



UNIVERSITY of  
RWANDA

COLLEGE OF SCIENCE  
AND TECHNOLOGY

---

**Regional Centre of Excellence in Biomedical Engineering and e-Health (CEBE)**

East Africa Regional Center of Excellence in Biomedical Engineering and E-Health (CEBE)

**DEVELOPMENT OF AN APPLICATION FOR REQUESTING MEDICAL  
APPOINTMENTS ONLINE,  
CASE STUDY CHUK.**

By

YANKURIJE Faina Francine Reg. No.: 220019562

A Dissertation Submitted to the Regional Centre of Excellence in Biomedical Engineering and e-Health (CEBE), University of Rwanda as partial fulfilment of the requirements for the Master's Degree in Biomedical Engineering.

1<sup>st</sup> Supervisor: Prof. Richard MUSABE

2<sup>nd</sup> Supervisor: Dr. Louis SIBOMANA

Kigali, February 2023

## DECLARATION

I, YANKURIJE Faina Francine, declare that this dissertation entitled “**Development of an Application for requesting medical appointments online, case study CHUK.**” is my original work based on research and prototype and has not been submitted for any other degree or professional qualification.

YANKURIJE Faina Francine

Reg. No.: 220019562

A handwritten signature in blue ink, appearing to be 'Faina Francine', written over a horizontal line.

Student Signature:

Date:02/02/2023



---

**Regional Centre of Excellence in Biomedical Engineering and e-Health (CEBE)**

**CERTIFICATE**

This is to certify that the project entitled “**Development of an application for requesting medical appointments online, case study CHUK.**” is a record of original work done by YANKURIJE Faina Francine (Reg. No.: 220019562 a MSc. Degree student in Biomedical Engineering).

This work has been submitted under the guidance of Prof Richard MUSABE and Dr Louis SIBOMANA.

**Main Supervisor:**

A handwritten signature in blue ink, appearing to read 'Richard Musabe'.

Prof Richard MUSABE

**Co-Supervisor:**

A handwritten signature in blue ink, appearing to be a stylized 'H'.

Dr Louis SIBOMANA

**Biomedical Engineering Master’s Program Coordinator**

**Dr. Gerard RUSHINGABIGWI**

## ACKNOWLEDGEMENTS

This work is the result of a long journey of learning, from my young age that have involved the education contribution of my parents, that of my colleagues, that of the entire education system especial CEBE who granted to us the full scholarship and the whole society in general. I would like to take this opportunity to express my gratitude to all those, in one or other way, have contributed to education.

My thanks are also addressed to our Director and **Coordinator in Biomedical Engineering Master's Program**, who have helped us to fulfill all the requirements of this master's program.

In a special way, from the bottom of my heart, I thank Prof. Richard MUSABE and Dr. Louis SIBOMANA who have accepted to give their precious time for the supervision of this work despite their multiple responsibilities. Their relevant remarks and inputs, their generosity and sense of responsibility have helped a lot to the elaboration of this work. I will preciously keep in memory the greatness of their virtues. May they find here my sincere thanks and my profound gratitude.

My thanks are also addressed to all my lectures of the department of Biomedical Engineering and E-Health at University of Rwanda who have contributed at my education and have allowed me to grow intellectually and morally.

For all of those, from near or far, directly or indirectly have assisted me morally or financially, and in special way to my husband who have been so close to me in everything find here my sincere thanks.

Yankurije Faina Francine.

## **ABSTRACT**

University Teaching Hospital of Kigali (CHUK) is a hospital that receives many patients from various locations across the country. If someone wants to book a medical appointment, he (she) needs to make a call at the hospital or personally attend the place. This is time and money consuming for the patient. For a fixed appointment, if there is any change or cancellation, the patient is not informed about that. He (she) will know about these changes on the day of appointment and this affects someone's planning. In this thesis, we developed a Web-based application which will help to book appointment online and will support practitioners to manager their daily workload as well as patients to know the exact day of their appointment with exact notification. The medical practitioner will also come to know the number of patients he/she has to attend to for whole day. Furthermore, to access this application will be easy because we added the option of using USSD code through mobile devices.

## LIST OF ACRONYMS

- CEBE:** Centre of Excellence in Biomedical Engineering and e-Health
- CHUK:** University Teaching Hospital of Kigali
- CSS :** Cascading Style Sheet
- DBMS:** Data Base Management System
- RDBMS :** Relational Database Management System
- HTML :** HyperText Markup Language
- HTTP :** HyperText Transfer Protocol
- JSP :** Java Server Page
- MySQL :** Structured Query Language
- USSD :** Unstructured supplementary service data
- TB :** Tuberculosis
- OS :** Operating System
- PHP :** Hypertext Preprocessor
- RAM :** Random Access Memory
- GB :** Gigabyte
- GUI :** Graphical User Interface
- ODBC :** Open Database Connectivity
- XAMPP:** Cross-platform, Apache, MySQL, PHP and Perl

## LIST OF FIGURES

Figure 1: System life cycle in prototype model .....	11
Figure 2: System Architecture .....	13
Figure 3: Diagram of the Proposed online Application for request medical appointment .....	14
Figure 4: High-Level Model of the Proposed System .....	15
Figure 5: Database architecture .....	16
Figure 6: Home Page of our system.....	19
Figure 7: Sign Up Page .....	19
Figure 8: Sign up confirmation message .....	20
Figure 9: Login Page.....	21
Figure 10: login confirmation page.....	21
Figure 11: Booking Appointment Page .....	22
Figure 12: Choose department .....	22
Figure 13: Select booking date .....	23
Figure 14: Doctors Management Page.....	24
Figure 15: Create doctor's account page .....	25
Figure 16: Confirmation of Create doctor's account page .....	25
Figure 17: Update doctor's account page .....	25
Figure 18: Confirmation of update doctor's account page .....	26
Figure 19: Delete doctor's account page .....	26
Figure 20: Confirmation of delete doctor's account page .....	27
Figure 21: Receptionist Management Page .....	28
Figure 22: Create Receptionist account page.....	28
Figure 23: Confirmation of receptionist account page .....	29
Figure 24: Departments Page.....	30
Figure 25: Enter department page.....	31
Figure 26: Confirmation of entering department page .....	31
Figure 27: Setting timetable page .....	32
Figure 28: Option of choosing doctor page .....	33
Figure 29: Confirmation for setting timetable .....	33
Figure 30: Result page after setting timetable .....	34
Figure 31: Approve or deny appointment page .....	35
Figure 32: Pending, approved or declined appointment page.....	35
Figure 33: Patient message .....	36
Figure 34: Confirmation of sending patient message .....	37
Figure 35: Report Page .....	37
Figure 36: Downloaded report.....	38

## **LIST OF TABLES**

Table 1:Functioning Tasks in our system .....	40
-----------------------------------------------	----

# TABLE OF CONTENTS

DECLARATION.....	II
CERTIFICATE.....	III
ACKNOWLEDGEMENTS .....	IV
ABSTRACT.....	V
LIST OF ACRONYMS .....	VI
LIST OF FIGURES .....	VII
LIST OF TABLES .....	VIII
TABLE OF CONTENTS .....	IX
CHAPTER 1. GENERAL INTRODUCTION .....	1
1.1 Introduction .....	1
1.2. Problem Statement.....	1
1.3. Research Questions .....	2
1.4. Objectives.....	2
1.4.1. General Objective .....	2
1.4.2. Specific Objectives .....	3
1.5. Study Scope.....	3
1.6. Significance of the Study.....	3
1.7. Organization .....	4
CHAPTER 2. LITERATURE REVIEW .....	5
2.1. Introduction .....	5
2.2. Medical appointment application .....	5
2.3. Android application for doctor’s appointment .....	6
2.4. Mr. doc: a doctor appointment application system .....	7
2.5. Online Doctor Appointment System.....	8
CHAPTER 3. RESAERCH METHODOLOGY.....	10
3.1. System Requirements.....	10
3.2. Research Process .....	10
3.2.1. Data collection Method .....	10
3.2.2. System development .....	11
3.3. Components of the proposed system .....	13
3.4. Proposed System.....	14
3.4.1. High-Level Model of the Proposed System .....	14
3.5. Database design .....	15

<b>CHAPTER 4. IMPLEMENTATION AND TESTING OF THE SYSTEM.....</b>	<b>17</b>
<b>4.1. Introduction .....</b>	<b>17</b>
<b>4.2. Main Menu Page.....</b>	<b>18</b>
<b>4.2.1 Home page .....</b>	<b>18</b>
<b>4.2.2. Patient account Page .....</b>	<b>19</b>
<b>4.2.3. Login Page .....</b>	<b>20</b>
<b>4.2.4. Booking appointment page .....</b>	<b>21</b>
<b>4.2.5. Doctors Management Page .....</b>	<b>23</b>
<b>4.2.6. Receptionist Management Page .....</b>	<b>27</b>
<b>4.2.7. Departements Management Page.....</b>	<b>30</b>
<b>4.2.8. Setting timetable of doctor's availability page .....</b>	<b>32</b>
<b>4.2.9. Approval or denial of an appointment .....</b>	<b>34</b>
<b>4.2.10. Making Report page .....</b>	<b>37</b>
<b>4.3. Testing .....</b>	<b>38</b>
<b>4.3.1. Table of successfully functioning tasks in Medical Appointment Request Online         Application at CHUK.....</b>	<b>39</b>
<b>CHAPTER 5. CONCLUSION AND RECOMMENDATION.....</b>	<b>41</b>
<b>5.1. Conclusion.....</b>	<b>41</b>
<b>5.2. Recommendation.....</b>	<b>41</b>
<b>REFERENCES.....</b>	<b>43</b>

# **CHAPTER 1. GENERAL INTRODUCTION**

## **1.1 Introduction**

Scheduling of appointments is an important task needed in Hospitals. Medical appointment is a meeting between a patient with medical professional or a doctor to get health advice or treatment for a symptom or condition. At University Teaching Hospital of Kigali (CHUK), we want the patients to make their appointments 24/7 with the doctor of their choice, easing the work pressure in the Hospital.

The application for Medical Appointment will be a Web Based Application designed to help in patient scheduling and patient management. This application will help both doctors and patients to save their valuable time. Appointments need to be coordinated and medical support staff has to be constantly aware of all new patients and medical professionals and doctor's schedule. The benefits of this application are numerous with the main one being improvements in access to medical care. To improve quality, efficiency, and delivery of health care services extensive use of technology has been made. The healthcare providers are constantly looking to reduce operation costs while improving the quality of service. A web-based application can save the precious time of the patients and decrease the physical gap between doctors and patients thereby providing fast and adequate medical services. It is difficult to get appointments by direct contact to the hospital or by standing in a queue[1]. Taking in accounts all those problems, an Online Medical Appointment Application has been created with improvement by adding the use of USSD code.

## **1.2. Problem Statement**

University Teaching Hospital of Kigali (CHUK) is a hospital that receives many patients from various locations across the country. Because of that big number of patients, it is becoming difficult to serve all the patients, due to the fact that patients are coming at the hospital without a prior planned appointment. In this situation of promiscuity of patients due to the unknown large number of patients received on daily basis in the hospital, that could be a risk of contagion of certain diseases like tuberculosis, Covid-19, Ebola, etc...or risks of contracting nosocomial diseases. In

addition, patients are wasting time and resources and are imagining that they are neglected when it is not the intention of the medical staff who would rather wish to offer a quality service.

When I was doing my internship in a hospital, I have been concerned by the way patients were managed by the reception to get the appointment with the Doctor. In a long queue, numbers were distributed to patients to allow them to know the first arrived to be first served. But due to the unexpected big number of patients, it was difficult to manager that big number of patients in a satisfactory way. Actually, the way it is done at CHUK; every new out-patient has to request a patient ID number in order to allow him to process all his clinical procedures. The patient can also visit the information and appointments desk at the CHUK hospital to request an appointment in person or send his relative. This is the reason which motivated us to develop an Online Application to shortcut all these barriers to schedule a medical appointment.

### **1.3. Research Questions**

The following three questions are baselines which guided this study:

1. How does the daily big number of patients which is difficult to manage should be well managed?
2. How should the medical personnel which is not informed about the daily workload due to the unknown big number of patients be helped?
3. Will the application have an impact on the way that patients who are spending their resources and time when lining up for unplanned medical appointment?

### **1.4. Objectives**

#### **1.4.1. General Objective**

The main purpose of this study is to develop a Web-based application for online medical appointment that will be extended to the use of USSD code. The reason that motivated us is to allow patients to request for a medical appointment from anywhere and at any time. That would solve the problem related to the unknown big number of patients daily received at the hospital and will allow both caregivers and patients to be satisfied. This system will show the daily availability of attending medical professionals in different departments and allow patients to request appointments accordingly.

