Health Sector: An Overview of Various Smartphone Apps

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Abstract By enhancing connectivity, performance, and service quality, mobile healthcare apps are revolutionizing the healthcare system. A person could make his life easier and healthy by utilizing number of beneficial mobile applications meant for health care. This paper analyzes numerous mobile applications for the efficient monitoring and treatment of diseases in patients in diversified domains used in the healthcare sector. This study divides mobile applications into two categories: general and unique and uses 21 criteria to compare them to show the areas in which more research is needed to help enhance the quality of health care and help link users to providers of health care. To conclude, several points that will help to strengthen the healthcare system are recommended.

Keywords Health care · Smart phones · Mobile apps · Treatment

1 Introduction

Health is a greatest importance factor as it affects the economic development and the well-being of a country in case of developing as well as developed countries [1]. Previously, patients go to the hospitals for their treatment which was not convenient and increases cost. To access, provide quality and affordability in health care is a big challenge all around the globe. The cost factor of health care is a big issue for millions of users [2]. To overcome with these types of issues, mobile technology helps by utilizing number of health apps, numerous types of sensors, medical devices, telemedicine, etc. In everyday lives, a number of mobile apps have become pervasive, and companies like Google, Apple, etc. have developed apps for differently able users by spending too much amount on the resources in order to update the operating system of mobile [3]. Due to this technology, care delivery can be facilitated, helps to lower

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the cost factor, users are easily connected with their care providers, time management is there, patient monitoring and so on. Now, users get services related to medical field with their cell phones rather than going to the hospitals. In a survey, it is concluded that there are approximately 5 billion cell phones in the world, out of which around 1 billion are smart phones [4]. There are number of mobile applications now which are used for patients who are suffering from dementia by using GPS function of cell phone for location tracking of patients, secondly there are number of social media websites who are also helping the patients, and thirdly wearable sensors are used for health care. Mobile application is evolving as a fast developing segment of the Information and Communication Technology in healthcare sector at global level. A vast amount of mobile apps have been developed during the past few years in an attempt to help patients to avail health facilities and doctors to monitor and support their patients at anytime from anywhere. This systematic review aims to shed light into studies that have developed and evaluated mobile apps for the monitoring, management, treatment, or follow-up of some general or specific diseases in patients.

- **Disease-specific apps**

Adolescents require a wide range of abilities to fulfill their aim of greater independence. Some teenagers struggle to make this adjustment. Their transition to independence can be stressful and upsetting for parents and families. Some aspects of this difficult transition are typical, and while stressful, parents should not be concerned. The MTNA [5] app is designed for an adolescent to deal with these issues. Based on four primary inputs in the app, an app for diabetes patients [6] was built for intervention and clinical decision-making for type 2 diabetics and was examined for practicality and acceptance. Both patients and general practitioners in the primary healthcare network approved of the development and use of a mobile application.

The Jakpros [7] application for pregnant women offered its patients "educational page" as a feature to get reproductive health information such as prenatal care, cervical cancer prevention, high-risk pregnancy, and contraception knowledge from the reliable obstetrician and gynecologist doctors. It is also directly connected the doctor and their patients with the help of question and answers' forum. In Jakpros, the patient could detect the doctor schedule and check the nearest hospital for them. Same way, the doctor could monitor their patient's health with the help of saved information such as estimated date of delivery and baby heart rate.

To cater to the need of spina bifida patients, five apps that comprised the iMHere [8] gallery were released to support preventive self-care for managing medications, neurogenic bladder and bowel, mood, and skin breakdown.

Manage my condition [9] created three smartphone apps to assist parents in managing their child's asthma and to increase oncology patients' adherence to prescribed drugs. The first app allowed parents to learn more about their child's condition. The second and third programs provided an organized schedule of reminders,

data logging, and active case management based on real-time data to the healthcare team.

- **General apps**

A mobile application [10] to make health care more convenient for the masses was proposed which provided general information about hospitals, cost, quality, facilities of hospitals, online appointment with the doctor, emergency call for an ambulance or healthcare service, and medicine alert system.

