

Designing an Android Application for Electronic Booking in Health Clinics and Building Health Record System

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Abstract—With the availability of fast internet technology and smart phones, there is a need for improvement in the interaction system between the doctors and patients. Nowadays, parents have heavy workload and work pressure which makes it difficult to remember important details about their children, especially the vaccination details for children. In addition, the lack of awareness of disease symptoms increases the probability of many serious and fatal diseases. Therefore, it is important to build an appointment and consultation system for medical vaccinations for children up to six years. In this paper, we have designed an effective booking system using Android-based mobile application and interactive website. A centralized database is developed to process the appointments and manage the health records. In this system, four modules are developed, i.e., Patient module Doctor module, Nurse module and Manager module. Our proposed system aims to improve the quality of healthcare by enhancing the appointment scheduling. Also, the system reduce the effort and time spent to perform the vaccinations appointment process and to insure that the vaccinations are taken on time.

Keywords—vaccination, appointment, mobile application, website design, patient, booking system, healthcare

I. INTRODUCTION

The evolution of wireless portable technology such as handheld devices and smart phones, tablets and notebook devices makes a radical development in the way people are dealing with technology. This revolution affects our daily life in various ways, especially in the social lifestyle [1]. Mobile technology has grown rapidly over the past few years and the capacities of cellular networks are developed from 2G to 3G, 4G and 5G. This increase in network capacity combined with unprecedented processing power and huge storage capacity of the mobile devices. This leads to high increase on number of mobile phone users to reach 5.22 billion users in October 2020 [2] which is around 70% of the world population. However, this technological development should have a

major impact on one of the most important side of people lives, which is health. Using mobile technologies has its advantages in improving healthcare services by using mobile applications that can improve the healthcare for our children.

Recently, parents face difficulties to follow up their children growth; they need to memories details about all vaccines up to six years. Parents need to visit the medical clinic regularly and attend on time and waiting for long time for registration and take these vaccines. Sometimes they don't remember the dates, which may cause serious diseases in the future. So, it is important to take the needed vaccinations on time to protect millions of children from serious diseases [3].

Children under five years are affected by various infectious diseases, which are considered as a major cause of mortality and morbidity [2]. According to World Health Organization (WHO) 83% of the children under five years are death by infection disease [4], a report published in 2016 shows that 5.6 million (60%) children died before completing their five years and 3.6 million deaths occur in African and South Asian countries [4]. The main reasons for these miserable indicators can be summarized as follows:

- Lack of awareness: The majority of mothers are not aware of the benefits of vaccinations.
- Lack of knowledge: With the prevalence of traditional beliefs, people feel that their child should grow with natural immunity.
- Lifestyle: As a result of work pressure and daily work, parents pregenerally tend to forget all the details about their children growth.

Vaccines can protect infants and children from serious diseases. This is because their immune systems have not yet built up the necessary defenses to fight serious diseases and infections. Therefore, receiving the vaccines on time means your child can have immunity against diseases [5].

In this paper, database technologies are combined with mobile computing to enhance the quality of service provided for children families and helps the medical staff in medical clinics. For this purpose, an Android-based

mobile application and interactive website have been developed to enable parents to booking appointments for their children vaccinations. The application helps parents to book appointments with doctors in spite of their location and according to doctor's available time. They can also view the upcoming vaccinations and receive a notification message to notify them of the details of the upcoming appointment. The system helps the parents and provide them important details about related to infectious diseases, including corresponding symptoms, diseases cause, children incubation period, preventive measures for children's, nutritional guidelines including breastfeeding and information about diagnosing infectious diseases based on symptoms. The medical staff can use the website of the system to manage the vaccinations booking, edit the prescription and receive medical indications based on the entered data. This give patients much satisfaction when visiting medical clinics and improve the provided medical services for patients.

Many researchers are proposing different booking systems, as will be discussed later in Section II. However, they still have some limitations. Our system adds several features for the existing systems including:

1. Design both a dynamic website and mobile application synchronized with central database to enhance the appointment scheduling system for new-born by compromising digital record of growth, periodic health examinations and vaccination.
2. The system consists of four working modules including parents, doctors, nurses and admins. This is done to improve work productivity and reduce the wait time for parents and their children.
3. The user authentication is proven to enhance the security of the proposed system.
4. The appointment can be booked only for a particular time slot on specific date.

The rest of our paper is organized as follows. Section II discusses some related works on mobile health care systems. Section III discusses the problem statement and describes the developed system. Sections IV presents our results and findings. Finally, we conclude our work and discuss some future directions in Section V.

II. RELATED WORKS

Mobile technology has grown rapidly over the past few years and the capacities of cellular networks are developed from 2G to 3G, 4G and 5G. This increase in network capacity is engaged with unprecedented processing power and huge storage capacity of the mobile devices. This leads to high increase on number of mobile phone users to reach 5.22 billion users in October 2020 [2]. This development increase the number of applications developed to help the community including the health sector.

Recently, several works have been done with regards to the use of smart phones and web technology for appointment booking at medical centers and hospitals [6–8]. These applications provide useful services and lead to better medical services provided for

patients and help doctors and medical staff to improve treatment service [9, 10]. Here, we reviewed the recent research papers and mobile applications.

In Khalid and Singh *et al.* [11], a real-time appointment scheduling has been proposed to enable the patient to schedule appointment on a fixed time and date and allocate a doctor available on that particular time and date. The system can also manage the booking schedule of patients with available doctors. In addition, the system enable the patients to start live consultation with available doctors. Object-oriented analysis is used to design and implement the android mobile application using JAVA as the programming language and uses Hypertext Preprocessor (PHP) as frontend, while using MySQL was used for the backend design.

Habibi and Abadi *et al.* [12] developed an Android-based mobile application to overcome the problems rise in traditional booking system. The booking system enable patients to book an appointment with their preferred doctors. The system consists of both doctor and patient panels. The patient register his information by himself on the first time, this information stored on the database to be used in future login. Patients can enter to the system and view their personal details, view doctors' appointments details, and they can book the appointment in the clinic or hospital they are currently attached with. This system is flexible and the patient can select the available time slot for booking an appointment based on the doctors available time. The doctors can view the appointments and confirm the booking based on their available time.

Android based online doctor appointment application "Mr. Doc" has been proposed by Malik and Bibi *et al.* [13]. The proposed system consists of two modules. The first model designed for the patient; he can register himself and login into the system. After that, the patient can view the list of doctors and check the profile of each doctor and access the schedule for each doctor and request for appointment. The patient will receive notification of the successfully added appointment. The other module is for the doctor; the doctor can view the patients request and can respond to the request by either accepting or rejecting the request.