### **1.4.2. Specific Objectives**

Specifically, the objectives of this research are:

1. To collect data by using interview from a randomly selected sample with the method of probability sampling in order to understand the information related to medical appointment.
2. To design and analyze a database that will store data related to scheduling medical appointments.
3. To develop a web-based application that will manage patients according to the requested medical appointment.
4. To build an USSD mobile code for a quick access to the application.

### **1.5. Study Scope**

This research aims to create an online application that will help patients to request medical Appointment at CHUK. This application will help medical professionals to manager their daily workload as well as patients to know the exact day of their appointment with exact notification. The medical practitioner will also come to know the number of patients he has to attend whole day. Interview will be conducted to a sample of medical personnel and to a sample of patients. This Application is limited to patients who request medical Appointment at CHUK. The research was conducted within a period of six months.

### **1.6. Significance of the Study**

By the end of this research, the result will be a powerful tool for helping patients to request a medical appointment online at CHUK. On the side of the Hospital planning, the application will help to upload online the daily timetable of Doctors and Specialists and patients will be scheduled accordingly. That will also help practitioners to manager their daily workload as well as patients to know the exact day of their appointment with exact notification. The doctor will also come to know the number of patients he has to attend whole day.

The impact of this research will be of beneficial on both two sides: Patients and medical professionals. In the side of the patients, time and money will be unspoiled and will be kept out of

contracting contagious and nosocomial diseases like TB, Covid-19 etc. On the side of the hospital, the management of patients will be easy and the reception work will be simplified.

### **1.7. Organization**

This work is divided into 5 chapters. The first chapter presented the general introduction, problem statement, hypothesis, objectives, study scope, and significance of the study. The second chapter discusses the related literature. The third chapter presents the research methodology used, and the fourth chapter talks about the implementation of the project. Finally, the fifth chapter discusses the conclusion and formulates the different recommendations.

## **CHAPTER 2. LITERATURE REVIEW**

### **2.1. Introduction**

The University teaching hospital of Kigali/CHUK is the largest hospital located in District of Nyarugenge at KN 4 Ave, Kigali City. It is also the biggest referral hospital of the country with a capacity of 519 beds. CHUK provides quality healthcare to the population, training, clinical research and technical support to district hospitals.

CHUK was built in 1918 and in 1928 it was working as health center. In 1965, it worked as hospital. From April 1994 to 1996, the CHK has served as a health center, a district hospital and as a referral hospital as well. In 2000, with the enactment of law Nr. 41/2000 on the establishment and organization of the University Teaching Hospital "CHUK", the CHK became a public institution with legal personality known as "University Teaching Hospital of Kigali".

CHUK is combining the best specialists and equipment to provide nothing short of the best in healthcare. These include : Oncology/cancer, General surgery, Emergency care services, Radiology/CT scan services, Physiotherapy, Gastroenterology, Orthopedics Surgery, Diabetes, Neurosurgery and others[2].

Our motivation to develop the application was driven by the issues that it will solve. The benefits of the application to schedule doctor appointments are twofold. First, they provide a simple way for patients to arrange visits with the healthcare providers of their choice. And secondly, these systems store all appointments and data entries under the same roof. The hospital staff will be very satisfied and facilitated.

This chapter discusses related works and point out limitations and presents improvements to our system.

### **2.2. Medical appointment application**

Medical appointment application is a web-based and mobile application for managing appointment and for booking process for a few medical organizations, regardless of the type of service they schedule in Parit Raja and Batu Pahat area[3]. The practices were signed up on the online appointments portal themselves and can view the appointment made by user, the patients. Medical appointment application is helping the patients to book their appointment using the Medical

Appointment application. The method used is based on Prototype Model that is used to develop this system. The hardware and software used to develop this system is MySQL Database and programming language used is PHP and JavaScript. The result is an important reduction of the number of calls for an appointment and avoid the morning rush for an urgent appointment. Also, it potentially reduced the need for extra reception staff, a significant reduction in labour. Furthermore, it helps user in time saving and avoiding the need to negotiate with the receptionist for a convenient appointment time[3]. The challenges in this system of medical appointment application are that the system is exclusively web-based and some users are not familiar to access a web-based application. That is the reason we have opted to add the USSD code to our system.

### **2.3. Android application for doctor's appointment**

The objective of this android application for doctor's appointment is to build an application that facilitates the process of booking appointment of the doctor. The patient is booking the appointment through his/her mobile phone. The Doctor is informed and will come to know the number of patients he has to attend whole day. This application saves patient's as well as doctor's time. It will also facilitate the receptionist's work. The system proves to be useful for doctor as he can check his appointments whenever and from wherever he wants from his mobile phone.

The application is based on Android system. Android is a Linux based open source operating system which is mainly used in portal devices with excellent performance. The system is dealing with components: Doctor and Patient. All users first download the application and install it in their mobile devices. The patient then registers into the application for the first time and receives a username and password and can log into the application. After logging in, the patient selects a filtration type done on two bases: Area wise and Specialty wise. After selecting the filtration type, the doctors list is displayed. The patient can select any particular doctor and view his profile. Also, the patient can view the doctor's schedule and look for an appointment according to his convenience. The patient then sends a request for an appointment. The doctor can either accept the appointment or reject it. Upon the acceptance of the appointment, the database is updated accordingly and the patient is getting a confirmation message. This is very useful in case the patient tends to forget the appointment. The results of this application prove to be very beneficial to doctors and patients as it is saving time, reducing the effort in paperwork of both patient as well as doctor[4].

The challenge of the android application for doctor's appointment is based on the fact that mobile applications are designed to work on different mobile operating systems. Mobile apps work in specific mobile operating systems such as Apple iOS or Android OS. If an app made for Android OS, then it will not work on Apple iOS or Windows OS[5]. The solution we intend to bring is based on the advantages of our application which will run on the web-based system. These advantages are that apps function in-browser, so they do not need to be installed or downloaded. In addition, web apps are easy to maintain, as they have a common code base regardless of the operating system. These apps are set to be updated automatically. They are easier and faster to build than mobile apps. They can be launched easily as they don't need App store approval to start. Mobile apps are more expensive to develop compared to web apps.

#### **2.4. Mr. doc: a doctor appointment application system**

The main objective of Mr. doc: a doctor appointment application system is to provide ease and comfort to patients while taking appointment from doctors and it also resolves the problems that the patients has to face while making an appointment. The android application Mr. Doc acts as a client whereas the database containing the doctor's details, patient's details and appointment details is maintained by a website that acts as a server.

The methodology in this work consists on an Android based online doctor appointment application "Mr. Doc" contains two modules. One module is the application designed for the patient that contains a login screen. The patient has to register himself before logging in to the application. After logging in, the patient can select a hospital and can view the hospital details. The patient has the option of selecting a doctor from the list of doctors and can view the doctor's details. The patient can request for an appointment on his/her preferred day/time. The selected day/time slot will be reserved and patient will receive the notification of the successfully added appointment.

The second module is the admin module that is designed on the website. The admin views all details of doctors and all appointments by the admin. The admin can add doctor, view patient's details and doctor's details and can view appointments also. All the doctors of the specific clinic are registered by the admin. Doctors cannot register themselves. Once the application is started the patient registers himself and then he/she is able to log in into the application. The patient can make an appointment by selecting the preferred doctor, date and time. The appointments are managed by the admin through a website. The admin also registers a doctor. Admin can view doctors, view patient's records and view feedback also. The back-end design includes a server which acts as a

centralized database. All the data of the registered doctors and patients and the data regarding the appointments are placed on the server. The data is approached and shared by using API'S between the website and the android application.

The result on this Mr. doc: a doctor appointment application system is an application that uses an android platform that makes the task of making an appointment from the doctor easy and reliable for the users[6]. The challenge is the way of the data is approached and shared by using API'S between the website and the android application and renders the system a bit complicated. Our application is more friendly because it is exclusively web based and working on windows platform and our application has the possibility of using USSD code for those who cannot have access to a computer or a smart phone.

## **2.5. Online Doctor Appointment System**

The idea of Online Doctor Appointment System came after the covid-19 pandemic. Due to the lockdowns, booking doctor appointments physically have become almost impossible. This application deals with the issue of managing and booking appointments according to user's choice. The objective of the research on Online Doctor Appointment System was to help patients book appointments easily and also allow doctors to keep a track of these appointments. For the front end, the system was implemented by using HTML and CSS. This creates adynamic User Interface easy to understand and can be navigated without any problem. Here, PHP (Hypertext Preprocessor) acts as the server side for managing the databases and session tracking related to patients, doctors, their details, the various appointments booked, prescriptions etc. An object-oriented programming language, i.e, JavaScript is used to enable dynamic interactivity so that the user can interact with the web pages without having to reload every time. The whole application has been developed using the Windows 7 operating system.

The result was that users could view various booking spaces available and select the preferred date and time. This saves time by avoiding long waiting time for the users and also makes the appointment process more efficient. With this application the doctor can adjust his own schedule according to his availability. Hospitals can easily manage their registration and appointment process and monitor the flow of patients to the doctors. The admin is between the doctors and patients in order to link them. This reduces fatigue and frustration[1].

When we come to analyze this application, we find many similarities in the methodology with our application but on our side, we have extended the system by including the access through USSD System. And also, our application was developed by using Windows 10 operating system.

## **CHAPTER 3. RESEARCH METHODOLOGY**

In this section, we describe methodology and approaches that we have used in the study. The data sources for this specific research are the patients and the medical practitioners involved in the medical appointment process.

### **3.1. System Requirements**

For developing this system, we used the following tools:

#### **Software requirements:**

1. Visual studio code: For the conception of the graphic interfaces allowing the users to interact with the new system and get access to database.
2. XAMPP is a free and Open-source cross-platform Web Server Solution Stack built by Apache Friends, which consists mostly of the Apache HTTP Server, MySQL Database, and interpreters for PHP and Perl scripts[7].
  - MYSQL: For the creation of the database.
  - JSP Technology, PHP, HTML, SCC and Java Script: For programming.

#### **Hardware requirements:**

- Computer
- Operating system: Windows 10
- RAM: 8 GB or higher.
- Processor: i5 core2
- 16 GB or more hard disk free space.
- Web browser (google chrome, Microsoft Internet Explorer, Mozilla Firefox)

### **3.2. Research Process**

#### **3.2.1. Data collection Method**

In this project, data are collected by using different methods, such as interview and documentation.

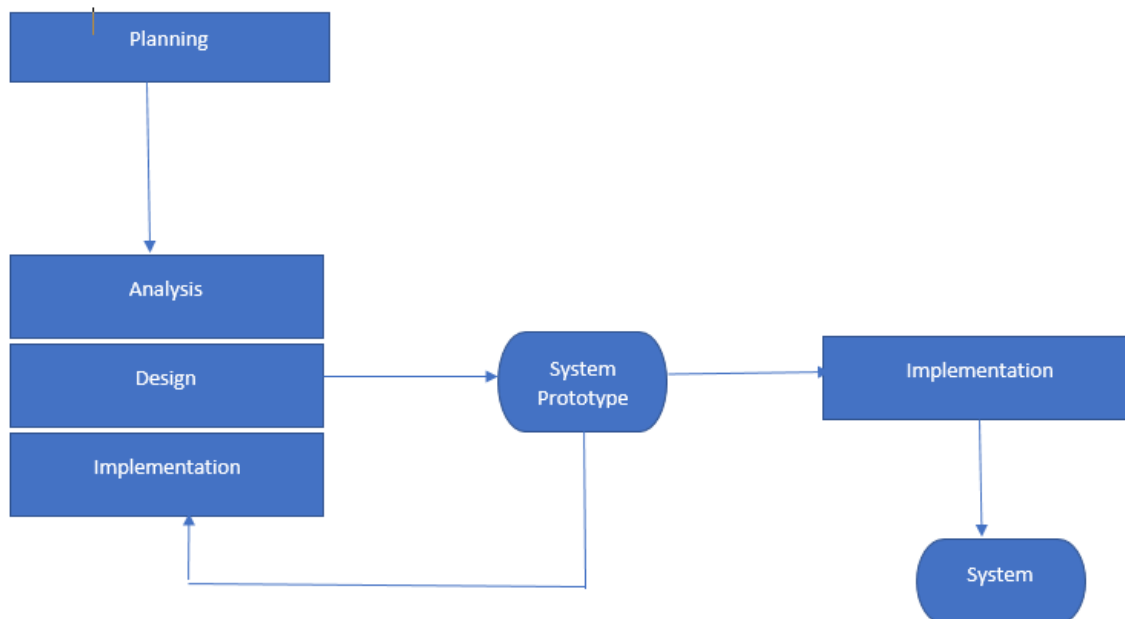
- **Interview:** was conducted on a sample of 12 patients and 8 medical practitioners to better understand the overall view of the current medical appointment system, to identify issues related to the performance of the existing system and to identify the changes required in the existing system which can be integrated with the system under study.
- **Documentation:** We used documentation to review the existing documents in order to understand how data is managed and processed. The results of these methods will be used to define how the system will be operating.