An integrated eldercare HER system (IEEHR) [11] that merged health data with sensors and telehealth (vital signs) measurements provided physicians' tools for chronic disease management, reduced nursing workload, and allowed the development of health context aware algorithms for predictive health assessment.

In view of patient data security, a secure system app [12] used public-key encryption allowing the secure sharing of medical resources. Most of the people lack first-aid knowledge which sometimes becomes life threatening. Keeping in view some remote locations and non-availability of internet services, an offline app [13] was programmed to give users' first-aid instructions based on the symptom/injury that they selected. It provided visuals of the symptom/injury and gave instructions in local language for easier understanding by the users in the community.

One more general Android application [1] had 11 features such as patient registration, login, insert health condition, view health condition chart, request appointment with doctor, view appointment schedule, view medical treatments, view health article, view message from doctor, do emergency calls, and logout feature.

2 Literature Review

Imteaj and Hossain [10] developed a mobile app in order to provide a healthcare system which is highly effective. This app is providing a number of benefits to the users, for example: ease of finding information of any hospital in city, cabin-related information, booking of cabin by using various modes of payment, suggestions for finding appropriate hospital, alert system for medications, etc. This app is very useful for users as they are able to find or select hospital, and they can book cabin when needed and so on. This paper describes the architecture and logic diagram for cabin booking system in online manner, and in future, this work can be extended for poor people by using AI concepts for the detection of diseases.

Amini et al. [14] proposed a technique for determining the sensor position on human body to ensure correctness and accuracy of the measurements in health monitoring. This paper uses the technique of accelerometers in a way to record motion data so that the location of device on human body is estimated. It uses both methods of time-series analysis: supervised and unsupervised. The proposed technique firstly uses the unsupervised way for time interval detection, in which a person is walking and then SVM is used for pattern analysis and estimation of device position on body.

This paper [11] presents an idea for US older adults that they prefer to live in an independent manner for as long as possible until some dementia condition occurs. So, a system is developed for their health monitoring by using sensor networks along with telehealth and electronic health record as there is no integrated system present till now. This paper describes an integrated system for elderly people with number of advantages. In paper [12], the concept of cloud computing is presented along with the usage of distributed networks and the combination of both technologies is described in a pervasive application. This paper mainly focuses on security requirements of unlink ability by using private as well as public clouds, and with the usage of these both clouds, the data of health records can be efficiently managed. The previous work related to this idea has not defined any security approach in medical record systems. The proposed idea of this work is to create a system which is highly secure by using elliptic curve encryption as well as public key encryption method.

In paper [1], a health index of Indonesia is compared with some other countries which shows a low value in Indonesia due to complex patterns of disease. So, to overcome this problem, smart health concept is used which monitors the health condition of persons from healthcare institutes in order to prevent diseases. This paper describes that the researchers just focus on the collection of sensor data, infect the requirement is to store, process and even synchronize between the systems, institutes and patients. That is why a proposal is given for the development of health monitor system in the form of an app which will be used by the patients later.

This paper [9] is describing an idea to create customized cell phone application for the management of medical conditions so that there will be number of improvements for patients as well as healthcare systems. The only barrier in this target is the paradigm of software design in medical field. In this paper, three mobile apps are developed: first is Manage My Asthma, second is Manage My Medications, and last one is Manage My Patients; from these three apps, a new app is created, i.e., Manage My Condition, an application for the development of medical conditions.

This paper [6] has shown the scenario of glycemic control by using effective mobile technology and diabetic's management in a proper manner. According to this paper, if tools are used for this scenario, it will require the commitment between the patient and physician for success. This paper [15] describes the strategy for fragile patients for their customized treatment at home. In this, mHealth apps can be utilized for home consultation management by following software resources for the result improvement. This paper described a mobile App related to health which is representing architecture for integration support and task automation with different phases of treatment so that it will help physicians in all types of home visits.

In paper [16], a model is presented named as electronic medical records which are highly sensitive due to shared information between peers for up-to-date patient history. In this paper, a challenge exits if there is a need to provide security, privacy, and availability to the sensitive data. There proposes an approach based on blockchain technology to provide security to medical records. For this approach, encrypted medical records are kept, and on the other hand, patient uses decryption key with healthcare professionals in which he/she trusts.