Kwadwo and Kusi *et al.* [14] proposed a web-based appointment system that enables the patients to register and search for the available doctors basing on the location of the doctors. The doctors can register and give the necessary details about their free time. After that, they can review the patient request and send the notification to the patient if the appointment is available and can view the comments given by the patients. Also, the patient must register to login and select the doctor by choosing his location and the problem faced by the patient. Then, the patients can select the doctors matching their choice and then the request is forwarded to online controller and the controller sends notification to doctor. The doctors then accept the request to the controller and the controller notifies the patients about their booking time then it confirms the booking.

TABLE I. MERITS AND DEMERITS OF RELATED WORK

Paper Title	Approach	Merits	Demerits
Medicus: A Doctor Appointment Booking System [11]	Android application that provides a portal for doctor and patient to book and manage the appointments accordingly.	<ul style="list-style-type: none"> •User authentication with database. •Patient can select the doctor and clinic. •System enables the user to select the available time slot for booking an appointment. •Using Google Maps. 	<ul style="list-style-type: none"> •Schedule appointments without any digital record available. •No notification for patients. •Lack of security. •Difficulty to manage appointments.
Effect of an Online Appointment Scheduling System on Evaluation Metrics of Outpatient Scheduling System: a before-after Multicenter Study [12]	Android mobile application portal for doctor and patient booking.	<ul style="list-style-type: none"> •Website and mobile app. •Question-answer communication between patient and physician. •Reminding appointment. 	<ul style="list-style-type: none"> •No user authentication with database. •Lack of security.
Mr. Doc: A doctor appointment application system [13]	Android based online doctor appointment application.	Two modules, one module is designed for the patient and the admin module.	<ul style="list-style-type: none"> •No website available. •No access for doctors. •Lack of security.
Design and Implementation of Hospital Reservation System on Android [14]	Android mobile application designed to help improve patient and doctor appointment bookings at hospitals.	<ul style="list-style-type: none"> •Two panels for doctors and patients •Confirmation messages for success appointments Booking according to doctor's available time and time-slots. 	<ul style="list-style-type: none"> •No website available. •Lack of security. •No admin management.
Doctor Patient Interaction System for Android [15]	four panels: Doctor, Patient, Hospital or clinic, and Admin.	<ul style="list-style-type: none"> •Doctors manage the booked appointments. •Patients receive confirmation message for booked appointment. 	<ul style="list-style-type: none"> •Lack of security. •No website available.
Mobile based medical appointment and consultation (MMAC) system [16]	a mobile based medical appointment and consultation system.	•Patient only fixes a time and date and the system allocate a doctor available at that particular time and date.	<ul style="list-style-type: none"> •Absence of security. •No website available.
Development of E-Healthcare Management System using PHP, Javascript and Cascading Style Sheets [17]	Online patient appointment system through website. Two modules for doctors and patients.	<ul style="list-style-type: none"> •Appointment based on doctor availability. •Appointment according to desired category and location. 	<ul style="list-style-type: none"> •No mobile application •No confirmation messages for success appointments.
Medical appointment application [18]	Medical Appointment Application is a web-based mobile application develop for managing appointment-booking process in Parit Raja and Batu Pahat area.	•The patient can easily book their appointment with the practice they wanted avoiding a long queue at the clinic.	<ul style="list-style-type: none"> •No access for doctors. •No website. •the patient can fill in the appointment form without knowing which appointment time is available for them.
Android Application for Doctors [19]	Healthcare Appointment booking is developed in Nagpur City.	<ul style="list-style-type: none"> •Two panels for doctors and patients. •Booking based on doctor specialization. 	•No confirmation messages for success appointments.

An Android mobile application has been designed to improve Hospital Reservation System (HRS) [15]. The objective of this application is to reduce the manual process related with hospital appointment bookings with doctors in a specific department of the hospital based on the doctor's availability. The patients can access the functionalities to book an appointment and select the reason for the appointment, then select a specific department to display the available doctors. The doctors then can access their panels to confirm patients bookings and send a confirmation message to remind the successful bookings.

An Android mobile based appointment application proposed by Chaudhari and Phadnis *et al.* [16]. This application allows patient to register and login to the system to book an appointment with a doctor and make complaints on the system. The doctors on the other hand can also login into the system, view the booked appointments, review the complaints, and put solutions for patient complaints.

Vijayasarveswari and Lim *et al.* [17] developed an E-healthcare management system for government/private institute to make doctor appointment online. Patients make appointments with the doctor with its specialized.

All the appointment details are processed and directly sent to the centralized database system. Then doctors confirm the appointment through their web page. Doctor can arrange the time that is requested by patient according to their availability. Finally, patients receive an alert from doctor after the confirmation.

An Android mobile medical appointment application is developed by Ismail and Kasim *et al.* [18]. The system is developed using MySQL Database, PHP, phpMyadmin, Bootstrap and JavaScript are used to develop the system. Patients can login to the system and register to make appointments with medical center. The administrators of the medical center can approve the requested appointments.

An Android-based booking appointment is developed to improve the health care sector in Nagpur City [19]. The system was implemented on android operating system, the system proposed two modules which include the Doctor and the patient. The patient can request an appointment with a doctor based on doctor specialization. The doctor can either accept or reject the appointment.

A range of patient appointment applications have been developed to facilitate better communication between patients and clinicians. However, most of them focus on

developing only mobile applications without developing websites, which is easier for managers to administer the booking process and simplicity and effectiveness of developed systems. Also, as there are a large number of smartphone models and makers, sometimes the mobile application may not work and some errors may occur. Table I demonstrated some of appointment applications and highlights their merits and demerits.

III. PROPOSED SYSTEM DESIGN

A. Problem Statement and System Objectives

Taking vaccinations and monitoring the children growth is essential for parents, and done through visiting the medical clinics. Nowadays, to take the vaccination you have to attend to the clinic and you have to come on time for registration and you have to wait for long time. You have to bring the vaccination card and follow a paper-based process to be served. Sometimes the parents forget the date of vaccination, which may cause serious diseases in the future. The medical staff also face several problems to handle the large number of children and keeping a medical record for them to monitor their growth. This record include information such as blood type, Rhesus (RH) factor height, weight, head circumference, apgar score, congenital malformation, child's talent, child's hearing and other preventive examinations [11].

The main objectives of this system include:

1. Helping parents to remember vaccinations date and reduce time and effort spent in waiting in clinics.
2. Helping the medical staff (doctors and nurses) to give vaccinations and reduce congestion in clinics.
3. Keeping a medical record for the new-borns to be used in the future.
4. Easily detecting any problems or abnormal characteristics of a child.
5. Reducing the burden of transportation for people living in remote areas.

B. Software Development Methodology

The methodology used to implement the proposed system follows the software engineering principles; which are as follows:

1) Planning phase

In this phase, the planning activities are created and the system schedule is defined to enable the project team to accomplish the developed system. Also, this stage determines the technical tasks to be conducted, the risks that are likely, the resources that will be required and the work products to be produced. The cost and system requirements are also defined to ensure the feasibility of the project [20].

