Mobile Application and its Role in Providing Efficient Healthcare System for Sustainable National Development

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Abstract
There are many procedures that patients are expected to comply with when visiting a doctor and which may cause discomfort to the patient. And considering these issues, we need a system that makes the patient-physician relationship more efficient. This study proposes her Android smartphone and her web application to facilitate the needs between doctors and patients. The proposed application aims to reduce the time and cost of transaction processing and increase the flexibility of accessing available information whenever and wherever you need it. The prototype of the proposed mobile healthcare application was implemented using HTML, CSS, JS, and Android Studio on the front-end and PHP and MySQL on the back-end. The methodology used for fact-finding was Structured Systems Analysis and Design Methodology (SSDAM) and the software development approach used was Object-Oriented Analysis and Design Methodology (OOADM).

Keywords: healthcare, mobile, android, application

1.1   Introduction

The integration of information and communications technology has transformed health care in recent years. Other aspects of healthcare, such as the patient's relationship with the doctor; The way health services are delivered and the ability to analyze data for clinical or research purposes are also relevant to this transformation. The field of health information technology is now quite well established and has a number of branches and implications. With the advent of mobile computing and wireless communications technology, applications are now designed to run on smartphones and use sensor networks to monitor patients in real time. Healthcare professionals can access all relevant or necessary data through a variety of computer interfaces (e.g. desktop, smartphone, tablet). Likewise, patients can easily access their medical journals through the Internet. Essentially, information and communications technology helps improve healthcare quality and patient experience at lower costs. However, security and privacy risks have increased accordingly. Huge amounts of data must be transmitted, processed and stored securely. Disruption of communication channels can prevent patients from receiving health care in an emergency. Data breaches of patient medical records can lead to social pressure, embarrassment and discrimination. The system has the potential to be abused to the detriment of patients. Privacy violations may occur, for example, due to misuse, unclear purpose, lack of patient consent, and privacy policy. Furthermore, in most countries there is no legal framework governing privacy and personal data protection (Sheikh, McLean, Cresswell, Pagliari, Pappas, Car, Black, Hemmi, Nurmatov, Mukherjee, McKinstry, Procter and Majeed, 2011).

Mobile access to healthcare services can bring enormous benefits to various stakeholders, such as patients, healthcare workers, and healthcare facilities. For example, patients can self-monitor their health status, become more involved in medical treatment and decision-making, and stay in touch with their healthcare provider at all times. By introducing mobile and wireless technology, healthcare organizations can reduce communication and treatment costs by reducing hospital visits and stays while increasing availability and productivity. Healthcare providers can be provided with quick and universal access to patient medical records, medical knowledge databases, and consultations with other professionals in specific areas as needed. Emerging technologies can also be used to collect healthcare data and convert it into electronic form, making medical information for healthcare professionals more centralized, accessible and up-to-date. With mobile technology, doctors can instantly update and retrieve patient records from anywhere with network coverage. This ensures that the patient's medical records are always up-to-date. And doctors with up-to-date information can make better prescribing decisions. In addition to improving the quality of patient care, the adoption of electronic prescribing applications will eliminate redundant paperwork thereby facilitate efficient and effective patient care. Electronic prescribing applications are designed to provide accurate billing and eliminate prescribing errors, as well as facilitate real-time access to medical records, minimizing inefficiencies in office involved in writing prescriptions at the hospital (Anita, Maria, and Gunvor, 2005). Electronic prescribing applications can be designed to support the function of automatically alerting the doctor if the prescribed drug reacts negatively with other drugs.

In this study, we examined the field of health informatics (HI) from the perspective of information security and privacy. More specifically, a significant portion of this work is devoted to mobile health systems (mHealth). This type of application arose from advances in mobile computing, wireless communications, and global positioning systems (GPS). mHealth leverages the core mobile phone utility of voice and short messaging (SMS) services, as well as more sophisticated features, such as bluetooth and mobile broadband (e.g., UMTS, GSM, LTE). mHealth operates as an umbrella term with many different sub-categories of applications. Solutions are developed to support healthcare workers in their activities or to help individuals take better control of their own health. In both cases, mHealth applications typically extend the ability to manage (i.e. store, retrieve, transmit, manipulate, and infer) health data. The use of health apps is not limited to clinicians using these tools in the workplace. Apps also provide mechanisms to empower patients so they can take greater responsibility for their own diagnosis and treatment. Patient apps are being developed to support healthier lifestyles, help with long-term disease management, and provide initial advice on an emerging medical problem. Employers are also testing how smartphone technology can improve patient safety and outcomes, while increasing efficiency. Several mHealth projects and initiatives exist around the world. Thousands of mHealth apps can be found on various digital distribution platforms (e.g. Google Play and App Store). In most cases, health and fitness apps help users better plan their diet and exercise regimen. However, other mHealth apps may have clinical value, targeting different user groups, such as healthcare professionals, the elderly, chronic patients, pregnant women, etc. The mHealth market thrives in developed and developing countries, with different business models and usage contexts (mHA, 2013).