This paper [17] defines the concept of Internet of Things (IoT), that it is mainly used in healthcare industry by utilizing number of sensors and actuators, and using wireless technology, by use of cloud computing and analysis of data, these all are converting the health care from a paid service which is case-based to value-based service which is referred as IoT-embedded healthcare applications. This paper uses a Diffusion of Innovations (DOI) model with a survey questionnaire for data collection.

3   Methodology

The need for systematic performance analysis of mobile applications in health care is increased significantly as this platform is widely used in smart mobile devices. Performance of mobile applications from user point of view is usually measured in terms of ease of use, availability, friendly interface, emergency help, medication help, hospital search and link facility, doctor link and availability, health record maintenance, secure patient data, and maximum possible support in case of physical absence of doctor and medical facilities. Many authors have studied Android platform, graphical user interface, memory usage, etc., as a base for evaluating performance of mobile application. For more detailed and integrated performance analysis, 22 parameters are used to evaluate the usability of a mobile application as expected by a patient and shown in a tabular form.

- **Mobile Application**

A mobile application is a software application designed to run on a mobile device such as a phone, tablet, or watch. To accomplish a comprehensive analysis in the mobile applications, we considered parameters from different categories:

- Doctor availability: How to search a specialized doctor, providing link to the doctor, remote patient monitoring.
- Hospital access: Hospital search based on emergency, treatment availability, distance.
- Data access: Patient medical record storage, privacy and integrity of data, security of data.
- Remote data accessibility, SMS/notifications, first-aid info, etc.

4   Results and Analysis

- **Data analysis**

Results are summarized in Table 1. To have a better understanding on the impact of the use of discrete parameters in the performance of a mobile application, we created a pie chart for each parameter for all the eleven mobile applications chosen for analysis. Values in Table 1 show that the most of the mobile applications succeeded

in providing only the basic facilities to the patients in the categories, general as well as specific. Moreover, whereas the security and privacy of the patient data, hospital cabin booking, exercise management, online consultation fee are concerned, very little work has been done in this regard as shown in Table 1.

Values in Table 1 show that only few mobile applications succeeded in providing the much demanded facilities to the patients.

On an average, 45% mobile applications provided the feature of SMS/notifications/alerts (45%) as shown in Fig. 1.

Other features like doctor's link (72%), medicine alarm (63.6%), health analytics module (54.5%), first-aid information (54%), search options for a specialized doctor (45%) were also provided by a considerable number of applications as shown in Figs. 2a and b.