### 3.2.2. System development

It shows all diagrams used to describe the structure's activities of the system.

- Software model development process

Is the process that is being designated for the development of the project according to the aims and goals of the project. There are different development modes which may be selected to achieve the required objectives. In this system, we shall use a prototyping model which has the following stages:



*Figure 1: System life cycle in prototype model*

## 1. System planning

The planning phase is the first phase in the Prototype Model. In this phase, every planning in the development of a project is done. We have made an evaluation of all the requirements needed in our project like duration of the project, hardware, software material and the related costs.

## 2. System analysis

In software development, requirements for the system to be designed are sourced in this step. For most projects, this step happens to be the primary focus. We have analyzed which data to be contained in our database. Which tables to construct and how they will be interrelated in the system.

## 3. System design

For our application to perform well, after analyzing our database, we have built a database by using MySQL database software. We have then proceeded by designing tables, schemes, and stored procedures. MySQL is a relational database, which means tables are linked together using primary and foreign keys.

## 4. System prototype

Our system prototype is making reference to the prototyping model which is a systems development method in which a prototype is built, tested and then reworked as necessary up to the achievement of acceptable outcome from which the complete system can be developed.

## 5. Implementation

After collecting all information, there is a step of coding, once we have the requirements specification and the design documents in hand, we can start programming. Besides coding, by writing java code in order to link our database and web browser or client side. Visual studio code software, PHP, HTML and Java Script are used[8].

### 3.3. Components of the proposed system

The interactive system architecture consists of three major parts: Graphical User Interface (GUI), Server and database. The architecture displays the basic flow of the system. Through GUI the system will interact with the user. GUI allows the use of icons or other visual indicators to interact with users. When the users of the system click on the particular link, the query goes to the server part. After that, the server fetches the required data from the database. i.e. database, the results are returned to the server and from there to GUI for displaying. Application will generate a message to the patient when the patient sends a request for appointment. The receptionist can either accept the appointment or deny it. The database will get updated accordingly and the patient will get a confirmation message. The add-on to this system is that the patient will receive a notification before the actual appointment. This will be very useful in case the patient tends to forget the appointment.

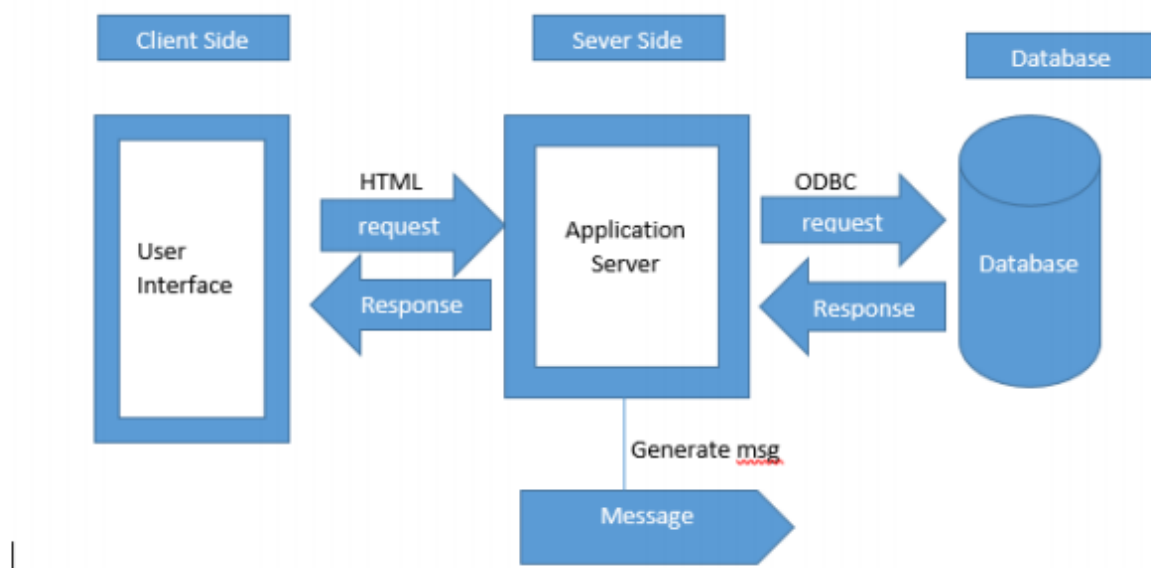


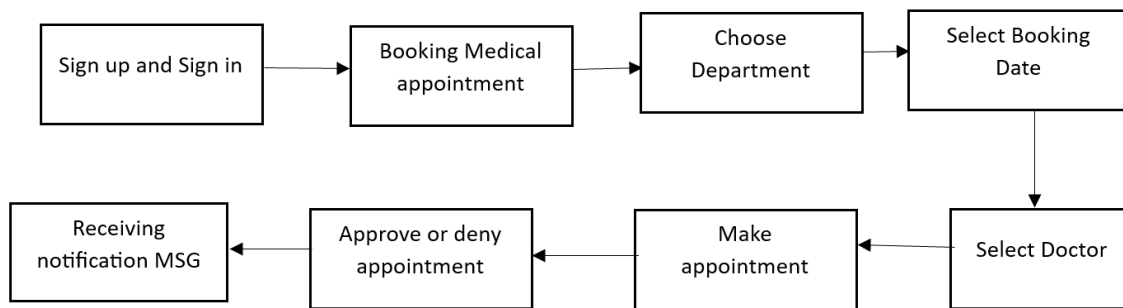
Figure 2: System Architecture

1. Client side is the user interface. The main function of the interface is to translate tasks and results to something the user can understand. Sometimes called the GUI or client view or front-end.
2. Server Application sometimes called middleware/back-end. Server coordinate the application, processes command, makes logical decision and evaluations and performs calculations. It also moves and processes data between Database and user interface[9].

3. A database comprises both data sets and the database management system (DBMS) or relation database management system (RDBMS) software that manages and provides access to the data. Here information is stored and retrieved from database. The information is then passed back to the server for processing and then back to the user[10].
4. Open Database Connectivity (ODBC) is an interface that makes it possible for applications to access data from a variety of database management systems (DBMSs)[11].

### 3.4. Proposed System

The basic function of this application is to help patients book appointments Easily and to help CHUK hospital to manage the patients. Figure 3 shows the main function of development of an application for request medical appointment online.



*Figure 3:Diagram of the Proposed online Application for request medical appointment*

#### 3.4.1. High-Level Model of the Proposed System

Our system has 4 users, Patient, admin, receptionist and doctor. The patient needs to register before and log in. After login, booking by choosing the department he/she wants to be treated in and select the date he/she want to meet the doctor and chooses the doctor he/she wants then sends information or make appointment. After make appointment, patient receive message. Admin have a task of dealing the account of doctors and receptionists, he can add, update and delete information in user's account. Admin can also add department in database. Admin have light to viewing all appointment and make report. Receptionist, the primary task of receptionist is to set availability of the doctor on calendar and approve or decline appointment request based on a doctor's schedule. After approve or decline appointment, the system can generate a message to the patient.

Doctor login in the system. After login, Doctor sees patients who have requested to see meet him on a certain date. Figure 4 shows the users of the system and their task.

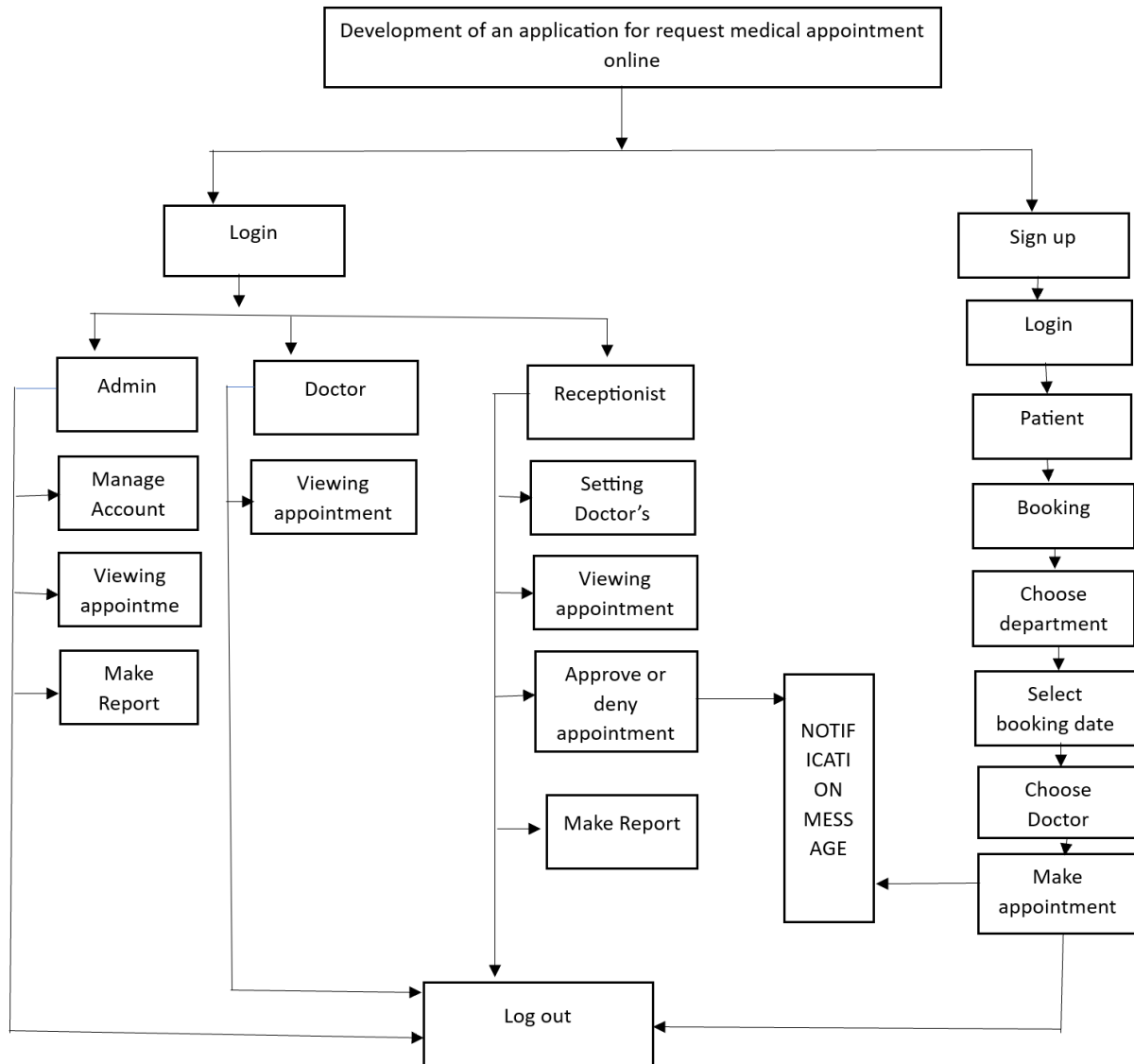


Figure 4: High-Level Model of the Proposed System

### 3.5. Database design

A database is a collection of information that is organized So that it can Easily be accessed, managed, and updated. Database management system (DBMS) is a database software Tools which are primarily used for storing, modifying, extracting, and searching for information within a database[12]. Figure 5 is database structure of development of an application for request medical appointment online at CHUK. The figure5 visualize all tables contain our database, how tables are structured, their attributes and how tables are related each other.

