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REMOTE PATIENT MONITORING SYSTEM (RPMS) MODEL TO IMPROVE EMERGENCY SERVICES IN PAKISTAN DURING COVID 19 - A CONCEPTUAL FRAMEWORK USING ICT TOWARDS OVERCOMING HEALTHCARE PROBLEMS IN PANDEMIC HISTORY

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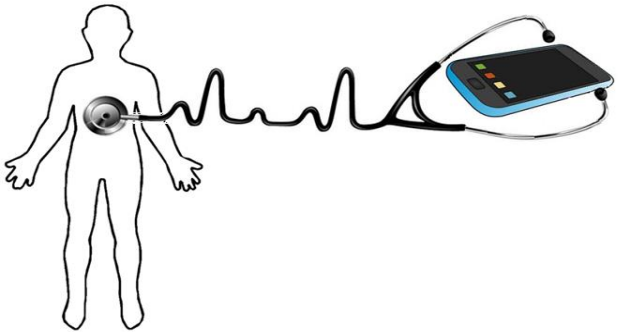
ABSTRACT

The history of the world during the pandemic era shows a worse kind of treatment to the effected people. The year 2020 is known as a terrifying year due to pandemics in the world. It badly exposes the healthcare system's weakness especially in the developing countries like Pakistan. Ambulance services played a major role in transporting affected people during pandemics. However, an independent survey shows that around 130 million people have very limited access to these facilities in Pakistan. The majority of the population of Pakistan lives in remote and rural areas and is deprived of these services. In this regard, remote monitoring of patients while they are in transit is very crucial. Considering the importance of providing better healthcare services to patients, we propose a model for remote patient monitoring systems (RPMS) integrated with emergency services in Pakistan. This healthcare model continuously keeps track of people including patients and nearest ambulances (the in-context emergency service and the key resource) for helping patients by transporting them to the appropriate healthcare center, as per needed assistance on the go. It helps reducing response time and yet increasing golden time by directly engaging the ambulance from the nearest location (using spatial and temporal features) and bypassing the call center to save the inevitable consumption of time shattered by conventional method. The represented model may enhance the availability of emergency healthcare facilities by reducing service time and allow efficient use of resources.

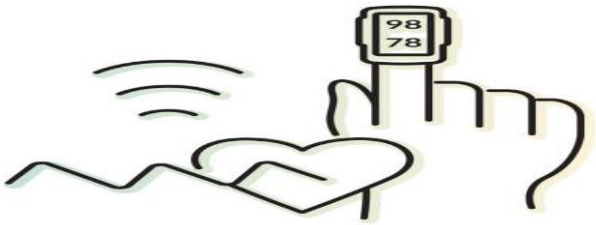
Keywords: ambulance service; pandemic; healthcare; remote patient monitoring; Pakistan; history.

1. INTRODUCTION

During medieval history, patients of infectious diseases were treated with sheer force and brutality. They were forcefully quarantined and isolated in their homes with their homes sealed and with no transportation to the hospital or any medical treatment. Even passengers from other areas were forcefully quarantined in remote areas where they remained on their own without any hope from outside world [1-4]. But nowadays, people around the world have eHealth and mHealth facility that can also be effective for patients in isolation as well as treating remote patients. When we say about the provision to key rural and remote health problems across the world, developed nations are no longer distinguishable from poor countries when it comes to environmental improvement and welfare in developed countries. There's no getting around the fact that in many developing nations, including Pakistan, the proportion of the citizens of suburbs, much greater than the percentage of the population living in metropolitan centres. As we all know, Pakistan is an agricultural nation that generates a significant amount of foreign money via agriculture, which serves as the foundation of our gross domestic product (GDP). Most of the People involved in agriculture and cultivation belong to the rural areas living in under-developed villages. Therefore, a large population in rural areas is directly connected with the development and growth of Pakistan. Unfortunately, this group suffers a lot in having primary and basic healthcare facilities for early diagnosis and quality healthcare services. Due to this the mortality rate is much higher in remote areas. In Pakistan most of the mass resource distribution especially human resource (i.e., doctors, nurses and paramedical staff etc.) is concentrated in urban or developed areas and in big cities as compared to rural arears. Due to the lack of infrastructure (transportation and communication network) and inappropriate medical services in remote arrears most of the patients have been transported to nearest city for better health services. The provision of cheap and easily accessible healthcare to the people of any country has always necessitated a significant portion of the national budgets. In contrast to wealthy countries, the average spending on healthcare services in the developing world is much lower. The World Health Organization (WHO) has released statistics on healthcare spending in relation to the gross domestic product (GDP) in a number of published publications.