Table 1 Summary report

Parameters	1 BG Medical Practitioner	2 IEEHR Eldercare	3 secure	4 first aid	5 MOOBLE	6 MTNA (Teenagers)	7 Diabetes	8 Jackprus (Pregnant women)	9 Mcare	10 iMHere (spina bifida)	11. (Manage mycondition)
Emergency call	√				√	√		√	√		
Cabin Booking	√										
Doctor search	√		√		√			√	√		
Doctor Link	√		√		√	√		√	√	√	√
Medicine Alarm	√	√		√	√	√				√	√
Hospitals Link	√		√		√				√		
Hospital Search	√							√			
Payment Ease	√										
Room Booking	√										
First Aid Info	√			√		√	√	√		√	√
Hospital Map	√		√		√						
App	√		√	√	√	√	√	√	√	√	√
Sensors		√					√				
Patient A. Monitoring						√		√		√	
nursing visit module records	√	√	√		√	√	√	√	√	√	√
Mood Scale		√						√		√	
Secure Data			√	√							
Diet Management						√	√				
Health Analytics module	√					√	√	√	√	√	√
Exercise management							√				
SMS/Notifications						√	√	√	√	√	
Disease	General	Specific	General	General	General	Specific	Specific	Specific	General	Specific	Asthma
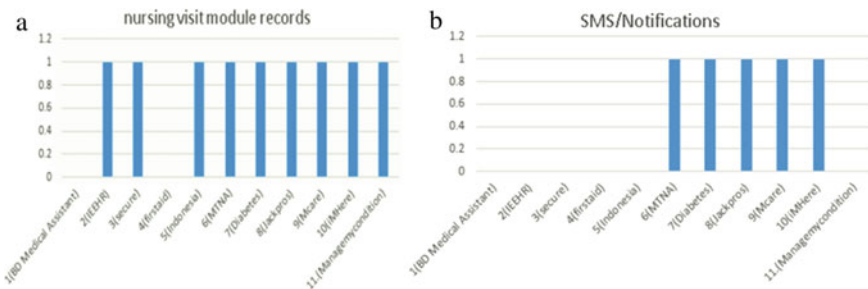
Fig. 1 **a** Nursing visit module feature in mobile applications, **b** SMS/notifications feature in mobile applications
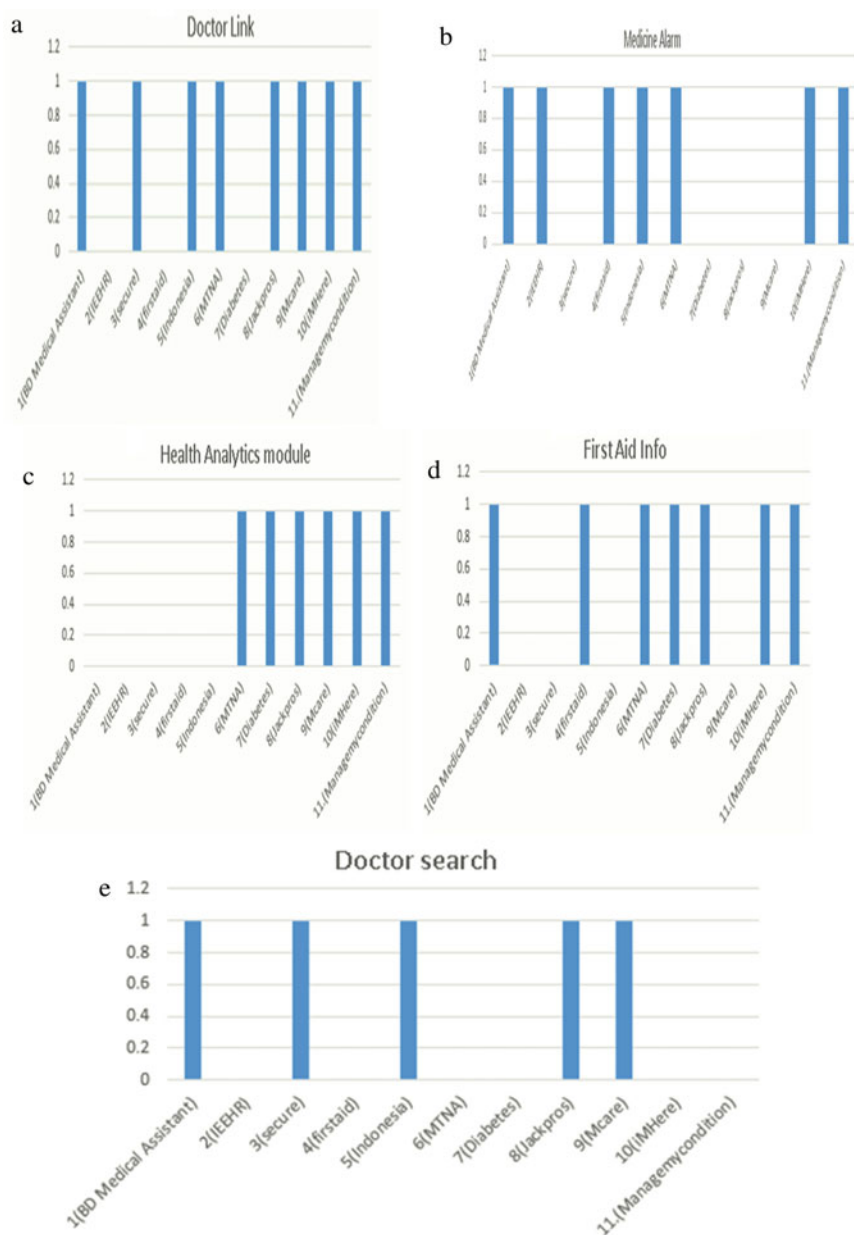
Fig. 2 **a** Doctor link feature in mobile applications, **b** medicine alarm feature in mobile applications, **c** health analytic feature in mobile applications, **d** first-aid info feature in mobile applications, **e** doctor search feature in mobile applications