- **Feasibility Study**

Nowadays, wireless portable devices, such as smart phones and tablets, have become the most widely used type of technology. This development has led to radical progress in the most important area of people lives, which

is health. The aim of this system is to develop a website and a mobile learning application that will help new-born families to book appointment with the doctor for their kids in the health clinics and hospitals. Before starting the development of this appointment system, a feasibility study is conducted to ensure that the system is feasible and prone to success. This study includes discussing the various constrains that need to be taken into consideration. These constrains are:

- **Time:**

The most important constrain involved is the time needed to get familiar with the different tools for the application implementation, especially with the chosen IDE for this application, which is Android Studio since it is the most commonly used for Android Applications. In addition, the time needed to build the interactive website and secure database is considered to ensure that the feasible study is acceptable.

- **Security:**

Security is a major issue in the health sector to ensure privacy and to store the medical records for patients. During the design and implementation of the application, website and the database, this factor is taken into consideration to ensure the application is safe and secure. The access to the application is restricted for authorized user with username and password. After verification, a confirmation link is sent to the application user.

- **Cost:**

In the economic feasibility, the development cost in creating the system is evaluated against the ultimate benefit derived from the new system. Financial benefits must equal or exceed the costs.

Our system is economically feasible. It does not require any addition hardware or software. Since the interface for the project is developed using the existing resources and technologies

For the development and implementation of the mobile learning application, only free available tools are needed to be used and mastered, which make this project economically sustainable. These tools include:

- Android Studio as the IDE to build the application.
- Java and PHP as programming languages.
- Webhost to host the database and the PHP files and MySQL as DBMS

2) Analysis and modeling phase

In this phase, the literature review has been studied and the system components are defined to build the system architecture. Also, the database tables are defined and the required flow charts and diagrams are developed including Data Flow Diagram (DFD) and the Use-Case Diagram.

3) Design phase

The defined software components, the system features and functions are used as input to generate the system code. The website has been developed using PHP, JavaScript and Bootstrap. The Database tables are implemented using MySQL and phpMyadmin. Also, the mobile application developed using Android Studio. As components are being implemented, unit tests are

designed and executed for each component. The interface between the database, website and mobile application is also accomplished during this phase.

4) Implementation phase

During this phase, how well the application process will be determined. The application and the website are tested and the problems are resolved to satisfy the stakeholders expectation. In addition, the mobile application is uploaded on google play and tested in real environment. The mobile application and the website are tested by all stakeholders to make sure that there no errors. In addition, the documentation of the project is accomplished in this phase.

5) System architecture

This section presents the system architecture that shows all components that are involved in the system. The proposed system also shows how exactly our system works. As shown in Fig. 1, the architecture consists of three main layers Presentation Layer, Service Layer and Resource Layer.

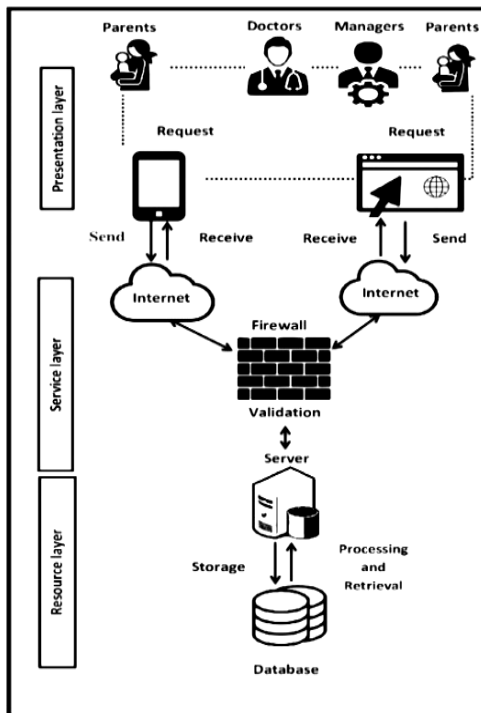


Figure 1. System architecture.

The Presentation layer presents the interface for the system to enable the users to login to the system by assigned access rights for each user. The website is used for management services and for users who cannot perform operations using mobile devices. While the mobile application can be available for all users. Parents can use the mobile application to manage their booking and view important information related to their children health record. Also, the parents can take advantage of the health system if they don't have a smart phone to check vaccination details, schedule appointments and all services provided through the mobile application. The doctors can use the developed website to view his appointment list, manage the appointments, consult the

medical records, write a medical prescription, and view the medical history of the registered children. The managers of the medical centers can admin and manage the work process of the medical clinics. The system admin can use the website to manage the whole system including the website, database and perform maintenance and updates of the system. The mobile application is synchronized with the designed website using the web service and centralized database.

The Service Layer is essential for our system and it performs services to the system units. It contacts with the Resource Layer and assembles information from the requested database. The third layer is the Resource Layer, which contains the system databases and respond to the requests from the database users (see Fig. 1).

C. Mobile Application Implementation

The mobile application is a patient side application where the registered users can access to this application. Initially, parents need to download the android application (ThanksMamy) and install it in their devices. Parents need to visit the medical clinic for the first time for registration since the medical record has medical details that parents may not be able to fill in the registration form such as blood type, height at birth, weight at birth, RH factor, apgar score, meconium passage, perineal tear, episiotomy blood transfusion, congenital malformation and vit.k. After registration, users can login to their respective profiles using unique user Identity Document (ID) and password. The proposed application allows parents to change the password after first login.

To develop the mobile application, different programming languages have been used including:

- Android Studio platform as the Integrated Development Environment (IDE) to the application.
- Java & Kotlin: Programming languages used to program Android App pages.
- XAMPP: a free and open source application package that mainly includes the Apache Hypertext Transfer Protocol (HTTP) server, Maria DB, and an interpreter for applications written in PHP.
- PHP: server side general purpose scripting language used to connect the Android application with the database using MySQL.

Extensible Markup Language (XML): used to design the graphical interfaces of Android applications and make them more interactive.

- MySQL is a relational database management system based on SQL.
- SQLITE is used for the database of the mobile application.
- JavaScript Object Notation (JSON) as a data interchange language to get results in a specific string format.
- Firebase: is a platform developed by Google for creating mobile and web applications and has been used to show notifications in the application.