(a)



(b)

Figure-1. Healthcare on the move.

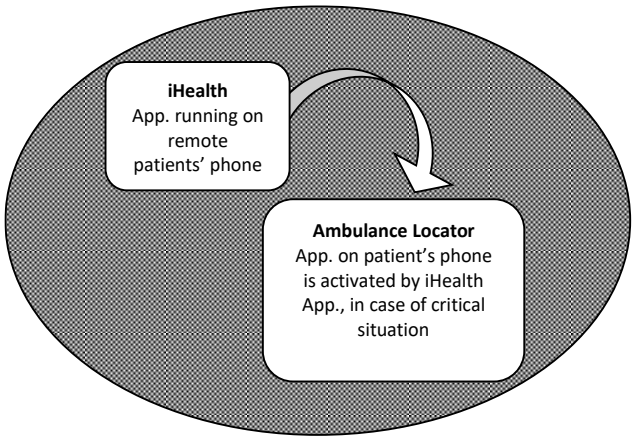


Figure-2. Proposed model showing integration of applications.

The (WHO) expresses worry about healthcare expenditures in developing nations in Africa and Asia, including Pakistan. There are many difficulties in the healthcare industry across the world, regardless of whether the country is developed, undeveloped, or developing. The recent Covid-19 pandemic has raised many concerns about the current state of healthcare systems in a number of nations across the world. Every hospital must make use of contemporary healthcare technology that is integrated with information and communication technology. This is a significant issue for hospital administrators. The development of eHealth and mHealth apps in the health sector has fundamentally altered the way people think about their health. The goal is to offer affordable, timely, and high-quality healthcare services to the general public while adhering to established quality and safety requirements.

According to WHO, Pakistan's gross national income per capita in 2019 was $1,357, while the overall spending on health per capita was about 3 percent of the country's GDP. The Federal and Provincial Governments of Pakistan has taken remarkable steps to upgrade the existing healthcare system and to provide quality healthcare services. The Government has also initiated the health card (insurance) scheme for masses which covers basic health requirements. Further, there has been a considerable increase in investment on digital health systems and health ICT infrastructure across Pakistan.

Despite technological advancements and opportunities in healthcare sector the process for digitizing healthcare services is slow. There is a positive trend for developing mobile health (mHealth) applications in private and public sector hospitals but we need much more emphasis on mHealth applications in Pakistan. In Pakistan, not much research has been done in the ICT adoption model in the healthcare sector. Investigations on the acceptability of e-health and m-health apps in acute-care hospitals are urgently needed. The purpose of this research during the recent pandemic and to examine, explore, and evaluate the technological acceptability of the usage of smart phones for health care-related applications and information from the perspective, viewpoint, and experience of those who will be using the devices. We have represented work discussed in [5-6] for the efficacy of ambulance service during recent pandemic.

Figure-3a. Patients' helper call in case of emergency.

This paper is organized as follows. Section 2 elaborates the related work and the review of the literature. In section 3, we discuss the applications for remote monitoring. Section 4 depicts the model proposed and in section 5 we present conclusion and potential future avenues.

