenging tasks. This involves several aspects like getting an ambulance in a brief period and giving the proper treatment to the patient, which increases the patient's chances of survival in a critical situation (Poonam, et al., 2016). The main objective of successful EMS (Eemergency Medical Services) systems can be operationally defined by the effective and consistent provisions of immediate medical care to the patients in case of any medical emergency (Wei, et al., 2015).

In Sri Lanka, EMSs are a recent concept. Both local and international health organizations have been interested in establishing an emergency medical service in Sri Lanka since the catastrophic natural disaster faced on December 26, 2004 (Wimalaratne, et al., 2017). The EMSs are being developed using a public–private approach aimed at providing emergency ambulance services, as well as emergency care and transporting patients to hospitals. Initially, the 1-1-0 number has been recognized as the emergency access number for Emergency Medical Services in Sri Lanka by the Telecommunications Regulatory Commission, and it is currently operating in Colombo, Galle, Kandy, and Jaffna districts, with the intention of expanding it nationally. The process of this system was when an EMS called the hospital or Government sector for an emergency case, they would send an ambulance from the hospital to the patient's location and take him/her to the hospital as soon as possible. But this process takes some time and factors such as the distance between hospital and the patient's location and traffic congestion can affect the time spent by the ambulance. In fact, accessing patient's locations at the right time will increases the possibilities of saving their lives and enables providing the right medical treatment (Campbell & Ellington, 2016).

In addition, in 2016, the Government of Sri Lanka launched a Suwa Seriya Emergency Ambulance Service as a free emergency prehospital healthcare service along with the 1990 hotline. This service allows the patient or patient's caretaker to call the Suwa Seriya Emergency Ambulance Service by dialling the 1990 hotline in case of an emergency. At that time, that person must wait until the call is connected and then guide the ambulance dispatcher to the location of accident or emergency. The dispatcher then alerts an ambulance near the patient's location and directs it to the patient to go to the nearest hospital. However, there are some drawbacks in this system, such as hospitals cannot track the ambulance and this system does not inform the hospital of an emergency patient's arrival. As a result of that, the nearest hospital where the ambulance travels may not have the facilities to treat the patient. Also, there are a limited number of ambulances available for this service throughout Sri Lanka and unfortunately, if an ambulance is not available close to the patient's location, it may not be possible to save the patient's life. Because In case of emergency, every minute is crucial for saving a life and one cannot afford to wait longer. Furthermore, both systems existing in Sri Lanka do not store and manage patient health records.

A. Research Problem

Although there are several systems in Sri Lanka to improve the efficiency of the healthcare sector, each of these systems has some limitations as defined above. Further, today thousands of unknown ambulance services are running to the public. Every hospital has its' own contact for the ambulances and even private and government services have their own contact number for the ambulances. Therefore, it is difficult for a person to find out nearest ambulance in that area in case of an emergency.

As a solution to the problems defined above, a Cloud-based Realtime Emergency medical service Platform can be built using a Web application and an Android application that serve as the admin panel and user panel, respectively. Further, a MySQL database hosted by a web server is utilized as a database connector between the Android application and the Web application. This proposed platform will help to solve the above defined limitations in the existing systems in Sri Lanka. The main aim of this system is to provide a mechanism to reduce the latency of finding a suitable hospital for emergency patients.

B. Research Objectives

The objectives of this study are twofold; to provide a common platform for all ambulances and to facilitate communication between hospital and ambulance.

The rest of the paper is organized as follows; through the section 2 of the paper, an insight will be provided about existing technologies related to sending ambulances immediately to the patient's location so that the patient can reach the hospital in the quickest time possible, controlling traffic lights and constructing spread health care centres. Further section 3 of the paper will elaborate a solution system that will overcome the defined problems in existing systems in Sri Lanka. Section 4 elaborates on how the proposed system works along with user

response to proposed system. Finally, section 5 concludes the paper with a note on further improvements.