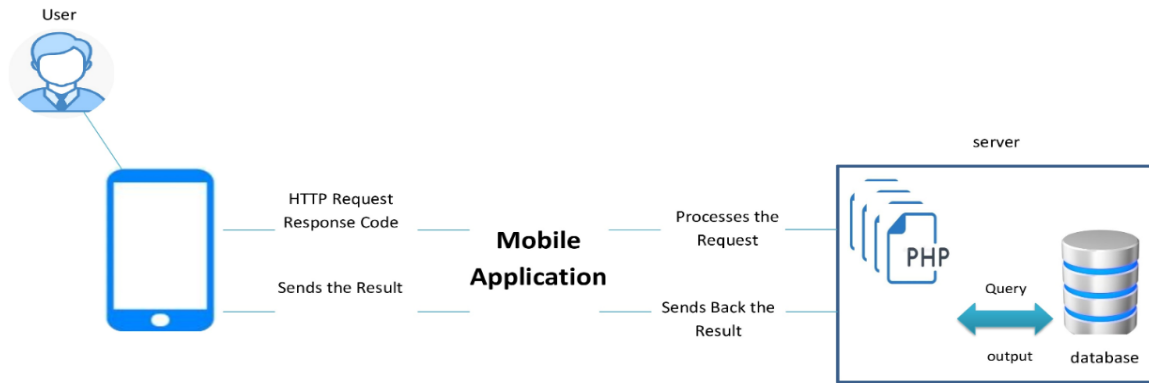


Figure 2. Effects overview of mobile application architecture.

Fig. 2. Shows the architecture of the mobile system. The android application is used to retrieve data from the MySQL database by sending HTTP Request, the application then processes the sent Request in the server side using PHP script files. PHP script files are located in the middle between the android application and MySQL database POST/GET commands used to perform communication. JSON object is used to handle incoming data from the database and encode/decode the result in JSON representation format. The outputs for PHP scripts are returned back to the Android application.

• **Main activities of Mobile Application**

Here, we will provide the main features of our implemented Android Application, which include login/logout, appointment booking, medical health record and medical consultation.

• **Parents Login/Logout**

On the first visit to the medical center, parents need to register because of the medical details the need to be registered by the medical staff. It allows parents to access the system with the account of one of their children and they can change the login information as shown in the Fig. 3.

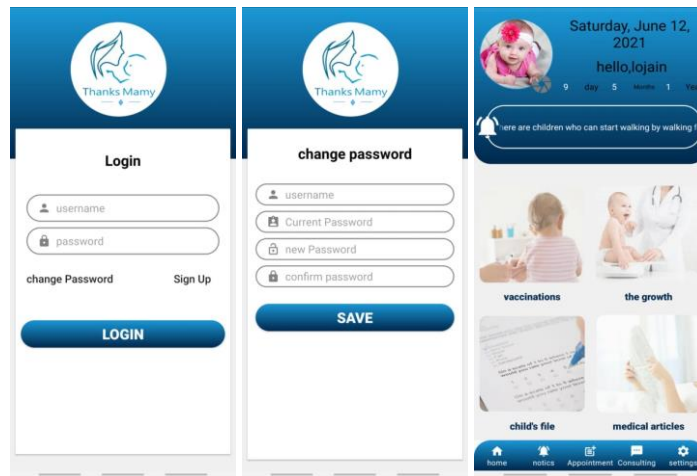


Figure 3. Login/logout screen for patents portal.

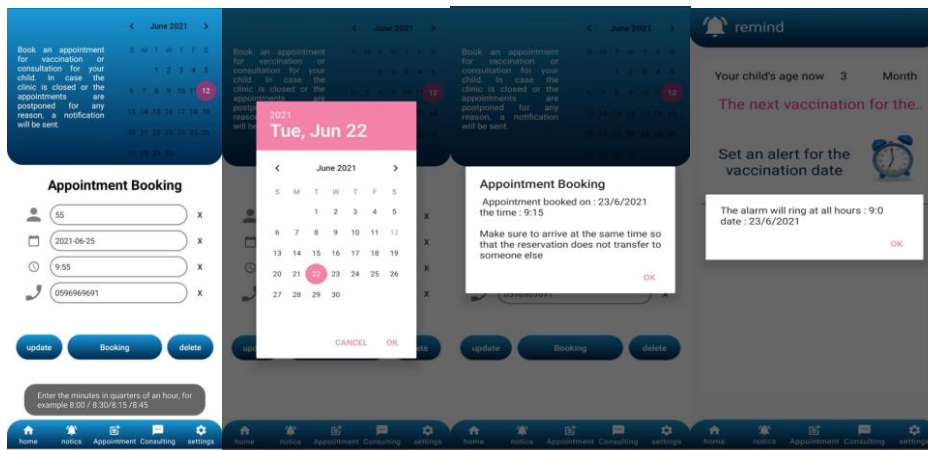


Figure 4. Appointment booking.

• **Appointment Booking**

Parents can select a doctor from a list of doctors registered in the system based on their clinic location. The parent takes his appointment from the available time slots and books an appointment to vaccinate the child. The booking schedule managed by the medical staff by giving a service time of about 15 minutes for each reservation. As shown in Fig. 4, only registered children can book for vaccination. The system prevent booking at the same time for other children. Also, the date of booking for appointment must be the same as the date of taking the vaccination based on the history of the child

vaccination record. The parents can set reminder for the next vaccination based on the vaccination history.

• **Medical health record**

Here, parents can view all information about the medical history of their child including medical tests, vaccination history and upcoming vaccinations and indications about medical tests as shown in Fig. 5.

• **Medical consultation**

Parents can use the application to directly contact with the medical staff for any queries regarding their child's health. Also, parents can choose a doctor from doctor list to answer their questions and an automatic bot is built to reply for the common questions as shown in Fig. 6.



Figure 5. Medical health record for registered children.