2. RELATED WORK

According to a study conducted by the State Library of the United States, 45,000 individuals die each year in the United States as a result of a lack of healthcare services [7]. In spite of the fact that Pakistan's health indicators, health financing, and health and sanitation facilities are all in poor condition, 12.9 million individuals in the country did not have access to health services in 2010. As reported by the World Health Organization, overall health expenditures in Pakistan reached (2.7 percent) of gross domestic product (GDP) in 2012, with

per-capita health expenditures amounting to (US$77) [8]. Government contributions accounted for about (25 percent) of overall health costs, with the remaining 75 percent consisting solely of private, out-of-pocket spending. Therefore, we need a robust infrastructure network as well as improved health services in order to adequately serve our clients in rural and remote regions. According to the World Health Organization [8] (CVD) Cardio-Vascular Disease is on the rise in low-income earning nations, with 86 percent of patients found globally, including Pakistan [9-10] According to the WHO MONICA protocol discussed above, a study conducted in Islamabad revealed that more than six percent of the population (or more than 5 million) are affected by CVD. This demonstrates that Pakistan has a significant risk of cardiovascular disease. According to the discussion in [11]

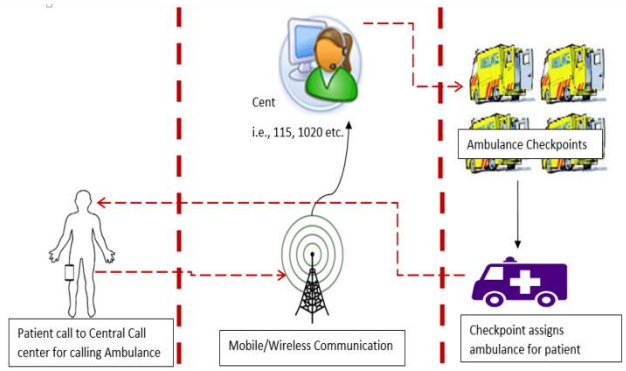


Figure-3b. Current system.

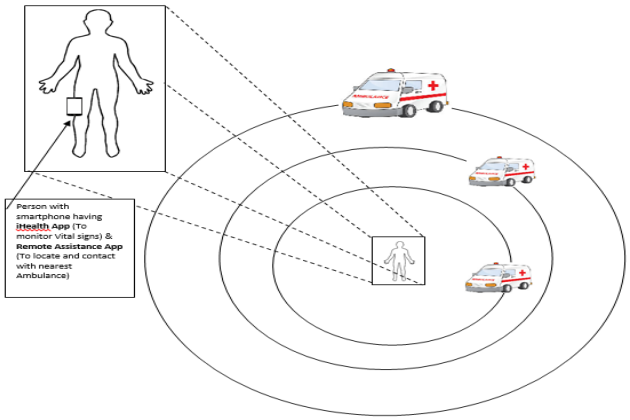


Figure-4. Locating nearest available ambulance at a glance.

only diabetic problem is the root cause of 0.1 million deaths per day. The World Health Organization predicts that Pakistan has risen to the seventh biggest nation in terms of diabetes population, and that it will be the fourth largest country by the year 2030, which is a concerning number. When compared to the general population, diabetes individuals have a (200 percent -400 percent) increased risk of heart attack and stroke. Women with diabetes are more likely than non-diabetic women to get heart disease (by 23 percent). [12] Mentions numbers that are almost identical to these. Another research published in [13] shows that cardiovascular diseases (CVDs), which include heart disease and stroke, are the world's leading cause of death, taking 17.3 million lives per year worldwide. The situation is worrisome in Pakistan, where coronary heart disease takes about (200,000 deaths per year), or (410/100,000) of the population, and the figure is continuously increasing. According to studies, developing nations account for more than two-thirds of all fatalities caused by cardiovascular illnesses worldwide. Premature death is a consequence of cardiovascular disease, and it is predicted that 0.23 billion people would expire from CVDs each year by 2030. It follows that by notifying people about these chronic illnesses via quick or early alerting systems, it would be simpler to avoid them and the above-mentioned proportion may be reduced. As a result of the aforementioned problems. Figures 1a and 1b depict a PAN (Personal Area Network) and a bird's eye view of the surrounding environment, respectively. As described in [14] and [15], several applications and models for remote patient monitoring have previously been suggested by scientists. We are concentrating on ambulatory services in relation to mobile patients by combining two apps, one of which constantly monitors vital signs and the other which performs administrative tasks. A web-based service for monitoring the closest ambulance and asking for help may be used to provide treatment and transport for the patient. Figure-2 depicts the main features and integration with ambulance tracking as required.