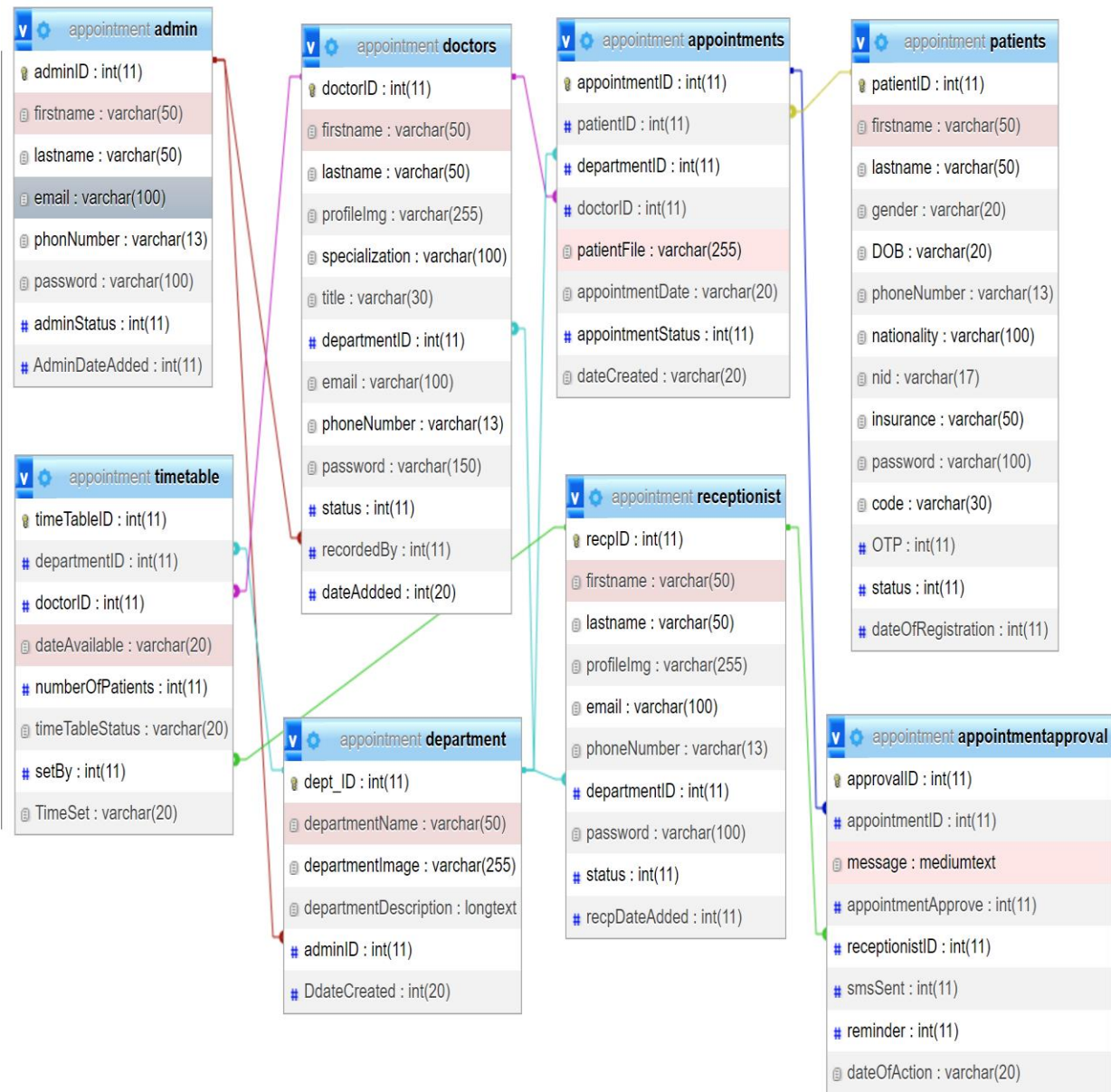


Figure 5: Database architecture

## CHAPTER 4. IMPLEMENTATION AND TESTING OF THE SYSTEM

### 4.1. Introduction

This chapter describes how our system was built with the new concept in order to obtain the expected results. As mentioned in chapter 3 as required software, we are coming back to some technologies and tools that were used for our System Implementation by bringing more explanations. These tools are Visual Studio Code and XAMPP and technologies are HTML, CSS, JavaScript, MySQL Database, Apache HTTP Server, PHP and Perl scripts and JSP Technology.

- **Visual studio code:** In simple words, Visual Studio Code is a code editor. It is a free editor that helps the programmer to write a code, aids in debugging, and corrects the code using the intelli-sense method [13]. Visual studio code were facilitated to write the code in an easy way.
- **XAMPP:** is a free and Open-source cross-platform Web Server Solution Stack created by Apache Friends, which consists of the Apache HTTP Server, MySQL Database, and interpreters for PHP and Perl scripts[7].
- **MySQL:** is an open-source relational database management system. MySQL stores data in tables made up of rows and columns. Users can define, manipulate, control, and retrieve data in database [14]. Used MySQL in our system for creating database.
- **Apache HTTP Server:** is a web server application. which delivers content that can be accessed through the internet. This includes HTML documents, multimedia such as images, CSS style sheets, and client-side scripts such as JavaScript. Apache HTTP Server is open source, which means the original source code is freely available for collaboration[15].
- **PHP:** is a server-side scripting language designed for the Web. PHP code can be added to an HTML page and run each time the page is accessed. PHP code is interpreted at the Web server and produce HTML or other output that the user will view[16].

**HTML:** HyperText Markup Language. HTML is made up of two components. First is hypertext, which means "clickable," and second is markup language, which means to represent things or indicate things. HTML used for creating Web pages. HTML describes the structure of a Web page. HTML consists of many elements. HTML elements tell the

browser how to display the content. HTML coding create a web page. Web pages combine to form a website. A website is a collection of different web pages. A web page composed with 3 parts: HTML, Java and CSS. This part in web development is very important. HTML deal with text, Java deal with the functionality of text and CSS deal with the design of web page[17].

- **JavaScript:** is a text-based programming language that allows us to create interactive elements on our web page. It is an integral part of our daily online lives. Together with HTML and CSS, JavaScript is one of the three core components of the internet that allows us to make our website interactive[18].
- **CSS:** allows us to design the content on our webpage. It's responsible for text styling, colors, fonts, and so on[17].

## 4.2. Main Menu Page

This system is made by the main menu also called home page. This home page is made by many links which give access to other pages.

### 4.2.1 Home page

The home page contains links which open other pages when a user click on

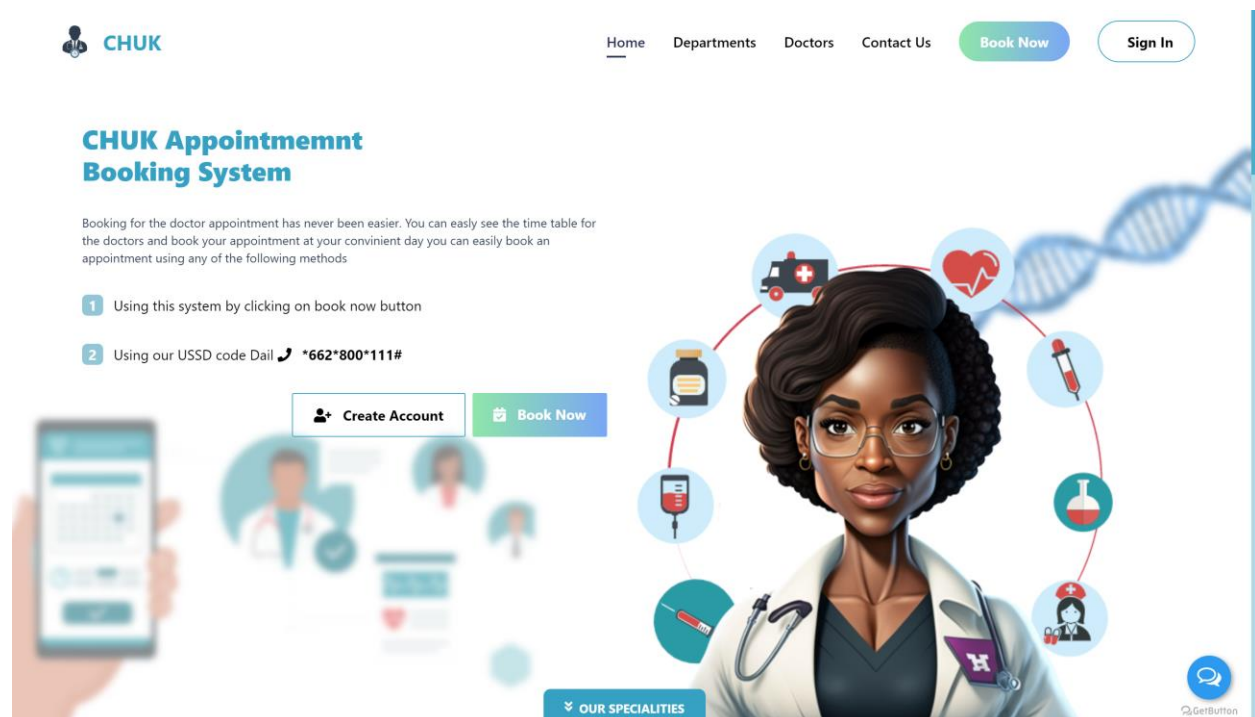


Figure 6: Home Page of our system

#### 4.2.2. Patient account Page

This page is helping the new patient to register into system by filling patient's information.

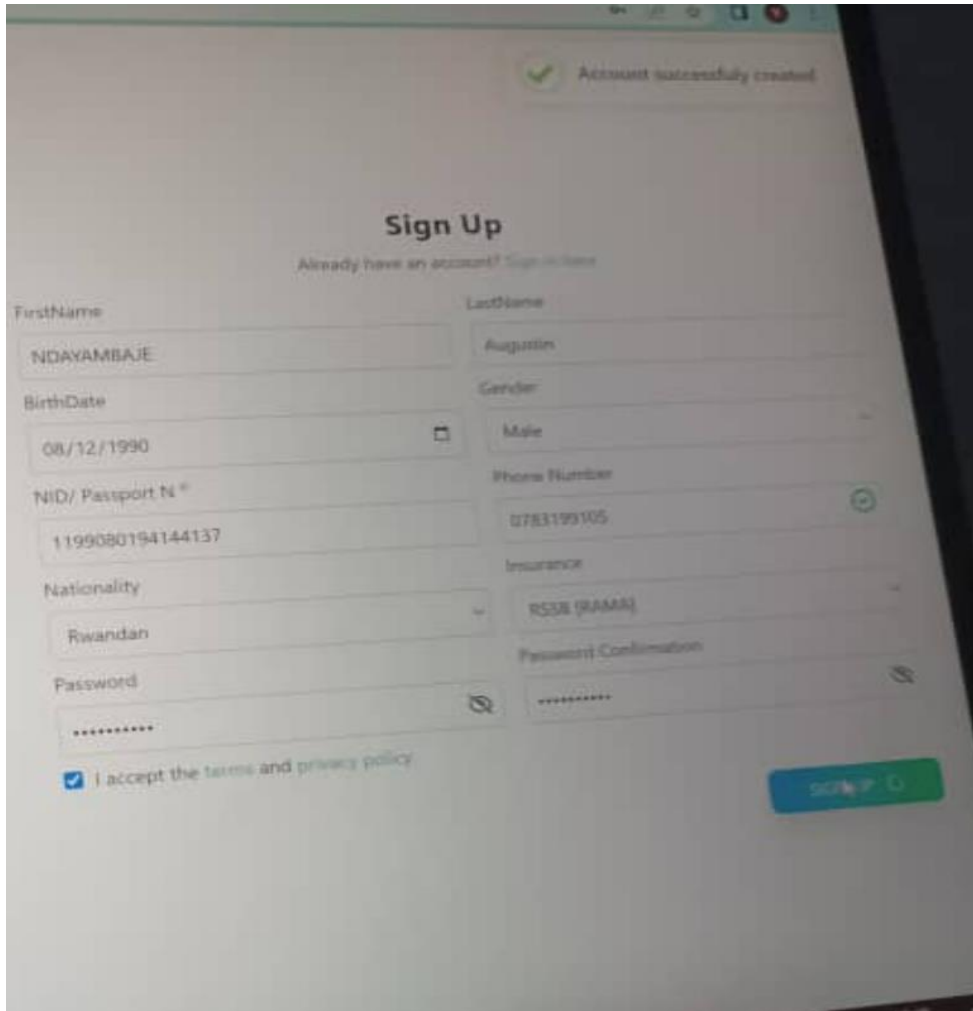
**Sign Up**  
Already have an account? [Sign in here](#)

FirstName	LastName
<input type="text" value="NDAYAMBAJE"/>	<input type="text" value="Augustin"/>
BirthDate	Gender
<input type="text" value="08/12/1990"/>	<input type="text" value="Male"/>
NID/ Passport N °	Phone Number
<input type="text" value="1199080194144137"/>	<input type="text" value="0783199105"/>
Nationality	Insurance
<input type="text" value="Rwandan"/>	<input type="text" value="RSSB [RAMA]"/>
Password	Password Confirmation
<input type="password" value="....."/>	<input type="password" value="....."/>

I accept the [terms](#) and [privacy policy](#)

Figure 7: Sign Up Page

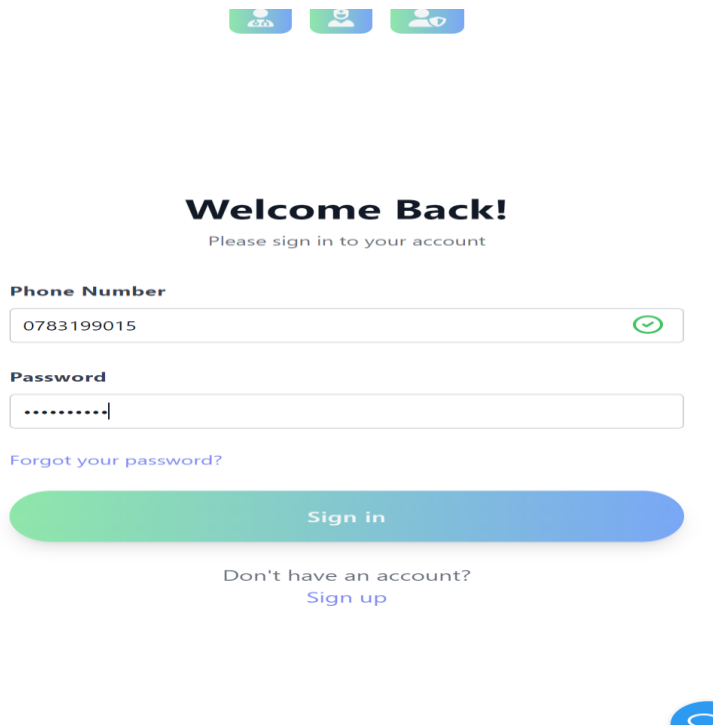
When the patient finished to enter all this information the system generates the confirmation message “Account Successfully created”.