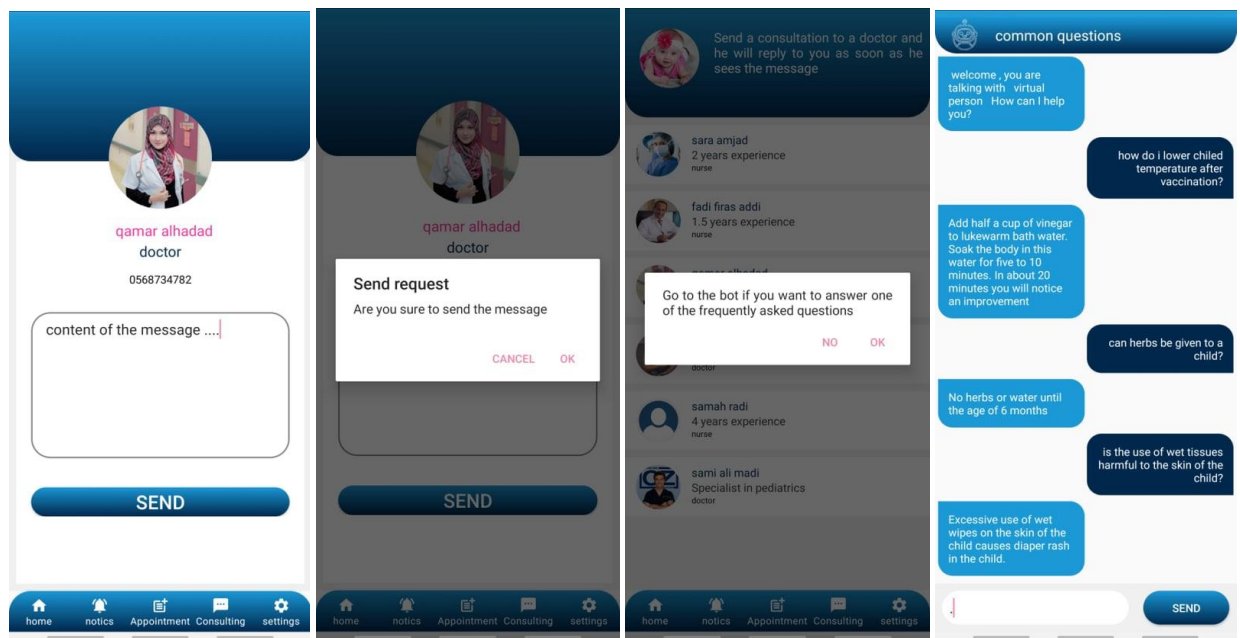


Figure 6. Online medical consultation.

D. Website Implementation

The system website was designed using many tools including Visual Studio, Apache HTTP server, Maria DB, MySQL, PHP, Ajax, HTML, CSS, JavaScript and Bootstrap. The website can be used by the health clinic administrators to manage the system. Also, the website can help the management staff, parents, doctors and nurses to perform useful tasks based on their tasks. Fig. 7. shows the login page for the website users website.

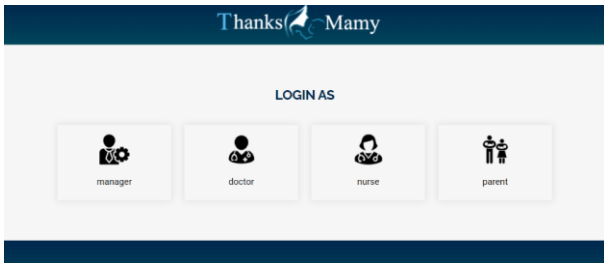


Figure 7. Website login page.

• Doctor Module

The doctors in the medical clinics can access to the system through the login page using their user ID and passwords that are given explicitly by the medical sector authorities. After succesful login to the system, they will be redirected to their personal profiles. Doctors can benefit from the website to perform different tasks including viewing the booking information of the registered children in the clinic and view their medical history. They can also handle the booked appointments and approve all the requested appointments sent by the parents. Also, they can add the needed prescribed medications and diagnosis regarding the vaccination and save them in the medical history. The doctors can send notifications and post announcement for parents and perform much more services. Nurses also can use the website to perform different services that they can perform during their work including, booking management and child registration as shown in Fig. 8.

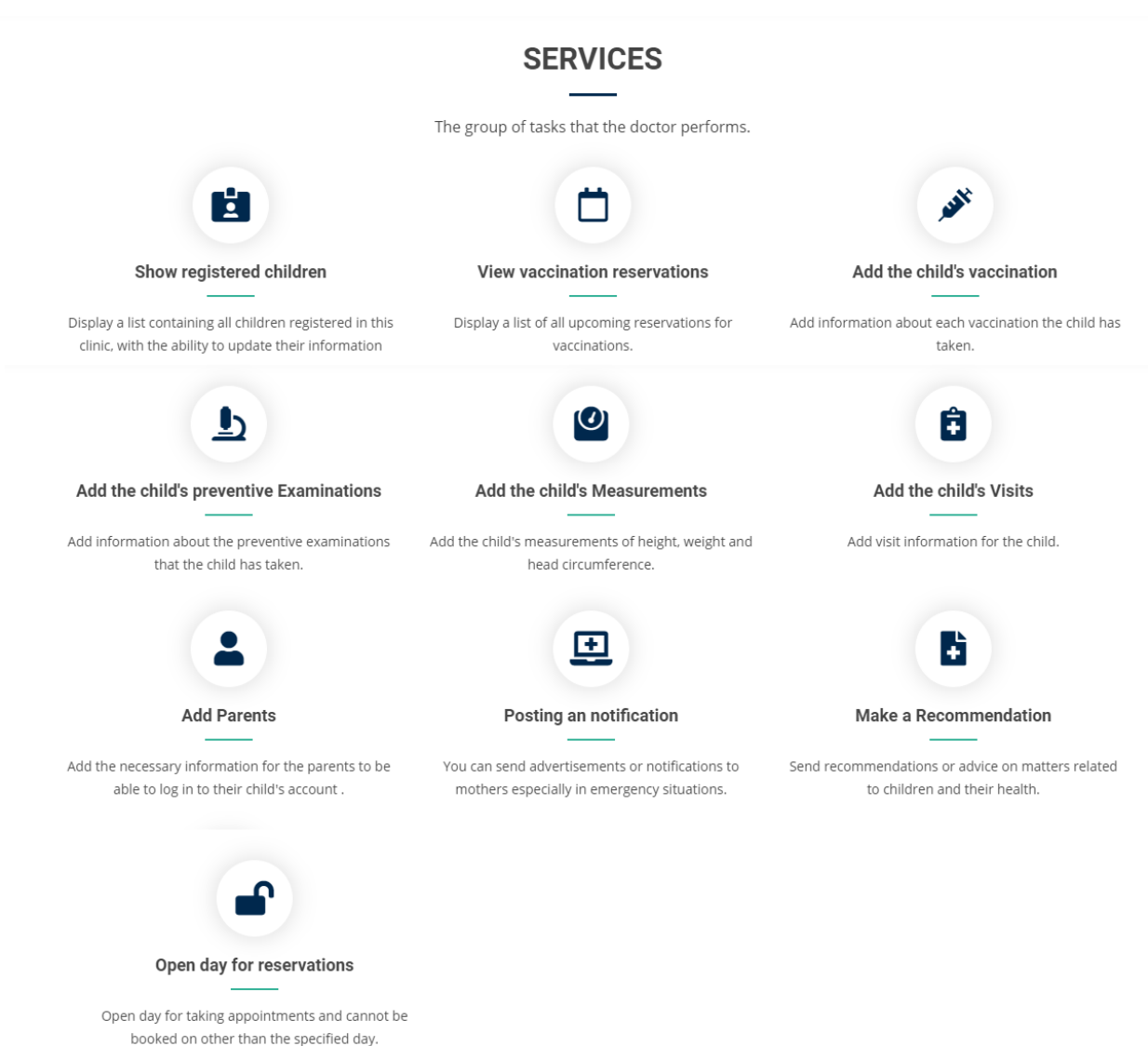


Figure 8. Services performed by doctors.