1.2 Motivation for the Study

Traditional methods use paper systems in medical examination and treatment activities such as: recording patient conditions, assigning patients to doctors, interactive sessions between patients and doctors, viewing X-ray images of patients and patient's medical analysis report. This leads to a slow, inefficient process and sometimes loss of patient records. The use of networks and mobile devices allows healthcare professionals to access important information faster, reduce transition times, and spend more time on patient care, anytime, anywhere.

The conventional method of using paper-based system in healthcare activities such as: writing notes about the patient status, allocating patient to doctor, patient interactive session with doctor, viewing patient X-Ray images and patient's medical analysis reports. This leads to make the procedure slow and less efficiency and sometimes loosing patient's records. The use of mobile networks and devices provide medical professionals faster access to critical information, reduce transition times, and enable them to spend more time on patient care anywhere and anytime.

1.3 Problem Statement

In the daily healthcare for patients, doctors and other healthcare professionals use papers to write notes about patient's status, view all patient medical history, all previous doctor visits etc. Under the present manual system, the patient have to be present physically at the doctor's cabin waiting in line to take appointment for the doctors and wait for the time to meet with them and discuss about the health problems. Thereafter, health information and other reports have to be provided many times at different places such as the medicine store which is again a burden of carrying documents. Patients have to visit on another day or after some hours to take their health reports which involves extra care person with patients anytime. There is also the tendency that the patient may not remember to take his medications/prescription as scheduled by the doctor. So, using mobile technologies will facilitate Healthcare procedures and dealing with patients and their records.

1.4 Study Objectives

This study have the following as its objectives:

1. To create interactive mobile based healthcare system that can effectively enhance participatory decision making for patients
2. To develop mobile based healthcare application that can provide an improved quality of communication between the patients and the health care professionals, which is a critical and predictive factor of treatment outcomes for patients.
3. To design an interactive mobile healthcare application that can improve the patients' adherence to both medication and behavioural regimens designed to both treat and manage

1.6 Significance of the Study

The major significance of this work is to provide a new design of mobile healthcare application that incorporates preventive care services for all stakeholders in the healthcare sector. By using the proposed mobile healthcare application, all the stakeholders will be able to access the accurate and up-to-date information with less time and effort as well as improved efficiency of the information flow.

2.0 Literature Review

Efficiency refers to the extent to which system goals are achieved with the resources invested in the system (WHO, 2020). Two types of efficiency, technical and allocative, have been distinguished (Farrell, 1957). Technical efficiency (TE) is achieved when resources are allocated such that output is maximized for a given level of input or input is minimized for a given level of output (Coelli, Rao, O ' Donnell and Battese, 2005). Allocative efficiency (AE) is achieved when resources are allocated such that output is maximized at a given level of input cost or input cost is minimized at a given level of output (Coelli , Rao, O'Donnell and Battese, 2005). Allocative efficiency and technical efficiency together constitute the "overall" efficiency of a system. Productivity, a concept related to but distinct from efficiency, refers to the relationship between output and input in a production system (Hollingsworth and Peacock, 2008). This research work focuses more on health system efficiency than productivity.

As we all know, until a few years back, the hospital generally was an uncomfortable and intimidating place for patients. Because at times, it was difficult to consult doctors or know medication options. However, it can be seen that the scenario is changing now especially in developed countries. But this may seem to still be the same for many developing countries. Even as Oju and Ogbonna (2023) acknowledged that in countries such as Nigeria, individuals residing in rural areas and urban migrant communities face challenges in obtaining good quality medical resources, and they also struggle to afford costly medical expenses. The distribution of medical resources is uneven, as evidenced by the surplus of medical facilities in certain large cities.