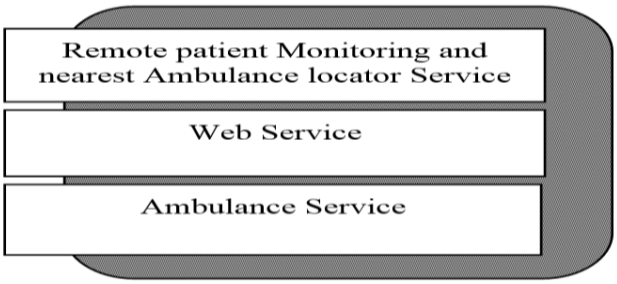


Figure-5. A Three-layer block diagram of proposed system.

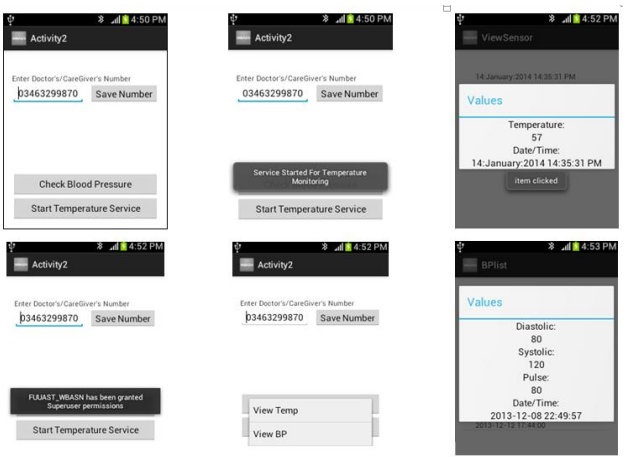


Figure-6. Different snapshots of ViHealth application.

3. REMOTE MONITORING APPLICATIONS

A. Applications and Services Working In Advanced Countries

There are various remote monitoring applications in the health domain being utilised effectively across the globe by a significant number of users that are confident and trusting of the technology. Research in [16] provides a description of the goods and uses, as well as specifics on how to use them.

B. Possibilities for Mobile Health Services

Around the world, there has been an amazing increase in the development of information and communication technologies. When it comes to user perception, mobile technology has made significant strides. The smartphone consumers are more comfortable with application-based services than they are with conventional text-based or SMS-based services [16]. As more and more individuals begin to use treatment options, the increase in revenues will be driven mostly by volume growth. The growing urbanisation and wealth of Asia, as well as the increasing prevalence and awareness of non-communicable illnesses, will all contribute to the growth of the wellness industry in the region. Nonetheless, the symptom domain in virtually every illness is the same, and this may be seen using existing body-worn sensors and technologies, such as ours, to detect disease progression. In countries such as India and the United Arab Emirates [16], wellness programmes that offer advice for healthy living have already been introduced.

C. Health-Care Applications and Services for Mobile Devices in Pakistan

When it comes to healthcare, the importance of ambulance service cannot be overstated owing to the time-sensitive nature of delivering necessary and needed first assistance to the distant patient. In most cases, patients who live in distant areas need medical attention at a hospital; thus, it is necessary to transfer them in the shortest period of time possible while providing adequate medical care. Patients have died in ambulances because there is no first assistance available or because they are sent a long distance from the main hospital on many occasions. In all of these instances, our suggested approach takes care of the situation by providing constant monitoring and, when necessary, automatically calling for an ambulance in the vicinity. The following are some examples of mobile patient monitoring initiatives that have been implemented in Pakistan, albeit with little success.

a) Teledoctor (Telenor Pakistan) is a broad public service in Pakistan that provides access to trained doctors 24 hours a day, seven days a week, allowing for primary health advice to be provided over the phone.

b) Telecare formed at the Department of Women's University of Health Sciences Karachi has been offering remote patient care utilising live video streaming to assess patients with the assistance of Telecare since 2007. (August 2010).

c) The Taaleem Foundation has been active in Baluchistan for some time now (25 years). Collaboration with DOW University of Health Sciences is allowing remote clinics to be conducted throughout the year. The majority of the apps created in Pakistan are for prenatal assistance, and some services need patients to participate in order to give feedback to the facilitator.