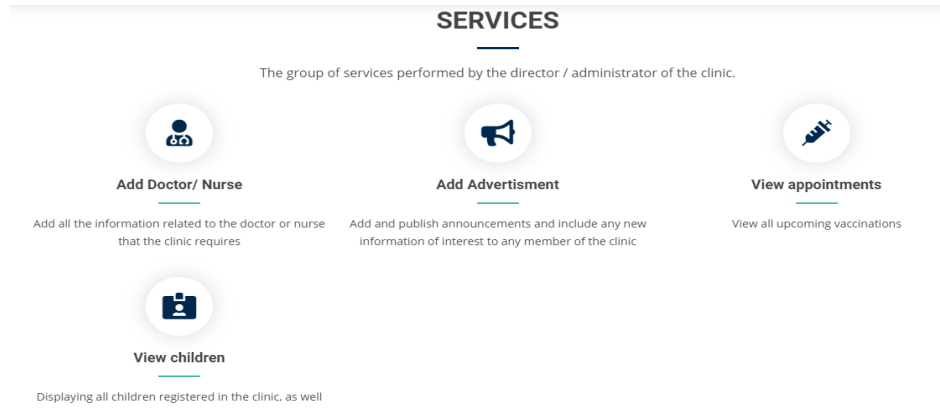


Figure 9. Services performed by managers of medical clinic.

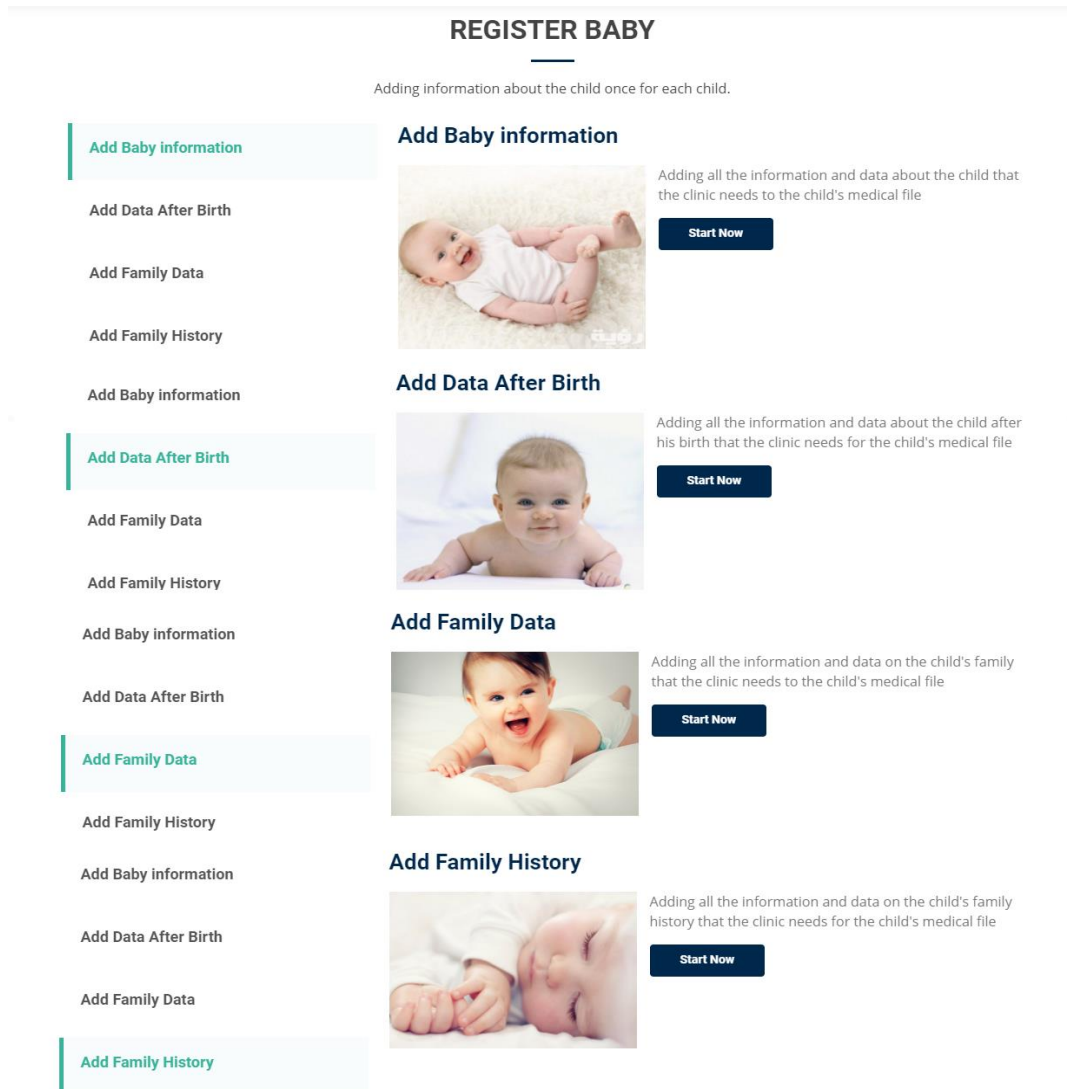


Figure 10. Website page for child registration.

- **Manager Module**

The manager of the health clinic can use the website to perform different tasks including add new doctors/nurse, add announcements and information for parents, view the appointments for each clinic and view the profiles of the registered children as shown in Fig. 9.

- **Parents Module**

Parents can access to the website using login information and use features similar to those used by the mobile application using the same user-ID and password. Parents also can use the website to perform all the activities available on the mobile application. The availability of both website and mobile application is

very useful for parents since some of them may not have a smart phone or face difficulties to use the mobile application to perform several services as shown in Fig. 10 and Fig. 11.

E. Database Design

A centralized database has been built to help the system users to store and access the appointments information, view medical profile, review medication history and retrieval of much more information. The database is synchronized with both the website and the mobile application using MySQL. This will enable the users to store, access and retrieve requested data anytime anywhere.

The developed android application can communicate with a remote MySQL database to authenticate the login process and also to retrieve/ update the patients' medical records. The HTTP protocol is used to establish connection with android application using PHP script located in the server. The PHP scripts are associated with specific tasks between the android application and MySQL database using POST/GET commands. On the other hand, JSON object is used to handle the incoming

data from the MySQL database and encode the result of the query in string as JSON representation format. In the android script, the returned values are decoded to extract the values from it in JSON array to be used later by the android application.

- **Entity Relationship Diagram (ERD):** The ERD diagram consists of the main tables used in this system and describes data requirement and assumptions in the system from a top-down perspective as shown in Fig. 12. This diagram shows the entities and identifies relationship between those entities and shows the functionality and dependency among entities.
- **Use Cases:** Use case diagram is a methodology used in system analysis to identify, clarify, and organize the functionality of the system and present the system requirements. This diagram shows the interaction between the system actors and describe the actions of system users. The use case diagram of the medical appointment booking system is presented in Fig. 13.