Since the scenario has positively changed in the developed countries when it comes to efficiency in the healthcare system as a result of the mobile revolution which is now dominating every industry, especially the use of mobile applications. Mobile healthcare app offers one of the most under-utilized features that is interaction and communication. It enables communication between doctors and patients and that too with great speed. Apart from emergency issues, digital solution in Healthcare facilities can spread out notifications about upcoming healthcare camps, upcoming appointments, and also information of discounts to the patients to increase volume during off-peak hours.

Since the healthcare industry has started focusing on digital solutions, it not only improved the patients' medication adherence and outcome rates but also transformed the patient experience. Hence, to meet the expectations of digital-savvy patients and improve the patient experience, Healthcare practitioners are looking for innovative ways and strategies. In simple words, by connecting patients with staff, Healthcare facilities are easily enhancing the patient experience. These facilities are not only helping patients get quicker responses but also reducing downtime (time during setup for an operation).

Apart from the communication part, in-app feedback feature of applications are helping doctors or healthcare staff to improve what patients are looking for in the app. Also, it is helping to incorporate patient feedback into the new-and-improved digital experience. And, the more hospitals address the feedback, the more their receptiveness and commitment to its target customers are shown. There are many more ways in which mobile apps are helping to

improve patient engagement and experience with doctors and staff viz (https://www.covetus.com):

- Mobile Apps Offer Transparency

Mobile apps can guide patients through every step of their journey, whether from the waiting room or at the checkout counter. In addition, these applications also help staff provide rooms to patients before they enter. And this facility can have a huge impact on patient experience and satisfaction, especially for urgent care centers.

- Enhance Patients' Engagement

Sometimes it is not possible to go to the hospital to reach a doctor. So, the main motto of most medical apps is to reach a doctor even without having to move from the comfort of your home. Not only in emergencies but also during routine medical examinations, the complexity of the appointment often makes patients hesitate to see a doctor; Therefore, medical applications reduce this complexity.

- Health Apps are a Blessing in Far Remote Areas

As we all know, we are in the digital age of the Internet and smartphones. And it's a way to reach every corner, people living in rural or remote areas. They can also expect to receive the best healthcare services through these applications.

- Lessen the Risks of the Faulty Diagnosis

We have witnessed a large number of cases where patients even had to risk their lives due to errors in diagnostic methods, especially in the first few days. But today, the expansion of healthcare applications has reduced all the previous life-threatening possibilities.

- Reduction in Medical Expenses and Bills

Hospitals charge as they see fit; Therefore, skyrocketing bills and large medical costs are always a headache for people. Hence this is one of the main advantages of medical applications.

- Help to Self Monitor One's Health

This can be one of the best benefits because we are often trying to help ourselves. And health apps allow us to do the same. These applications have rich features that allow patients or people to monitor their own health.

- Facilitated with Easy Payment of Bills

We can see that before the advent of medical applications, paying medical expenses was not simple. The applications are supported by integrating a highly secure payment gateway, allowing users to pay the amount quickly without having to queue up to pay the bill.

- Bridge the Emotional Gap

For any patient, it is very important to trust your doctor. Well, this is only possible if they have the right connection. And these smartly designed healthcare mobile apps do the same.

- Lower the Medicare Fraud

Today we see that Medicare is rife with fraud just for money. However, digital interactions reduce fraud because they increase patient access to care. Therefore, we can say that the reduction of fraud is one of the most significant results of digitalization in the healthcare sector. This happens because digital applications have the incredible ability to track people and transactions from anywhere.

- Healthcare Apps Give Rise to New Business Models and Opportunities

This shows that healthcare applications are not only focused on patients and doctors but also brings new opportunities and business models. Medical staff today use applications to guide patients instead of outdated methods.

2.1 Different Applications in the Healthcare Sector

In this section we reviewed a number of existing application types drawing on examples from around the world. The following are some of the applications on healthcare management systems with more details in the last evolution that is related to our work (https://www.rootstrap.com).

(i) Generis: DNA & Nutrition

Generis' mission is to help people improve their lives by understanding their genes. This innovative health app is powered by an individual's DNA. At first glance, you realize that the interface is easy to use and aesthetically pleasing, which is probably why patients love it.