D. Emergency Medical Services in Pakistan

It is a necessary component of any community. While Pakistan is the only nation in the world to have Edhi, the world's largest network of hospital ambulance services. This service is provided by numerous other NGOs, including the Chhipa Group, the Alamgir Welfare Trust, the KKF, the Rescue 1122 and the Aman Foundation. As a general rule, ambulances offer two key healthcare advantages for remote patients: firstly, they can immediately and immediately give medical care; secondly, they can transport the patients to the closest medical facility if this is required. An ambulance service should be publically available in densely populated areas and large cities, such as Karachi and Lahore. Individuals calling various emergency services providers are usually witnessed in emergencies, which might take more time and require more services/resources than necessary to reach local healthcare institutions, as depicted in (Figure-3a) and (Figure-3b). In addition, when two ambulances come at the same time from separate ambulatory service providers a more complicated scenario emerges which makes it harder to receive credit. In the future, it will therefore be inevitable to reduce the effluence of the wealth proposed via ICT solutions. Since the direct contact of a physician with a traumatised patient in faraway areas is not possible, an ambulance that could also have a paramedic facilities on-board is the only method of urgently transferring a patient to a physician in Pakistan. When someone is involved in trauma on the road or in a rural region, an ambulance is needed to provide basic medical care fast. Consequently, on the road people request several ambulances, resulting in waste, i.e. two or more ambulances, if another is required in a chronic situation. This means that additional ambulances are required. Sometimes, someone who requests for an ambulance does not know the exact location and cannot instruct the ambulance service, which causes the ambulance service to waste time. This initiative seeks to resolve the aforementioned two fundamental problems. It is easy to operate. All that we need is a mobile phone that is running on Android.

4. THE PROPOSED MODEL

This system has no negative impact on the conventional/current system. Using this technology,

ambulances that have been registered with the online service may dock a tablet in their vehicles, which will constantly record and monitor the location of those ambulances for use as a ready-reference for calculating the closest ambulance. Applications that are running on the patient's end The ViHealth (see Figure-6) application with ambulance locator and in ambulances' both record geolocation for a specific time while only the ambulance application sends its own point (location) periodically to the web service after every (3 seconds), if the ambulance is in motion (which may be calculated from the built-in speed sensor in tablet PC docked in ambulance) as described (Figure-7).

The suggested system's design depicts the system's primary levels.