II. RELATED WORKS

Several works were conducted to enable patients to request ambulances or check the availability of the ambulances in case of emergencies and for the hospitals to implement fast-tracking systems to reduce patient waiting time and overcrowding. Some of these works depend on GPS (Global Positioning System) and GIS (Geographic Information System) systems and others depend on tracking down the minimal path between the patient location and a hospital considering the street conditions. But unfortunately, a working system as this research paper proposed has not been developed progressively in the current world. As researches suggested, a system was developed that consists of two applications. One is the web administration panel for the hospitals and other is the mobile application, which was introduced for the ambulance staff who transport patients to the hospital. Further, this proposed application stores the Personal Health Records (PHRs) of patient on a Cloud Based Platform and creates a unified space for patient. This will enable doctors to take decisions in future and they can view those health records only through the hospital application. After considering some related existing works, there are some technology-based solutions for the issues related to delays in arrival patients to the hospital and some concepts for providing an effective emergency medical system to prevent death and disability as mentioned below. These will be reviewed to understand their unique functionalities and differences.

A. One Click Smartphone Application

The work presented by Khalique, et al., (2017) is an application named "One - Click Smartphone Automatic Sending System". It was created to provide access to patients for request ambulances effectively by a convenient interface. This smartphone-based application which comprises an "Automatic Ambulance Dispatch System" (AADS), simply requires the user (victim or the caretaker of the victim) to press a "help" button to notify the nearest ambulance driver directly of any emergency instead of calling the emergency service numbers. After accessing this application, it looks for the nearest accessible vacant ambulance and sends a message to the system including patient information such as patient's location, personal information, and kind of infection. After receiving the message, the ambulance driver can see the real-time position of the patient on the map through system and then move towards him/her. This can be considered as a major advantage to reduce the time consumed in communication between the victim or victim's caretakers with ambulance.

B. Ambulance emergency response application

The deployment of a control room, based on GPS and GIS system was developed by Sakriya & Samual (2016) to monitor streets congestion and control the traffic lights. The Authors of this work developed a mobile application for viewing vacant ambulances nearest to the patient's location and that was more efficient and reliable for emergency medical services. The application responds with just one tab on the button and sends the user's details and location via GPRS to the nearest ambulance control Center. This allows the user to get any ambulance at any time without calling hospitals to check for the ambulance availability. Furthermore, based on the data provided to the application, the control rooms can identify the route of the ambulance to reach the requested hospital, which allows the control room to regulate the traffic lights involved in the road to facilitate the patient's arrival at the hospital. This is immensely helpful because if an inexperienced ambulance driver has taken a wrong route, the driver will be late for the arrival on the emergency scene (Nordin, et al., 2012).

C. GPS and GSM (Global System for Mobile) based intelligent ambulance monitoring system

Another system relates to the development of a device with an ARM 7 processor module, including biomedical sensors, GPS receiver, and GSM modem, presented by Dixit & Joshi (2014). The method will be useful for tracking the location of an ambulance using Google Maps. It includes a body temperature sensor and a heart rate sensor to obtain patient health information. The information gathered in this compact device is saved in the microcontroller's memory and

transferred to a dedicated server. After receiving SMS messages, the position of the ambulance can display the patient's heart rate and temperature and hospital staff can be prepared for the proper treatment of coming patient.

D. Blockchain technology in health-care for emergency patients

A blockchain technology health care system is being developed to improve the quality of the health care system in modified form for emergency patients to get the immediate treatment without any wait (Tahir & Nadeem, 2019). The main objective of this system is to manage the emergency patients and suggest the nearest hospitals with a minimum queue. In this system, patient's request sends through a certain server and in response to the request, the patient receives information about the shortest distance hospital. When some hospital responds to a patient, the hospital will also ask from the patient about the Smart Ambulance (SA) service for basic treatment. The request will then be sent to the SA if the patient gain this service and then SA goes to the location for basic treatment. Furthermore, the medical history of the patients can be saved in this system using blockchain architecture. The main limitation of this system is that the proposed system is private and the data set of the experiment is only a single node of the hospital. Therefore, the feasibility assessment of this system has not been confirmed.