*Figure 8: Sign up confirmation message*

#### 4.2.3. Login Page

When the user click “Sign in” the system displayed a confirmation message “Login Successful”



The image shows a login page with a header containing three user icons. The main heading is "Welcome Back!" followed by the instruction "Please sign in to your account". There are two input fields: "Phone Number" with the value "0783199015" and a green checkmark, and "Password" with masked characters. A link "Forgot your password?" is below the password field. A large green-to-blue gradient button labeled "Sign in" is centered. Below it, the text "Don't have an account?" is followed by a blue "Sign up" link. A blue circular icon is visible in the bottom right corner.

Figure 9: Login Page

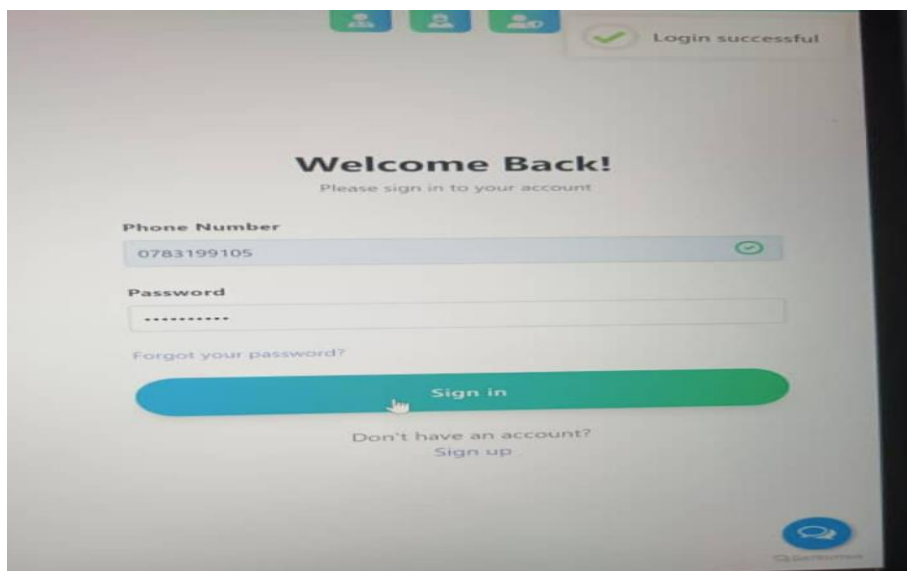


Figure 10: login confirmation page

#### 4.2.4. Booking appointment page

This page is opened when the patient is logging in the system by clicking at “Booking now” link. From there, the patient can choose the department where he/she wants to book the appointment. A timetable will be displayed, and the patient know the availability of doctors and will be allowed to

choose the date of the appointment. A green tick shows that the Doctor is available on that date. In other word the patient clicks on green tick sign, the system display doctors working on that day and choose one doctor and then click make appointment.

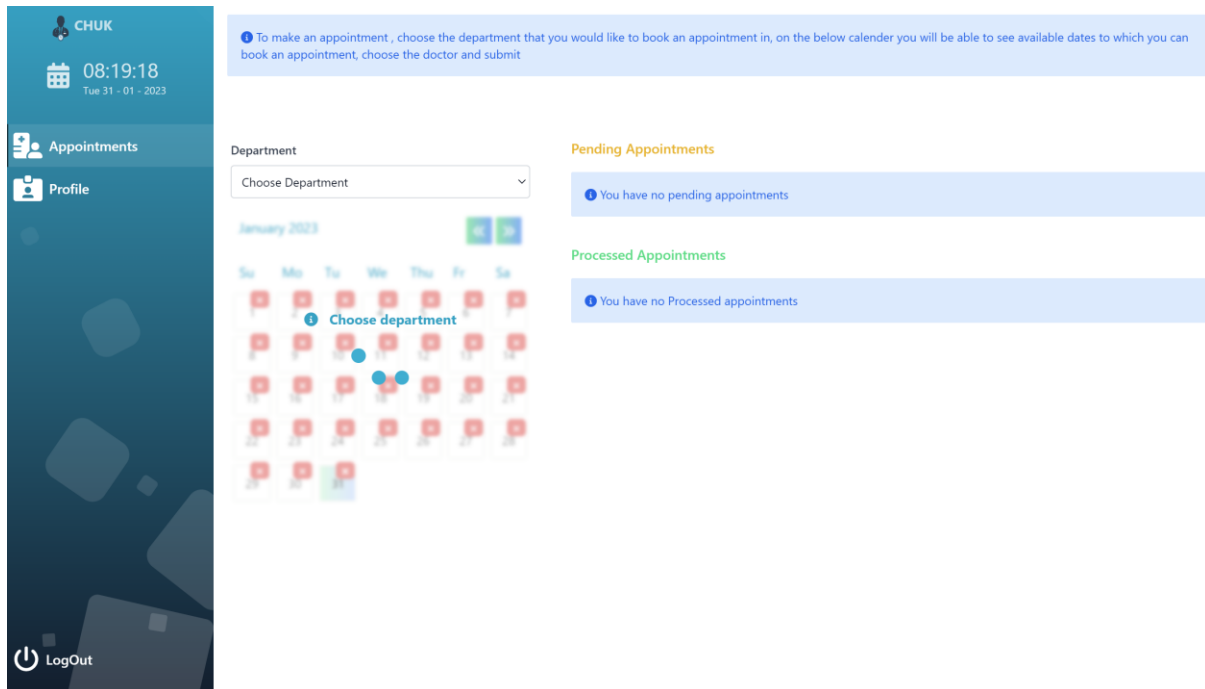


Figure 11:Booking Appointment Page

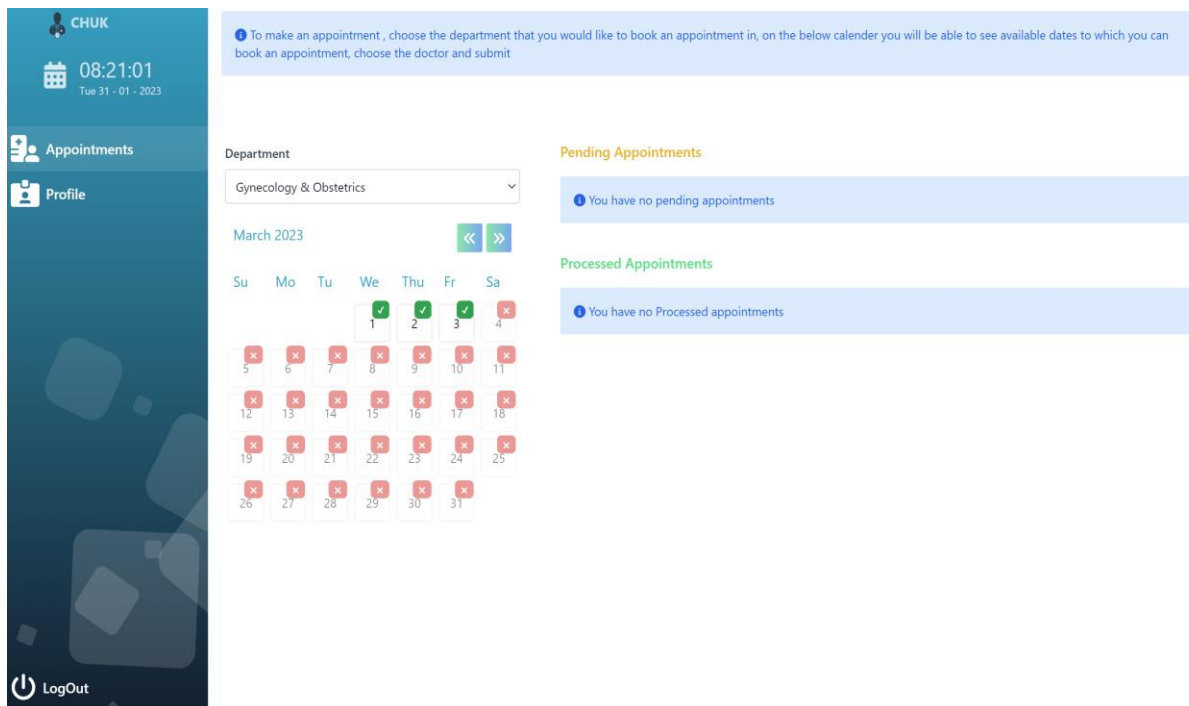


Figure 12:Choose department

After the patient click on make appointment, directly receive a confirmation message on his/her phone. And then, his/her request appointment goes in pending Appointments by waiting approve from receptionist.

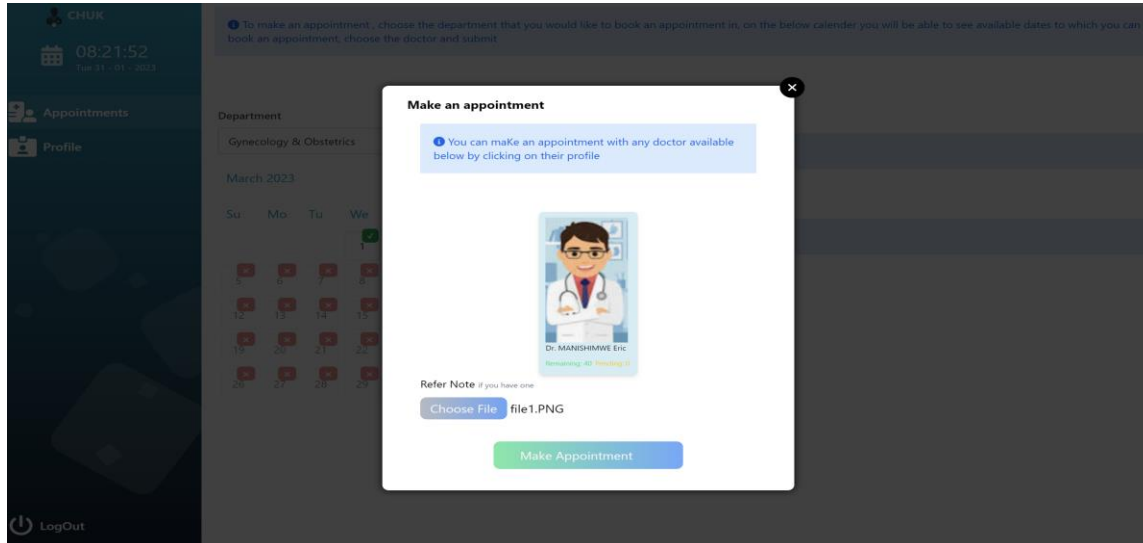


Figure 13: Select booking date

#### 4.2.5. Doctors Management Page

This page allows the admin to create the Doctors 'accounts with their information. He can add, update or delete a doctor when he no more work at CHUK.