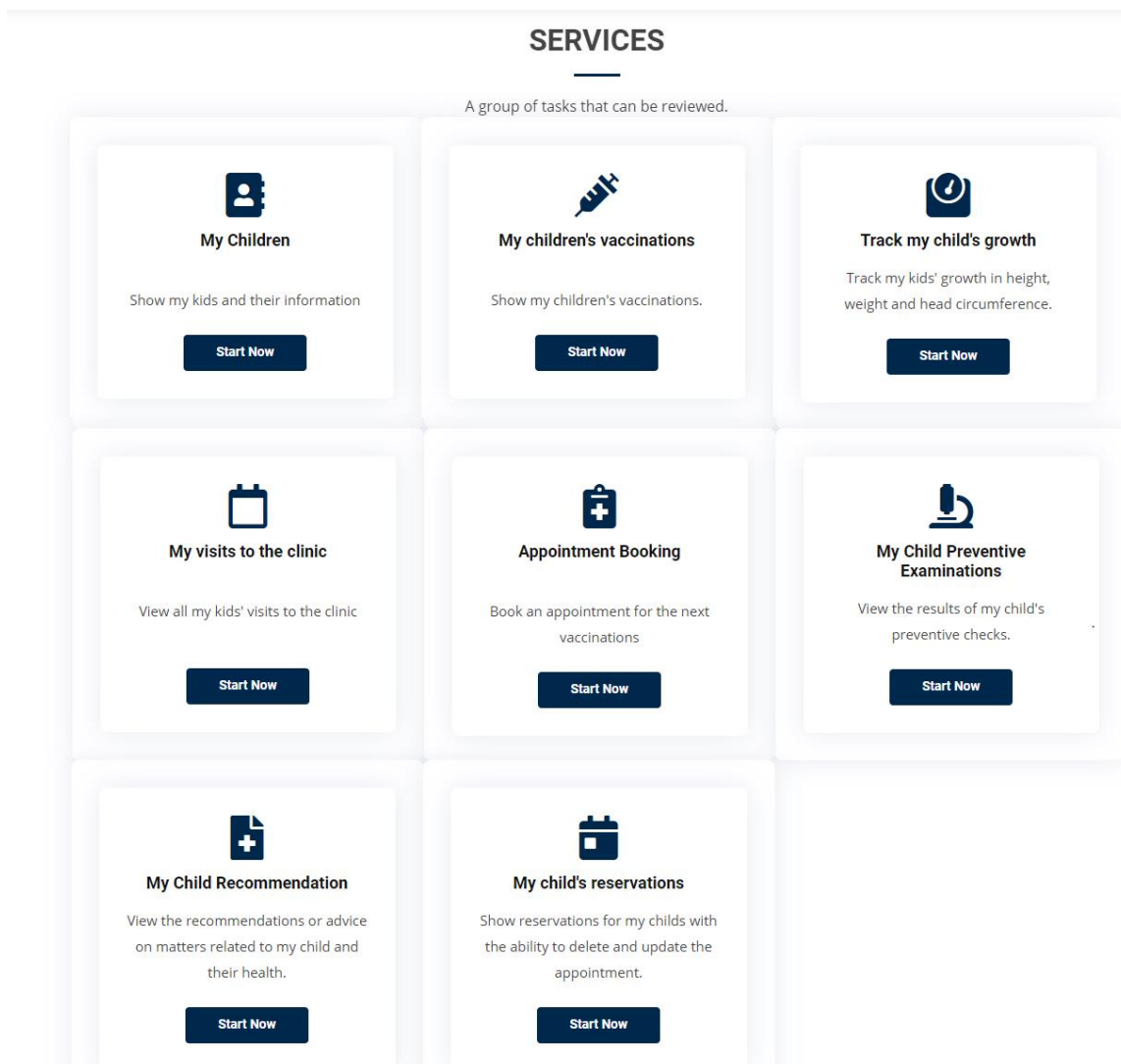


Figure 11. Services performed by parents.

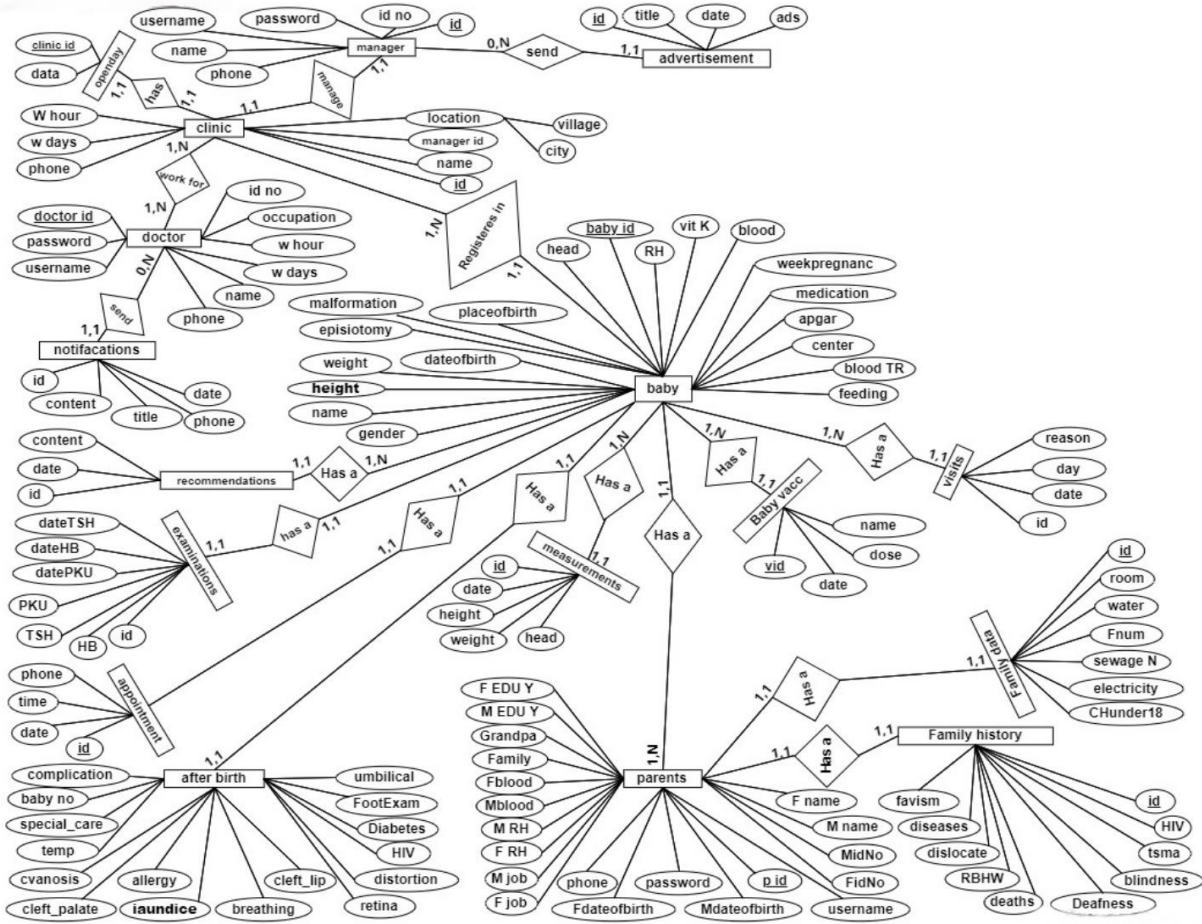


Figure 12. ERD model.