III. DESIGN & IMPLEMENTATION

The proposed solution is a Cloud-based Realtime Emergency medical service Platform, which is important for reducing the latency of finding a suitable hospital for emergency patients and providing a common platform for all ambulances. The figure 1 shows how the practical situation works from the time of patient is in an emergency to the time patient is taken to the hospital.

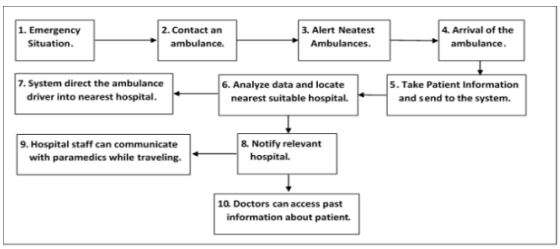

Figure 1. Practical Situation Diagram
Source: Author(s) 2021

Furthermore, the proposed system facilitates communication between hospital and ambulance and stores the PHRs of patient which will be useful for doctors to take decisions in future. The basic architecture of the Cloud-based Realtime Emergency medical service Platform is depicted in figure 2.

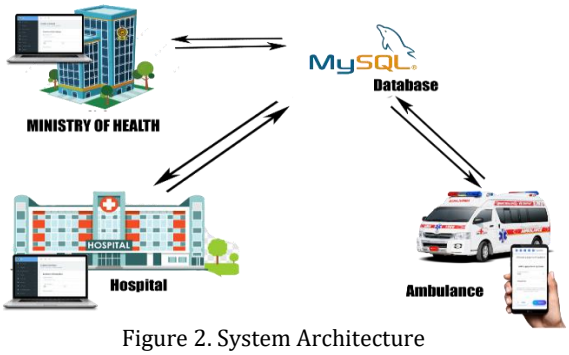

Figure 2. System Architecture
Source: Author(s) 2021

Web application as admin panel, an Android application as user panel, and MySQL as database connector between the Android application and the Web application are the main components used in the construction of this system. Android Studio is used to create the mobile application, and HTML, PHP, and CSS (Cascading Style Sheets) are used to create the web application. This mobile application can be considered as the system's "user-interface" (Ref. figure 3), while the web application can be considered as the system's "admin-interface" (Ref. figure 4). The MySQL platform is used to capture changes in the information and keep the system synchronized with the mobile application.

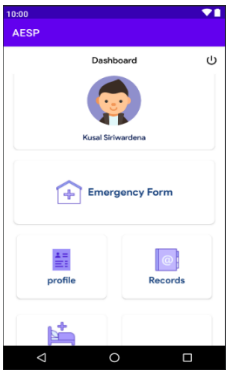

Figure 3. Mobile user interface of the system
Source: Author(s) 2021

User interfaces of the system (Ref. figure 3, figure 4) are designed to be straightforward and user friendly. Using this, the user can manage the device. User type 1 which means drivers get patients locations as well as the nearest hospitals location.

User type 2 which means paramedic can fill out a quick survey using the application.

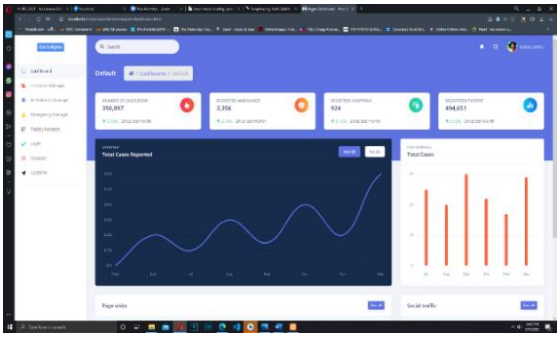

Figure 4. Web admin interface of the system
Source: Author(s) 2021

A. Process of Registering Ambulance and hospitals

The administrator of the proposed system oversees registering ambulances and hospitals. Ambulances of any kind, whether government, private, or other, can register via this system. While registering, the ambulance's administrator should also update the driver's and paramedic's details. When registering a hospital, the name and location of the hospital are required so the hospital must be identified on the map after registration.

B. *Process of updating hospital facilities*

Hospital staff can log into the systems after registering the hospital. Staff members of hospitals are responsible for keeping their facilities up to date. There are two different methods of updating services.