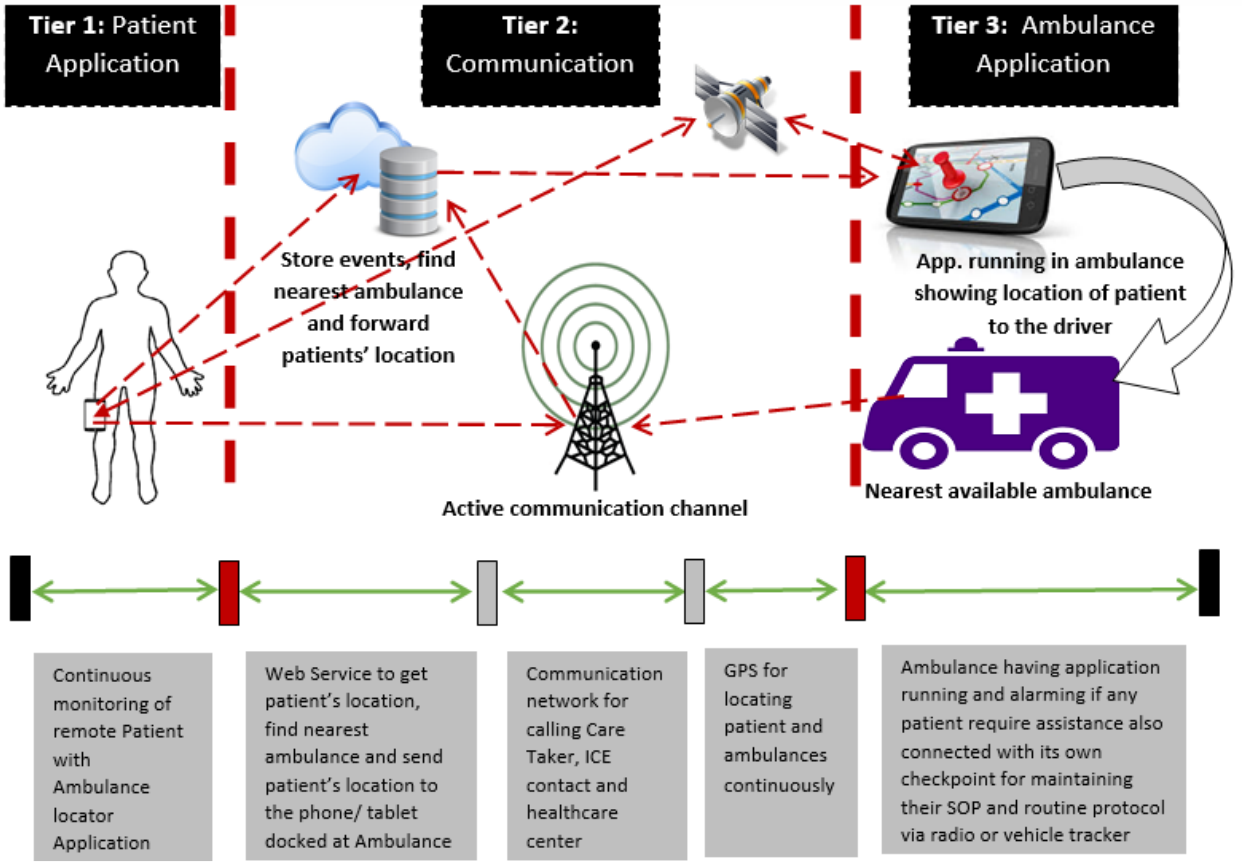
A. Patients' Side

This tier is monitor the distant patients through the app., which consists of the three components listed below:

- **Bio signal sensors:** Wearable sensors that take bodily data and send them to a patient-side app. App ViHealth Electrocardiogram (ECG), temperature, blood pressure, heart rate, respiration rate, blood oximeter, blood sugar, and motion sensors are some of the signal sensors available today. As such, they are called biological parameters. They evaluate a patient's health. A biosignal sensor analyses data and makes decisions based on it. Choose whether to create an alert depending on the user's current health or not (Ambulance Locator - a function accessible in the ViHealth application for locating the closest ambulance). A comparison of the threshold values is made after each reading. In an event when a patient's readings go over a threshold, the ambulance locator will send an alert to their phone. If the patient ignores the warning, the software switches to manual mode automatically. A patient will be transferred if the user does not reply within a certain time period. Automatically, the software will contact the patient's relatives and doctors using their phone numbers.

- **Management of False Alarms:** The ViHealth programme utilises a well-defined knowledge base. Throughout this application, the actuators are guided by a set of rules, which include monitoring the patient's pattern of vital signs and health history, making decisions about the patient's health status, and only calling for ambulance assistance when the patient is absolutely in need of assistance; this helps to avoid any unnecessary ambulance calls.

- **Ambulance location application (on patients' smartphones):** The ambulance locator's duty is to transmit the patient's location and identity to the online service (to find the nearest ambulance for the user). Figure-6 depicts screenshots of the programme operating on the caller's end and in the ambulance.