CHUK 👤

📅 10:00:15  
Tue 31 - 01 - 2023

- 🏠 Dashboard
- 📄 Reports
- 👤 Manage Doctors
- 👩 Manage Receptionists
- 👥 Manage patients
- 🏢 Manage Departments
- 👤 Profile

🔌 LogOut

+ Add doctor

📄
📄
📄
📄

Search:

Profile	First name	Last name	Title	specialization	Email	Phone number	Department	Date Added	Action
	abayo	himbaza	Dr	Surgery	abayo.henock@gmail.com	0786165953	Surgery	30-12-2022 11:10:50	🗑️ ✎️ 🏠
	MANISHIMWE	Eric	Dr	Obstetrics and gynecology	manishimwe@gmail.com	0787450379	Gynecology & Obstetrics	31-01-2023 07:53:23	🗑️ ✎️ 🏠
	CYUBAHIRO	Ian	Dr	Pediatric	cyubahiro@gmail.com	0783199105	Pediatrics	31-01-2023 07:56:44	🗑️ ✎️ 🏠

Showing 1 to 3 of 3 entries Previous 1 Next

Figure 14: Doctors Management Page

CHUK 👤

📅 07:52:53  
Tue 31 - 01 - 2023

- 🏠 Dashboard
- 📄 Reports
- 👤 Manage Doctors
- 👩 Manage Receptionists
- 👥 Manage patients
- 🏢 Manage Departments
- 👤 Profile

🔌 LogOut

<< View Doctors

Profile Image

doctor.PNG  
(64.12 KB)

🗑️

<p style="font-size: 8px; margin-bottom: 5px;">FirstName</p> <input style="width: 95%; border: none; border-bottom: 1px solid #ccc;" type="text" value="MANISHIMWE"/>	<p style="font-size: 8px; margin-bottom: 5px;">LastName</p> <input style="width: 95%; border: none; border-bottom: 1px solid #ccc;" type="text" value="Eric"/>
<p style="font-size: 8px; margin-bottom: 5px;">Title</p> <input style="width: 95%; border: none; border-bottom: 1px solid #ccc;" type="text" value="Dr"/>	<p style="font-size: 8px; margin-bottom: 5px;">Specialization</p> <input style="width: 95%; border: none; border-bottom: 1px solid #ccc;" type="text" value="Obstetrics and gynecology"/>
<p style="font-size: 8px; margin-bottom: 5px;">Email</p> <input style="width: 95%; border: none; border-bottom: 1px solid #ccc;" type="text" value="manishimwe@gmail.com"/>	<p style="font-size: 8px; margin-bottom: 5px;">Phone Number</p> <input style="width: 95%; border: none; border-bottom: 1px solid #ccc;" type="text" value="0787450379"/> <span style="float: right; font-size: 12px; color: green;">✔️</span>
<p style="font-size: 8px; margin-bottom: 5px;">Department</p> <input style="width: 95%; border: none; border-bottom: 1px solid #ccc;" type="text" value="Gynecology &amp; Obstetrics"/>	

CREATE ACCOUNT

Figure 15: Create doctor's account page

CHUK

07:53:28  
Tue 31 - 01 - 2023

Dashboard

Reports

Manage Doctors

Manage Receptionists

Manage patients

Manage Departments

Profile

Logout

<< View Doctors

Profile Image

Click to select

FirstName

Enter doctor's first name

LastName

Enter doctor's last name

Title

Enter the doctor title

Specialization

Enter the doctor title

Email

Enter your Identification number

Phone Number

Enter your phone number

Department

Select one...

CREATE ACCOUNT

Doctor successfully registered

Figure 16: Confirmation of Create doctor's account page

CHUK

08:59:49  
Tue 31 - 01 - 2023

Dashboard

Reports

Manage Doctors

Manage Receptionists

Manage patients

Manage Departments

Profile

Logout

+ Add doctor

Search:

Profile	First name	Last name	Title	specialization	Email	Phone number	Department	Date Added	Action
	duhimbaze	elie	Dr	gene	duhimbaze@gmail.com	0786135953	Surgery	30-12-2022 11:10:50	
	abayo						Surgery	30-12-2022 11:10:50	
	MANISHIMWE						Gynecology & Obstetrics	31-01-2023 07:53:23	
	CYUBAHRO						Pediatrics	31-01-2023 07:56:44	

Showing 1 to 4 of 4 entries

Previous 1 Next

Are you sure you want to edit abayo himbaza Account

Edit User Cancel

Figure 17: Update doctor's account page

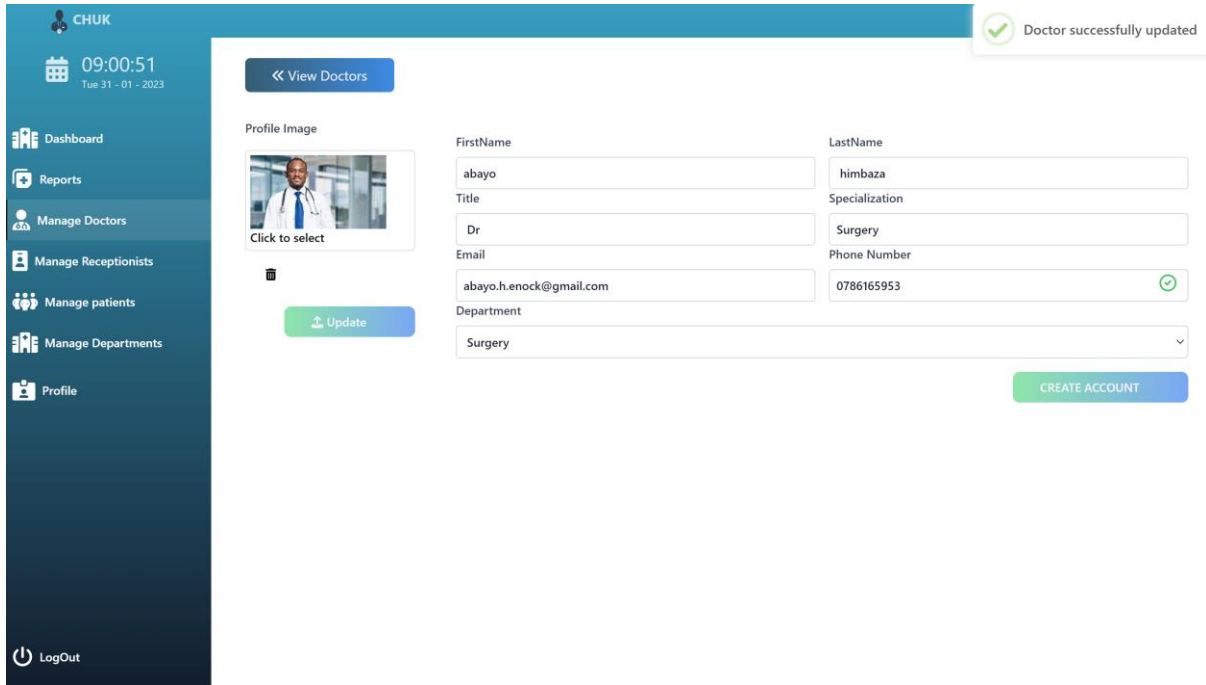


Figure 18: Confirmation of update doctor's account page

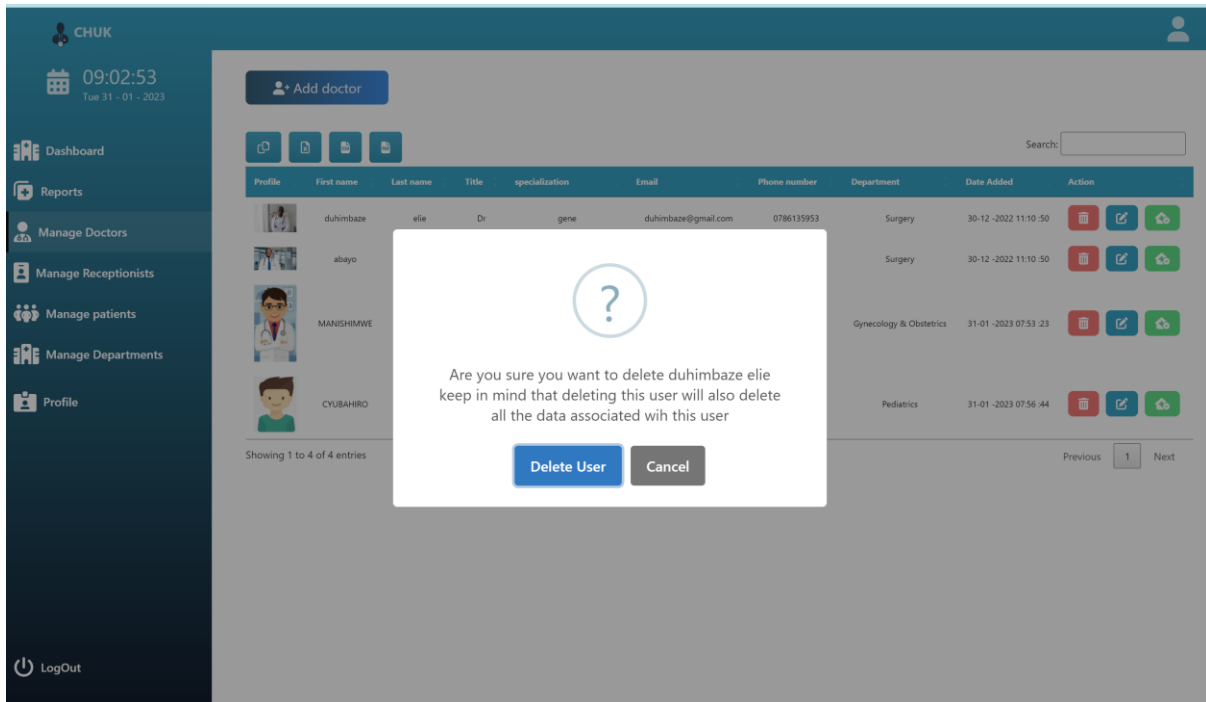


Figure 19: Delete doctor's account page

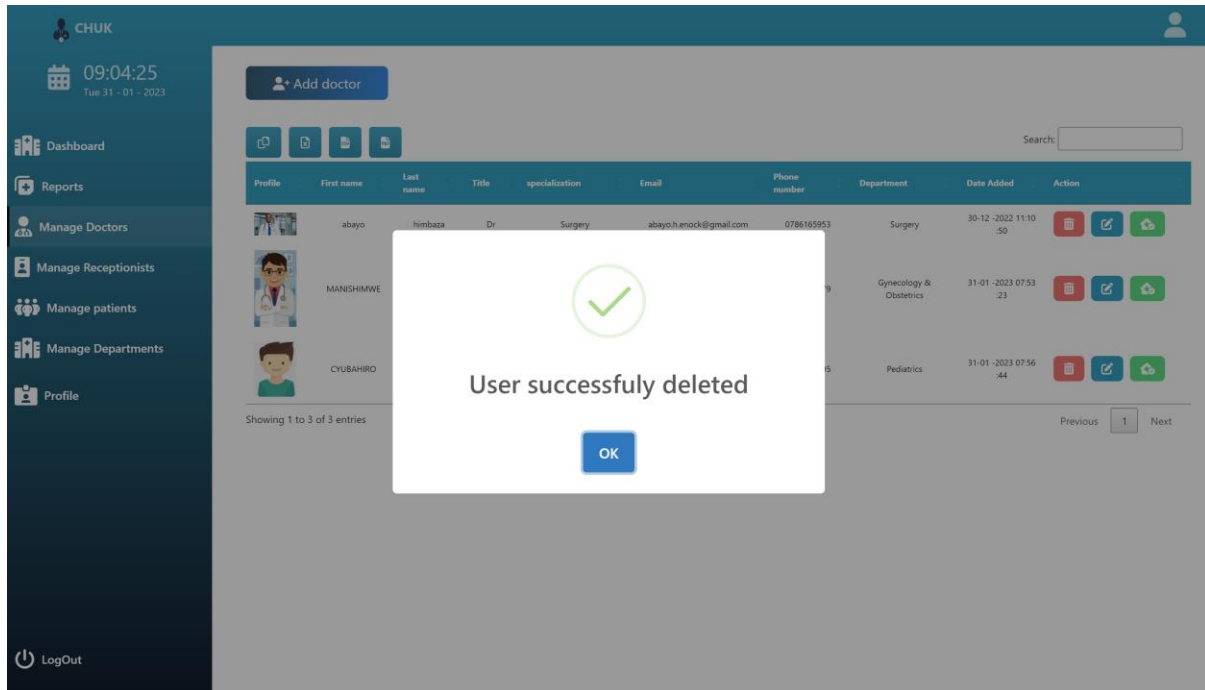


Figure 20: Confirmation of delete doctor's account page

#### 4.2.6. Receptionist Management Page

This page is for allowing the admin of the system to create receptionists accounts. He can add, edit or delete a receptionist when he/she is no more a staff of CHUK.