1. Facility updates - A country has many health-care services. As a result, hospital employees should be aware of the types of services they can offer as well as their capacity.
2. Daily updates – Since service recipients change daily, the availability of a facility can fluctuate from day to day. Hospital staff should oversee keeping those regular changes up to date.

C. Process of finding an ambulance

Someone should call the hotline number and provide basic details such as the patient's or guardian's name, address, and ID number. The information will be sent to the administrator, and the data will be updated in the database. After that, the system will send an alert to all registered ambulances within a radius of 5-kilometer from the specified area, and wait for a response. If no response is received, the radius will be increased, and ambulances will be alerted until one is found. When the ambulance arrives at the hospital, it can be tracked.

D. Process of finding the nearest suitable hospital

After the ambulance arrives at the patient's location, the paramedic can take care of the patient while completing the quick survey through the paramedic's application. After submitting the survey, the system analyses the data provided by the paramedic and sends a message to the driver's application recommending the most appropriate hospital for the patient's needs.

E. Process of creating a unified cloud space for patient

The data collection phase begins when a patient requests for an ambulance. As soon as the ambulance arrives at the patient's location, the paramedics fill out a quick survey and send it to the system. The system then creates a unified cloud space for that patient. If the patient is already accustomed to this service, the previous form relevant to him or her will be updated. This file stores all the record information such as date, actions etc. These reports may be useful in the future when doctors make decisions about a patient's health.

The platform can be used across the country to link all ambulances and hospitals. After that, the method becomes more accurate and efficient. Hospitals and administrators should connect to the system through Wi-Fi or Ethernet, while ambulance crews should use mobile data. To keep this proposed system running, the government should provide smartphones to every ambulance driver and computers to hospitals so that they can access this platform as a simple necessity.

The proposed system employs algorithms to locate nearby ambulances and hospitals, which are implemented in the administration application. These algorithms are linked to a database to extract data as input for the

operation Admin program sends alerts to drivers when the algorithm is being processed. For system implementation in the administration application, researcher is also use two Google APIs (application programming interfaces). That are connected to system database system (Ref. figure 5).

1. Maps JavaScript API
2. Places API

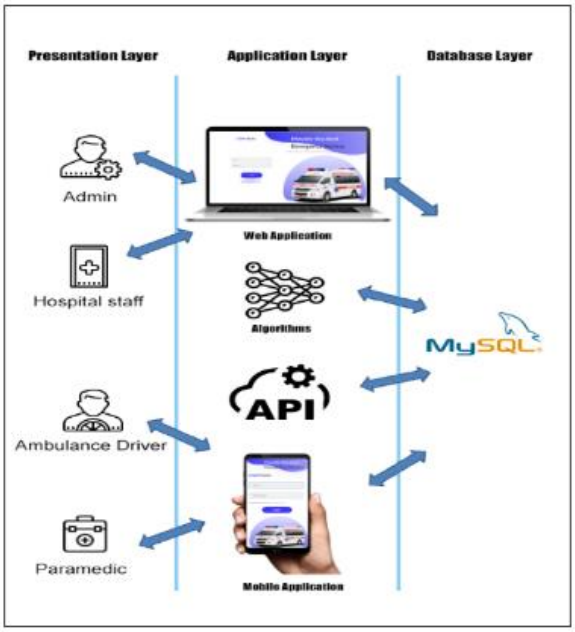

Figure 6. Overall System Architecture
Source: Author(s) 2021

Maps JavaScript API allows us to customize maps with our own content and imagery for use on websites and mobile devices. The Maps JavaScript API includes four basic map types (roadmap, satellite, hybrid, and terrain), each of which can be customized with layers and styles, controls and events, and a variety of services and libraries (Google, 2021).

The Places API is an HTTP-based service that returns information about locations. Establishments, geographic areas, and famous points of interest are all examples of places in this API. Each service is accessed through an HTTP request, and the response is either JSON or XML. The https:// protocol must be used for all requests to a Places service. A place ID is used by the Places API to uniquely identify a location (Google, 2021).