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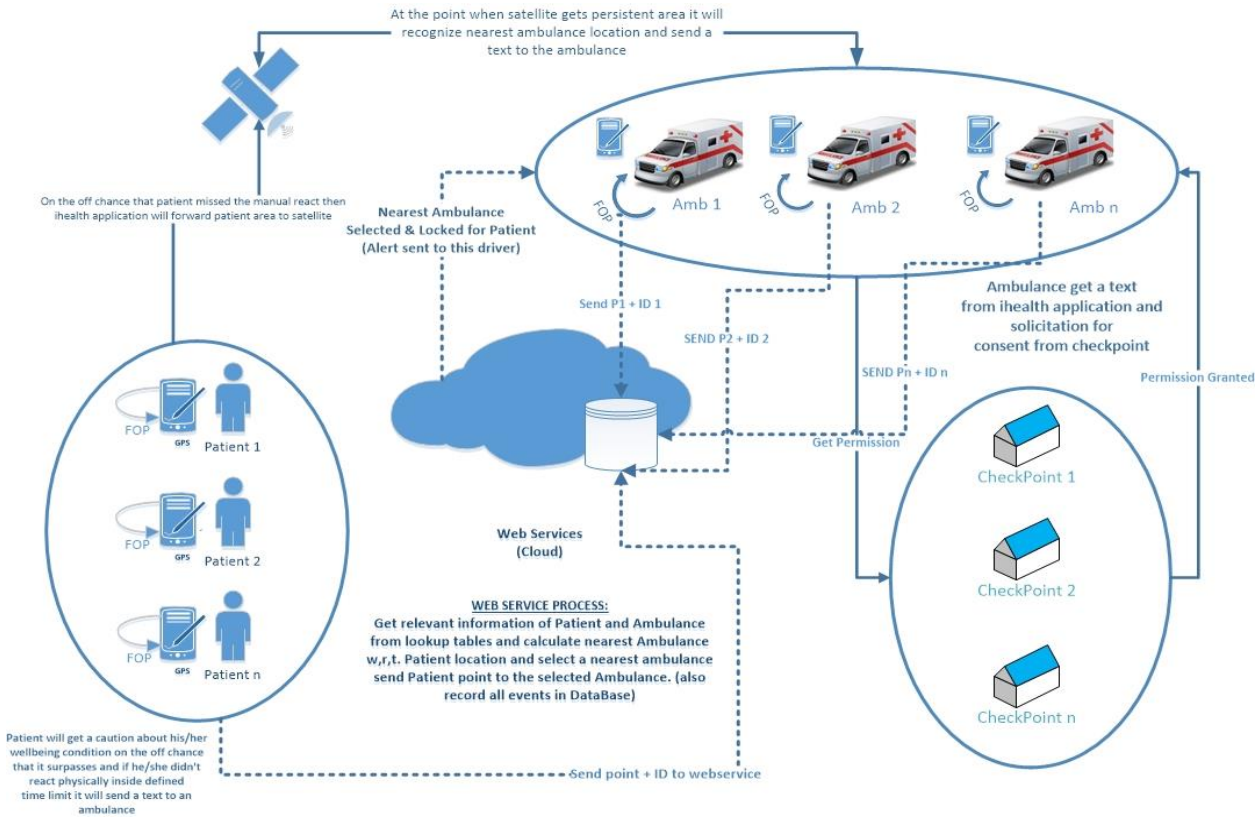

(b)

Figure-7. Proposed deployment diagram - many patients, many ambulances [6].

B. Communication

Web service: The database-driven software finds patients and ambulances in real-time. Receiving and updating the database on the regular basis is one of the ways this online service works with the patient's ViHealth GPS watch. The online service procedure begins immediately after the patient monitor sends an alarm. The online service uses a satellite-updated lookup table or database to find the nearest ambulance to the patient's current location. The ambulance closest to the patient is determined by their straight-line distance.

Data communication: This module is responsible for transmitting and receiving data from the server about patient readings and ambulance locations. This module's job is simple: find and route patients to appropriate ambulances. An individual's longitude and latitude coordinates show their location. Generally, a GPS satellite monitors an item that is linked to or uses a GPS service. In this instance, the module constantly monitors the position of a patient (wearing a GPS-enabled health monitor) and the nearest patrolling ambulances so that in an emergency, the satellite may transmit the patient's location to the closest ambulance (under the control of the web service). This satellite will constantly monitor patients and ambulances, recording their whereabouts in a computer database.