But for most of the applications, there was a performance decay in terms of hospital link (36%), hospital map (27%), mood scale monitoring (27%), patient activity monitoring (27%), patient data security (18%), relevant hospital search (18%), diet management module (18%), sensor-based monitoring(18%), hospital room booking (9.0909%), exercise management module (only 9%), ease of payment (9%) that goes from slight (36%) mobile applications to very significant (only 9% mobile applications) as shown in Figs. 3a–k, respectively.

5 Conclusion and Future Work

The purpose of this study is to analyze mobile applications used by patients, doctors, and hospitals for health care in different domains aiming to provide remote health services in order to reduce the burden on hospitals and help patients and general public to maintain a healthy life. Based on the research that has been carried out, it has been concluded that:

- Most of the mobile apps under general category fulfill the basic requirements of patients and doctors, but scalability may become a bigger challenge when there is increase in number of patients.
- There is dearth of mobile applications which deal into specific diseases like heart failure, paralyses, skin problems, etc.
- Security is a major challenge in maintaining patient database. Very few mobile apps are dealing with issues of privacy and data integrity which is a basic necessity of the time.

In future, real-time analytics with its solution will be much valuable if considered [18–20].
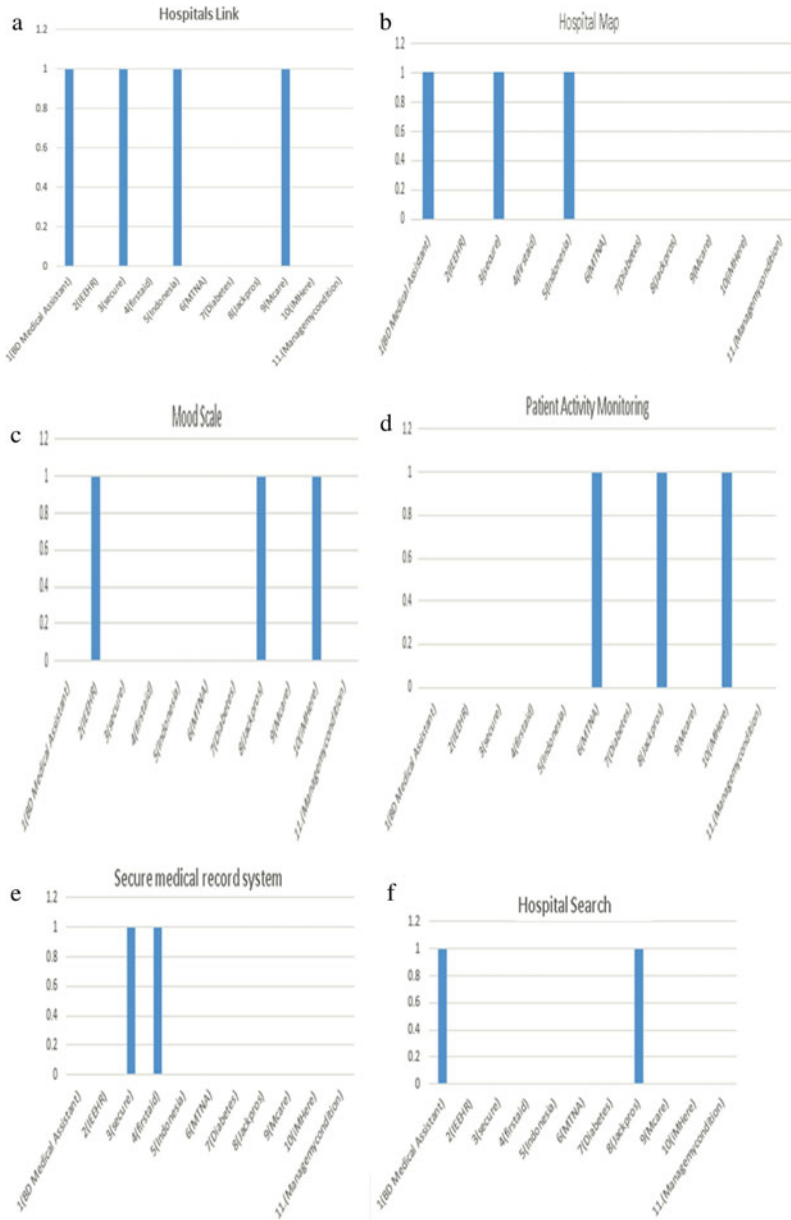
Fig. 3 a Hospital link feature in mobile applications, **b** hospital map feature in mobile applications, **c** mood scale feature in mobile applications, **d** patient activity monitoring feature in mobile applications, **e** secure medical record feature in mobile applications, **f** hospital search feature in mobile applications, **g** diet management feature in mobile applications, **h** sensor-based feature in mobile applications, **i** hospital room booking feature in mobile applications, **j** exercise management feature in mobile applications, **k** ease of payment feature in mobile applications
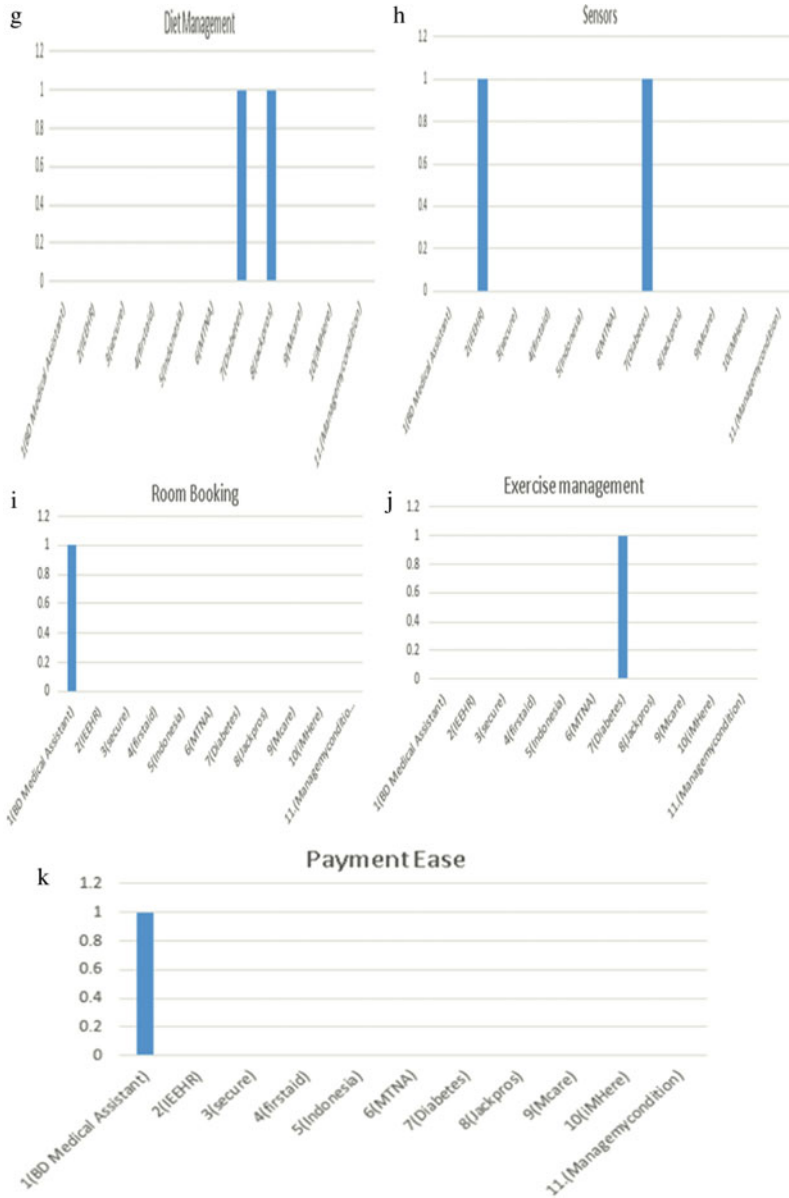
Fig. 3 (continued)

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