Since implementation is not in production level, researchers will host web application and database on a private web server to manage resources. When it reaches the production stage, it will take more latency to process and update real-time data. As a result, researchers can migrate it to Amazon Web Services (AWS) such as Amazon EC2 as system server (Amazon, 2021) and Amazon Simple Storage Service (S3) as system storage (Amazon, 2021). It will assist in improving the system's efficiency.

IV. RESULT & DISCUSSION

The Cloud-based Realtime Emergency medical service Platform sends an alert message to all registered ambulances within a radius of 5 km from the patient's location and wait for a response. Once a response is received, the ambulance can arrive at the patient's location and the paramedic can take care of the patient while completing the quick survey through the paramedic's application. Then the system analyses the data provided by the paramedic and sends a message to the driver's application recommending the most appropriate hospital for the patient's needs. Additionally, paramedics can use the application to communicate with the hospital while on the road, and hospital staff can advise paramedics on pre-meditation techniques. Figure 6 shows the system interrelated diagram that explains how system modules and processes are linked.

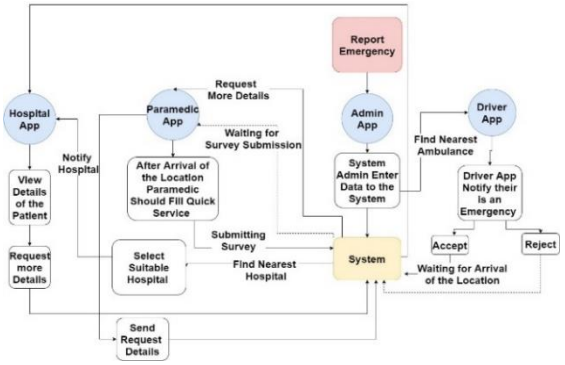

Figure 7. System Interrelated Diagram
Source: Author(s) 2021

To understand the significance of the new system, the researchers compared the proposed system with current systems in Sri Lanka. Initially, the 1-1-0 number was identified as an emergency access number for emergency

medical services so that patients could get an ambulance in case of an emergency. However, this system has some limitations such as delay in contacting an ambulance, delay in identifying the exact location of the patient and the hospital not knowing about the facilities required by the patient. Therefore, the hospital is unable to make any preparations for the incoming patient, and the patient's case records do not last long in this system.

The Suwa Seriya ambulance service arrived shortly after, resolving some of the issues in the prior service, such as the time it takes to contact an ambulance and the time it takes to transport a patient. However, there are still some issues such as hospitals cannot track the ambulances and this system does not inform the hospital of an emergency patient's arrival. As a result of that, the nearest hospital where the ambulance travels may not have the facilities to treat the patient. Also, this system has a limited number of ambulances and does not store and manage patient health records.

The proposed system solves these problems by including features such as finding an ambulance closest to the patient's location, selecting an appropriate hospital for the patient's needs, setting up a patient arrival notification system, providing a common platform for all registered ambulances, facilitating communication between hospital and paramedic and store and manage patient health records in an assigned cloud space. Furthermore, with the spread of the covid19 epidemic, people are now accustomed to working with digital devices and therefore the technical literacy of people is now improving. Hence, people can now quickly grasp such a technical based system without a hesitation.

V. CONCLUSION & FURTHER WORKS

In this paper, researches have presented a Cloud-based Realtime Emergency medical service Platform that can be used across the country, providing a proper mechanism for all people in need of immediate medical treatment to reach the hospital as soon as possible. This application is built using a Web application as admin panel, Android application as user panel and MySQL database which is host on web host as database connector between the Android application and the Web application. This proposed system allows the patient to find a suitable hospital that can meet his/her needs in an abbreviated period. It provides a common platform for all ambulances and facilitate communication between hospital and ambulance. Further, this system stores PHRs of patient and it will enable doctors to take decisions in future.

For future works, researches plan to develop the paramedic application, including a function of taking a voice call to the hospitals over the internet and activating a mobile application into the IOS platform. Further, this system can be improved by using this application in both Sinhala and Tamil languages and USSD activation mode can be developed in this system as an additional functionality.

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