C. Application for Ambulance

Ambulance locator (operating on a tablet computer in the ambulance): This module sends and receives data from the server regarding patients and ambulances. Intuitive search and route patients to suitable ambulances. Longitude and latitude coordinates indicate a person's position. It generally monitors anything that is connected to or utilises GPS. An ambulance may be sent in an emergency by the satellite locating the patient (who is wearing a GPS-enabled health monitor) (under the control of the web service). This satellite will continuously track patients and ambulances in a database.

Ambulance: This study's primary source. The ambulance could be a car or a helicopter, as long as the satellite has seen it before. If the patient is in danger, the closest ambulance will be notified. The ambulance's GPS will also help it find the quickest route to the patient. The ambulance will attempt to locate the patient after collecting all necessary information. When an ambulance gets a patient's emergency signal, it contacts an automatic response system to request authorization to accept or leave the patient.

Checkpoints: These are resource stations for ambulance services/NGOs. The server-side software monitors and manages these checkpoints. All ambulance drivers must obtain permission from their respective checkpoints before travelling to the patient's address. Ambulances may encounter several roadblocks. An ambulance's trip begins and finishes there (while there is no emergency). After receiving a satellite-based emergency signal, an ambulance contacts its checkpoint (through the automated system). When the ambulance arrives, the checkpoint looks for any previous emergency calls. If a more severe (or closer) emergency call comes in, the ambulance will be diverted and the patient will be transferred to another ambulance. An ambulance's request to find a patient if no emergency calls are received.

5. CONCLUSION AND FUTURE WORK

We presented a conceptual model for replacing conventional paper-work with appropriate use of user-friendly ICT applications that collect necessary and sufficient data before, during, and after serving patients' requests (as per required SOP of ambulance service providers) input by voice or other convenient modes, we believe that this average response time in Km will be reduced significantly.

The conventional approach requires about one minute response time while calling an emergency contact centres, followed by approximately (8 to 10 minutes) response time, which adds up to approximately (9 to 11 minutes). In the case of in-trauma distant patients when every second matters, this may significantly reduce the response time and enhance the Golden Time since it immediately locates and engages the closest ambulance, which is a major step forward in the direction of healthcare innovation. Rather than wasting time learning and guiding ambulance drivers to find patient's geo-locations on maps, verification, and due paperwork, they can instead focus on and concentrate on facilitating the patient(s) in the shortest possible amount of time, saving both time and money.

As stated in [17] and shown in [18], about 97 percent of emergency phone callers request that an ambulance could take them and give first aid services. Patients pay more for transportation than they do for information. Patients may be constantly monitored and cared for on the go rather than at home or in the hospital, allowing them to live a more independent life. We have provided an ICT model for the benefit of the people of Pakistan, and for the benefit of all mankind, in order to allow them to be assisted more effectively. For example, there are (1800) Edhi ambulances throughout Pakistan [18], and only in Karachi do Edhi ambulances receive (6000 calls per day). The maximum response time has been estimated to be approximately (10 minutes per call) [19], and the Aman Foundation and Chippa have response times of less than (10 minutes) [20-21]. More importantly, a highly attentive, dependable, and trustworthy monitoring of all actions is a very essential and extremely significant problem that must be concentrated on and designed with extreme care.

Many people working alone (for example, a solitary security guard at a bank, ischemia patients sleeping, working, and travelling alone, among others) become dizzy and unattended for an extended period of time, resulting in Golden Syndrome. Rather by wasting time and suffering, this suggestion is necessary to cater to such situations and many others; raising the overall quality of life and healthcare standards [22].

In our future work, we aim to build on this foundation, providing pre-hospital healthcare services for villagers and interurban severe Road Traffic Injuries (RTI)

in low and middle-income countries, including determining the availability of the nearest required emergency healthcare facility and determining the shortest route to the healthcare facility in the event of traffic congestion, may be added as an extension of the current system. Because of the availability of 3G and 4G services in Pakistan today, distant patients' treatment will presumably improve over time as services are enhanced in the country.

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DISCLAIMER

Authors do not favour, recommend, like and/or dislike any particular ambulance service in any context.

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