IV. RESULTS AND DISCUSSIONS

Recently, smartphone becoming increasingly useful in different fields of work, there is great promise for its role in the future, especially in the medical applications. Several works have been done with regards to the use of mobile devices for appointment booking at hospitals and medical clinics. In this paper, we surveyed relevant apps that benefit both clinicians and patients. Most of the surveyed papers based on developing only mobile apps with limited functions for both doctors and patients. These apps may face problems due to large number of smartphone models and makers. Also, these smartphone-dependent apps will require skilled personnel and may have limitations in accessibility to the general public. These limitations reduced with developing websites that enable patients to easily manage their booking.

Considering the drawbacks of the reviewed apps, we develop an effective booking system that enable all stakeholders to manage their booking and manage their daily works. The system also address privacy and security concerns which is essential in medical applications. The feedback from all stakeholders was generally positive and the system shows high performance when it is tested by all of them.

V. CONCLUSION AND FUTURE WORK

In this paper, the main objective is to offer an effective and comfort patient appointment scheduling system for medical centers. This project consists of two parts. The first part is to design an Android-based mobile application to help the parents to keep track of their baby's growth and to enable them to book appointments for visiting the clinics at a specific time and date to take the vaccinations. The second part is to design a user-friendly website to enable the parents and the medical staff to manage appointments and take advantage of the health system if they do not have a smart phone. The proposed system helps in improving the services provided in the medical clinics and reducing the burden on the doctors as well as parents.

Future improvement for the proposed system is possible. In the future, we plan to expand the system to include an application for iOS phones. The iOS version can be very helpful since iOS is also another competitor of mobile operating system. Also, the scope of the system will be expanded to include large clinics to take care of all age groups, including the elderly, women, youth, and men. Furthermore, communication can be proven to help in the effectiveness of appointment bookings to enable voice calls and video call features to enhance interactions between patients and doctors.

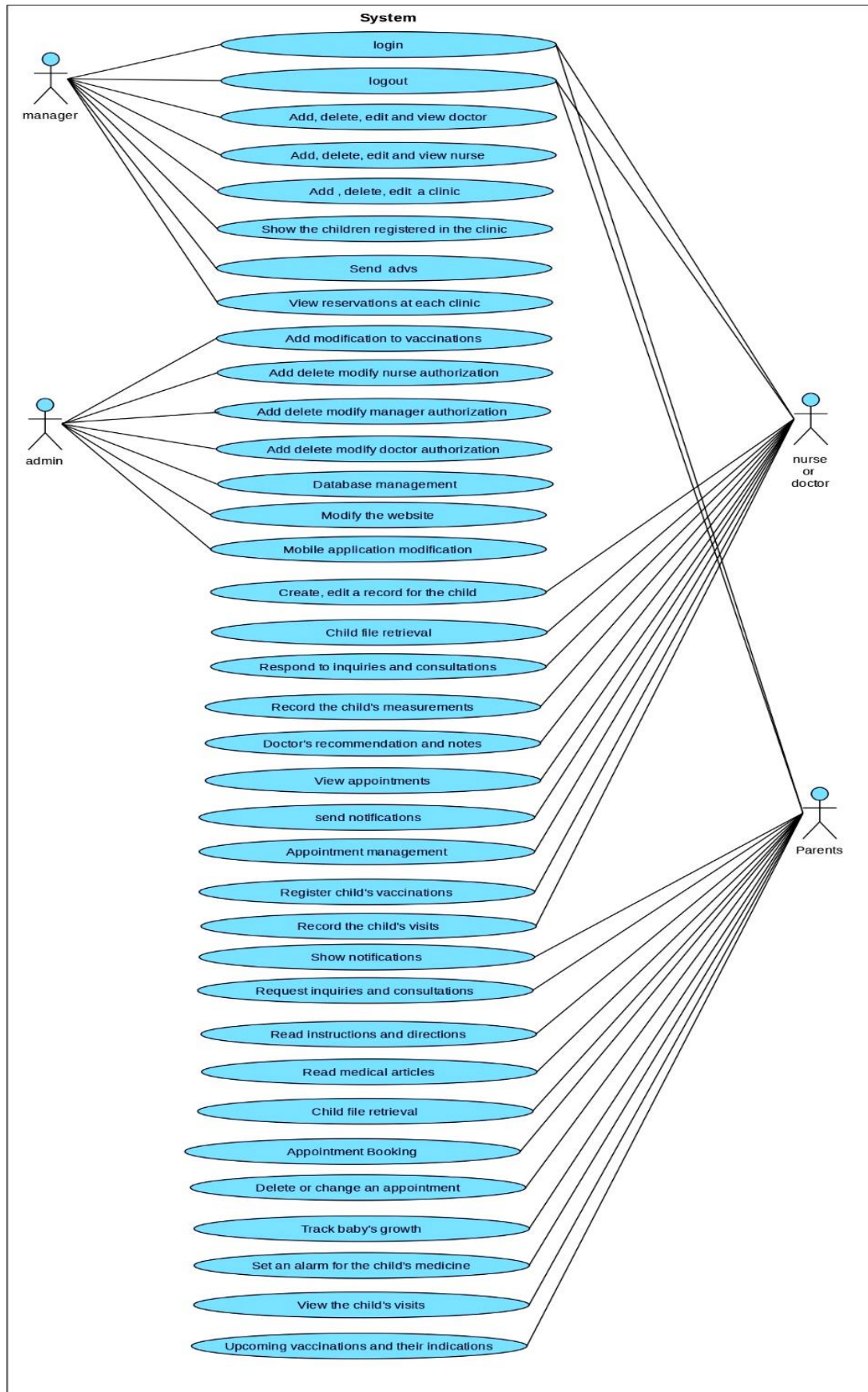


Figure 13. System class diagram.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

All the authors conducted the research together. Particularly, Shima, Hamam and Jamila designed and implement the website and the Android application. Mohammad contributed in all the aspects of writing this paper like writing the Introduction, performing extensive literature survey, Proposed Strategy, Performance Evaluation and conclusion. All authors had approved the final manuscript.

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