(ii) Teladoc - 24/7 access to a doctor

Teladoc connects patients with board-certified physicians 24/7 through the convenience of phone or video visits. This app allows patients to communicate quickly and easily with doctors who are ready to listen and solve their problems.

(iii) Better Help - Online Counseling

This mobile health application is a pioneer in the field of consultation. BetterHelp gives patients quick, inexpensive, and easy access to mental health professionals. BetterHelp is a convenient way to get professional help online from licensed therapists and counselors.

(iv) MDacne - Custom Acne Treatment

MDacne provides users with immediate access to dermatologists. Gone are the days when patients had to wait months for an appointment to see a dermatologist. MDacne is said to be the future of acne treatment. In less than 5 minutes, they can provide care tailored to the user's skin. This app is extremely easy to use and has a great interface.

(v) Leafly

This app has over 200,000 positive ratings. With the rise of medical cannabis being prescribed to treat a variety of health conditions, Leafly has become a one-stop shop for cannabis information. This health app connects patients with doctors, clinics and dispensaries with just one click.

(vi) MySugr - Diabetes Tracker Log

The motto of this healthcare app is "Make diabetes less dangerous!" .MySugr allows patients to track blood sugar, carbs, boluses and estimated HbA1c at a glance. Users say MySugr has changed their lives. Recording data daily allows them to better monitor their condition. Doctors are also allowed to review data to better treat patients.

(vii) EyeCare Live

EyeCare Live allows you to connect with your own eye doctor conveniently from your smartphone. Do not use this application if you are having serious problems. This healthcare app works best for patients with dry eyes, red eyes, eye allergies, or questions about contact lenses.

(viii) Heal - Physician house calls are back

Doctors' house calls had been routine since the 1930s, and their popularity declined during the 20th century. Heal was determined to bring doctors home. Due to the COVID pandemic, Heal provides peace of mind, helping patients avoid exposure to infectious viruses at a doctor's office or urgent care facility.

3.0 Proposed System

Healthcare must always be about people, not about a system. After conducting a careful study and detailed analysis of the existing systems, the researchers proposed the development of an application that can accommodate the communication needs between doctor and patient. The healthcare management application is designed to make available the prescriptions and health

records, medical image records (like scanned images etc.) of patients, on their Android powered mobile phones. The health records are stored and managed in the cloud OS. The records are transferred from the cloud to the mobile device, where it is displayed. EyeOS is the cloud platform used to build this application. The information that resides in the cloud is managed by the hospital management staff and the doctors (for uploading prescriptions and medical image records). The Android OS supports the connection to the Cloud OS that allows the patient to retrieve, modify, manage and upload medical images and text data using the internet services and REST API concepts
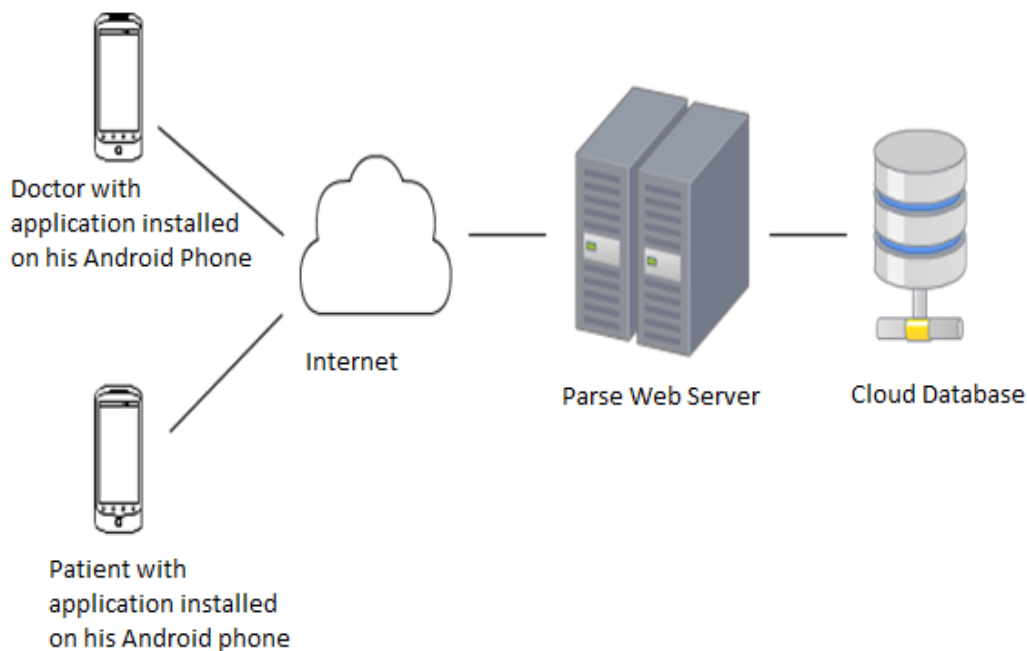