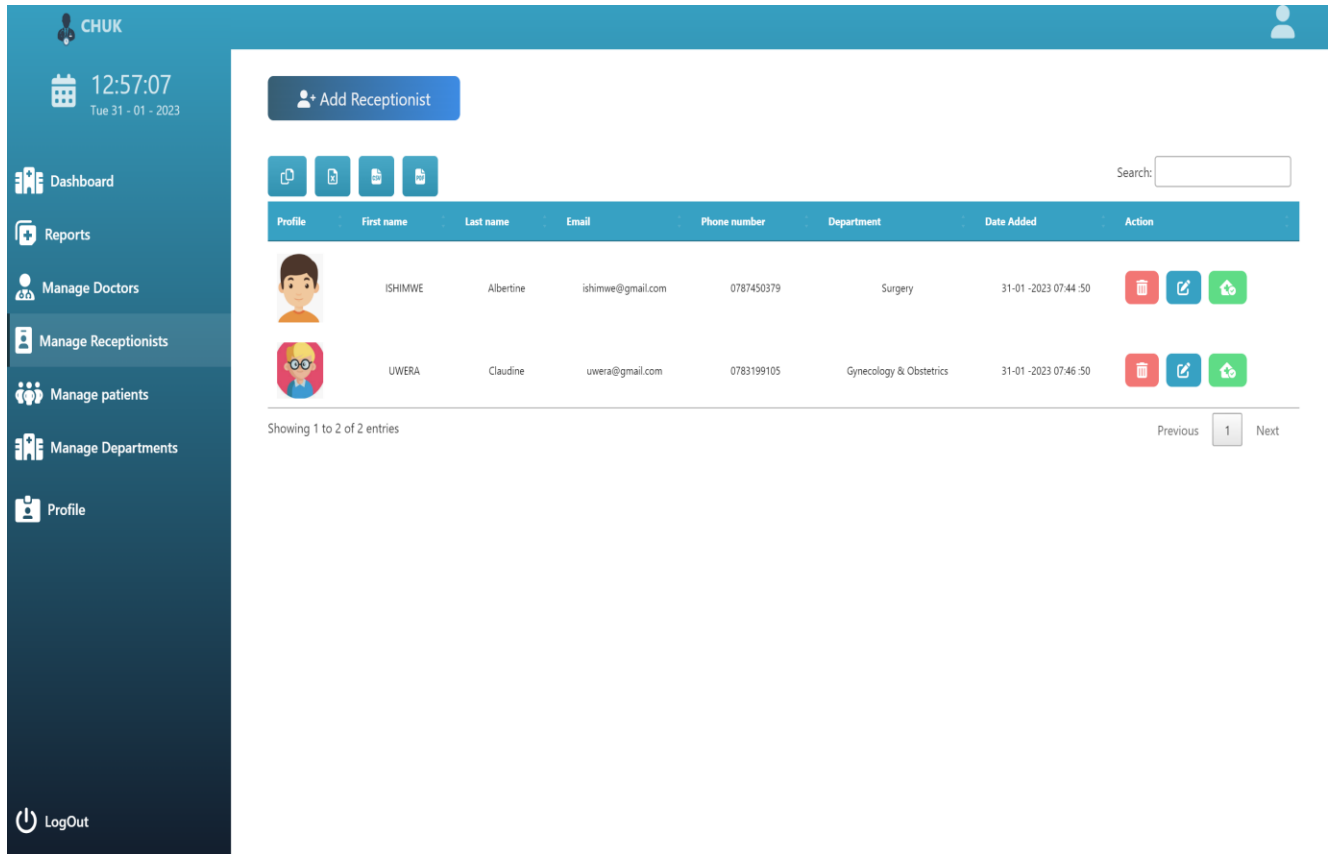


Figure 21: Receptionist Management Page

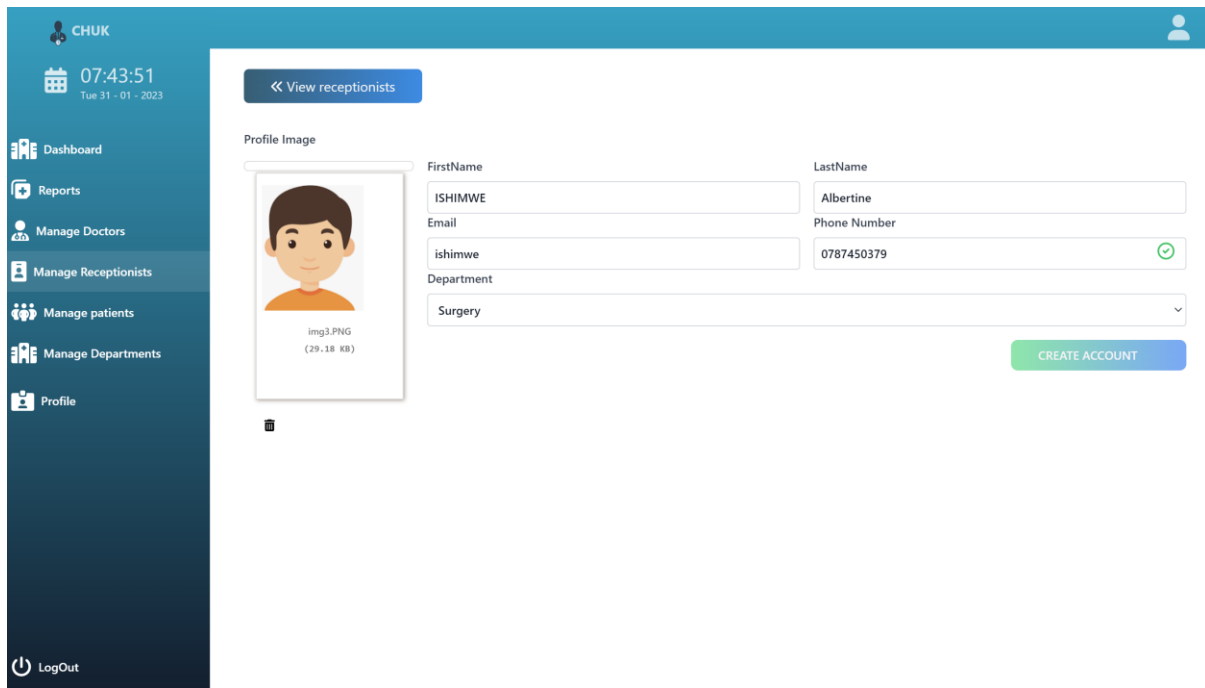


Figure 22: Create Receptionist account page

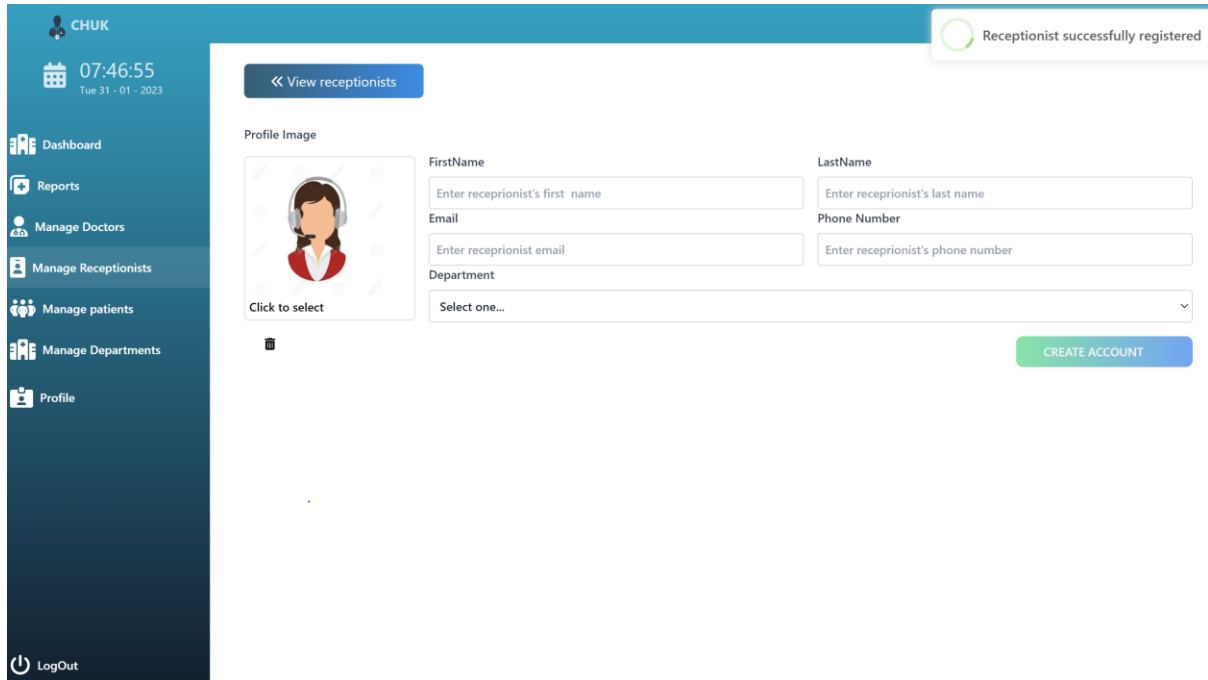


Figure 23: Confirmation of receptionist account page

## 4.2.7. Departements Management Page

This page helps the admin to manage the medical departments for adding or editing accordingly.

The screenshot displays the CHUK Departments Management Page. The sidebar on the left contains navigation links: Dashboard, Reports, Manage Doctors, Manage Receptionists, Manage patients, Manage Departments (highlighted), Profile, and LogOut. The main content area features a blue header with the CHUK logo and a user profile icon. Below the header, there is a date and time display (13:01:06, Tue 31 - 01 - 2023) and an 'Add Department' button. A search bar is located to the right of the 'Add Department' button. Below the search bar, there are four icons representing different department types. The main content area contains a table with the following data:

Icon	Department Name	Department Description	Date Added	Action
	Surgery	The Unit of General Surgery at Kigali University Teaching Hospital provides excellent care to patient with both emergent and non emergent general surgical conditions.	30-12-2022 11:10:50	
	Accident & Emergency	our emergency room is responsible to deliver high level of care on the national referral pathway.	30-12-2022 11:10:50	
	Gynecology & Obstetrics	At CHUK, we care deeply about women's health. In service of the CHUK mission, we hope that this website can provide accurate, up-to-date medical information as well as learning resources and inspirational stories from our department, patients and caregivers	09-01-2023 18:25:44	
	Pediatrics	Pediatrics and Child Health at Centre Hospitalier Universitaire de Kigali-CHUK is dedicated to the improvement of health of all children referred from all over the country.	31-01-2023 07:29:02	
	Anesthesiology & critical care	The department of Anesthesiology and Critical Care at CHUK provides expert anesthesia care for the full spectrum of medical and surgical indication seen at tertiary care teaching institution	31-01-2023 07:35:06	