Figure 1: Proposed system overview

The figure above illustrates how communication takes place between doctors and patients in the proposed system. The users set up the application in their Android phone, both the doctors and patients are differentiated based on their logins. All the interactions between a doctor and a patient such as messaging, sending health tips, sending prescriptions, patient referrals and appointments are initially sent to the parse web server, these interactions are RESTful API service requests made by the user to store data on the Parse web server. Similarly the data is fetched from the Parse web server and then through the web server to the user. The web server acts as an intermediate for the interaction between the doctors and patients for data exchange. The users should always be connected to the internet in order to interact with the web server through the web services. Hence this way the communication takes place in the mobile healthcare app.

3.1 Application Implementation Details

The project is divided into two modules. The client module serves the mobile (Android OS device) end functionalities for both the healthcare professionals and patients, the server module contains the Cloud OS. The client module coding is performed and tested using the Java Eclipse. Android SDK toolkit is first enabled in Java Eclipse and then coding is done for the mobile end cloud application and for the connection-oriented details between the Android

OS and Cloud OS. Also, the Android device screens are designed with respective elements using the IDE and coding is performed for every element's action. The cloud is accessed from the mobile through Web APIs and coding is given for the same. The cloud OS used in the application is EyeOS also known as web OS. The EyeOS has all the features that are available in a normal OS. It supports dynamic content with the goal to work from everywhere and allowing sharing ability from anywhere in the easiest way possible.

The front-end web pages are designed in XML files and the backend database support is provided by Oracle 10i Express Edition. The HMS page has authentication screens for Patient, Doctor and Administrator separately. The tables are created for Patient, Doctor and Administrator details. Patient ID and Doctor ID is generated for every patient and doctor for authentication purposes. A patient can register his/her details and can sign-up for free. Patient can then fix appointment with the doctors. Doctors also have to sign-up and register their details. All these details are stored in the database for each screen operation. Doctors can view their appointments, update the medical prescriptions and upload medical images. The administrator approves the patients' files and the doctors' files after proper authentication. The database connectivity is established in the cloud location files.

The entire process works as follows:

(a) the client at the mobile end opens the cloud application as either patient or doctor and is authenticated by the cloud end.

(b) The client enters his/her profile details by registering first, and then logging in. The username is the corresponding 'id' and password is the one set by him/her in the cloud server.

(c) Then the Patient id is required to "search" for the records under that id. Then the particulars, diagnosis details and medical images are viewed by selecting the same via the checkbox.

(d) When the user requests for an operation in the mobile end, the request is sent via REST API like HTTP URL to the cloud OS.

(e) The cloud OS responds by sending the requested information by searching in the database and sending them back to client.

(f) The mobile application checks whether there are any files that were received and are waiting to be downloaded, and will download them and make them viewable to the client. There are features in Android SDK that make the received content to be fit to the screen size. Apache Tomcat server was used to contain the XML servlets of the cloud server and XAMPP control panel was used to run the Apache Tomcat server. The results were tested through the Android SDK in the Java Eclipse IDE.

4.0 Conclusion and Future Work

The healthcare management application was built for providing vital connection between home healthcare and primary healthcare providers for making their work easier. The application is cost-effective and a boon for elderly people who find it difficult to come to the hospital and spend time for collecting the medical records or prescriptions and also for people in remote areas. It also benefits the patients to make available the medical records while consulting different physicians at any given time. The application implemented as above serves as a basic platform for further research in the areas of (a) compression of medical images for more efficient storage in the server and faster communication (download) time to mobile device, (b) security and privacy implementations of the medical data at cloud computing server side (c) implementation of higher healthcare standards for data

maintenance and communication (d) image operations at mobile interface like zoom in / zoom out at the time of viewing and analysing.

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