Showing 1 to 5 of 5 entries

Previous 1 Next

Figure 24:Departments Page

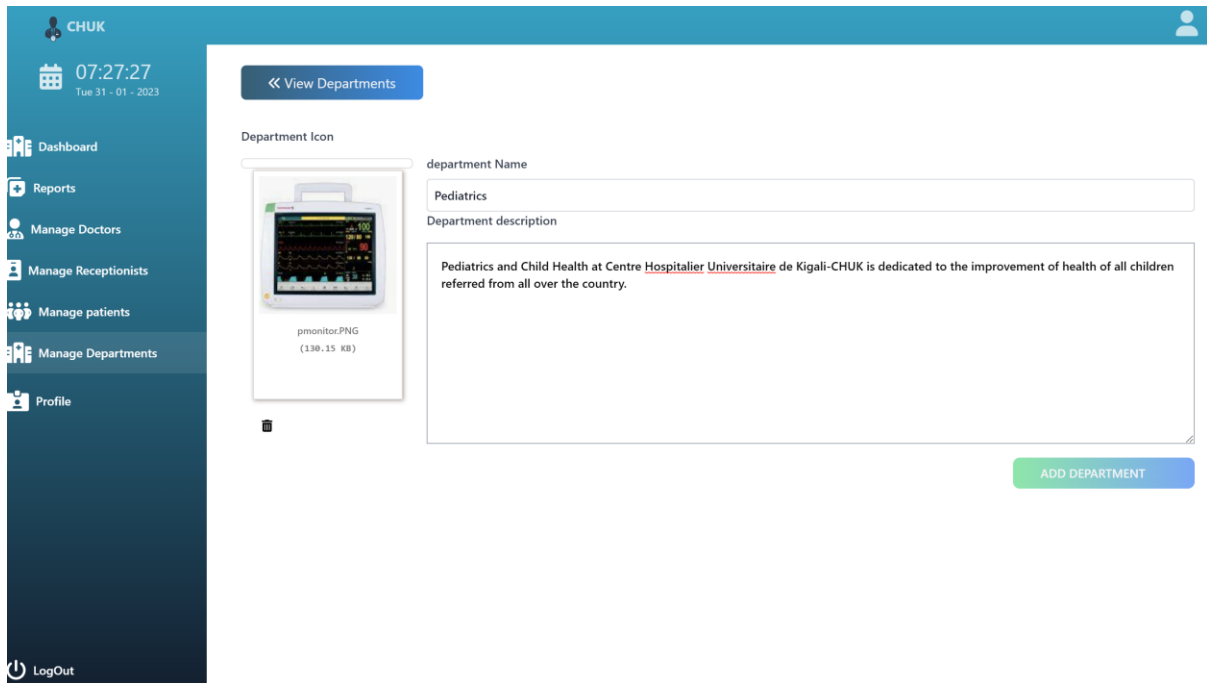


Figure 25: Enter department page

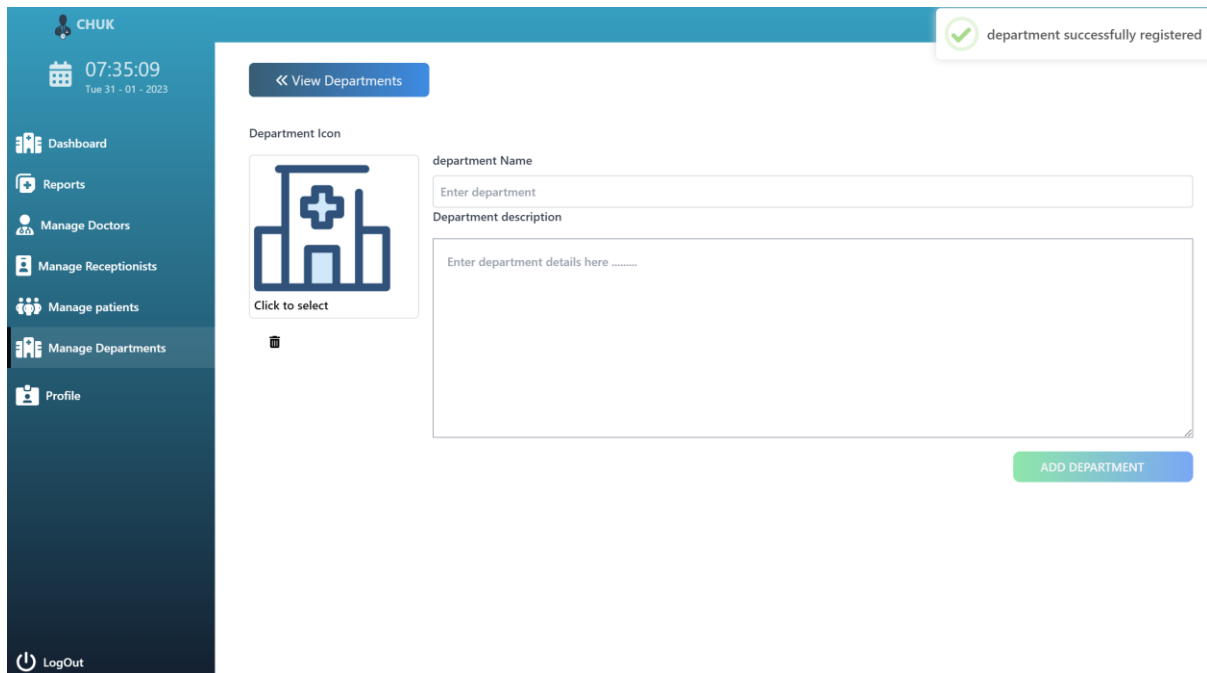


Figure 26: Confirmation of entering department page

#### 4.2.8. Setting timetable of doctor's availability page

When the receptionist is logged in the system, he/she views this page and click at the timetable which generate the calendar. He /she can choose the date of availability of a doctor and a list of available Doctors per department will be displayed. And then the calendar displayed with a green tick shows that the Doctor is available on that date.

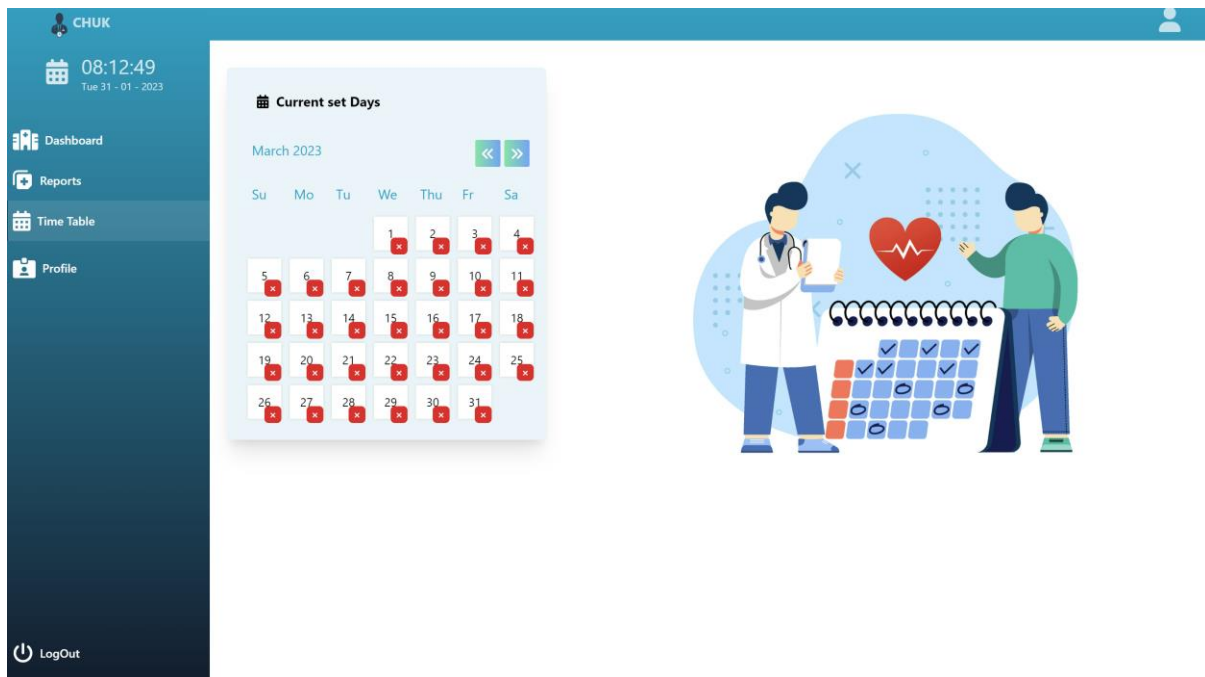


Figure 27:Setting timetable page

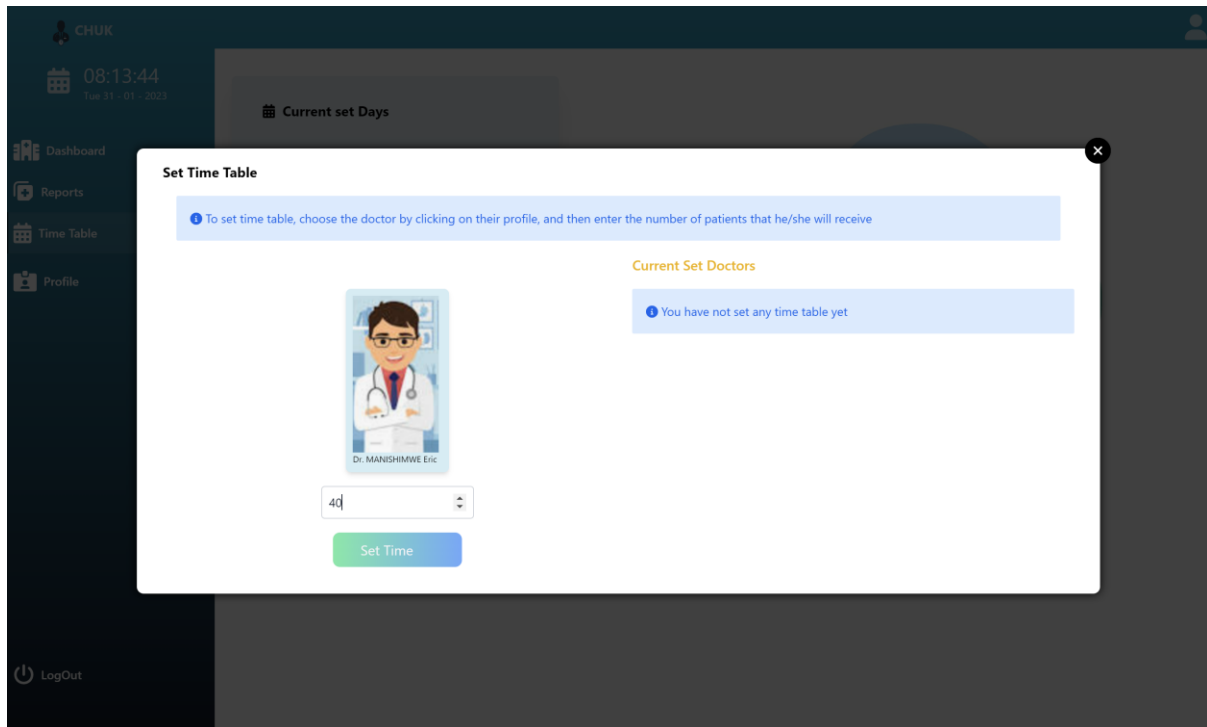


Figure 28: Option of choosing doctor page

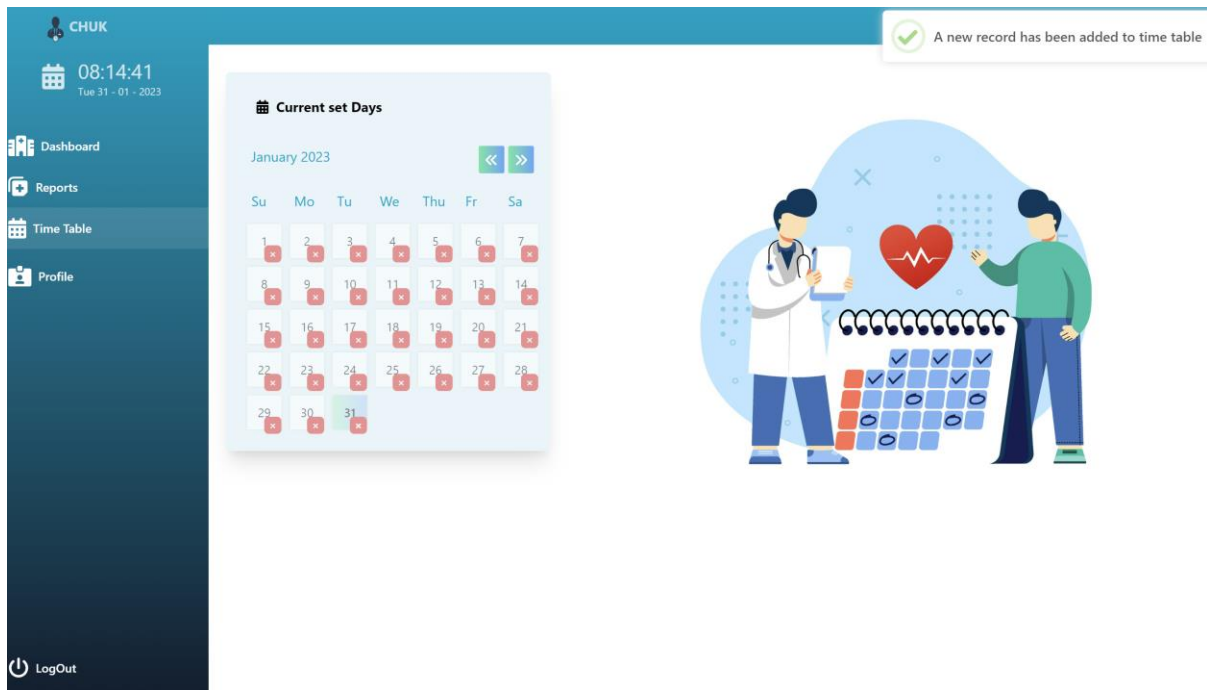
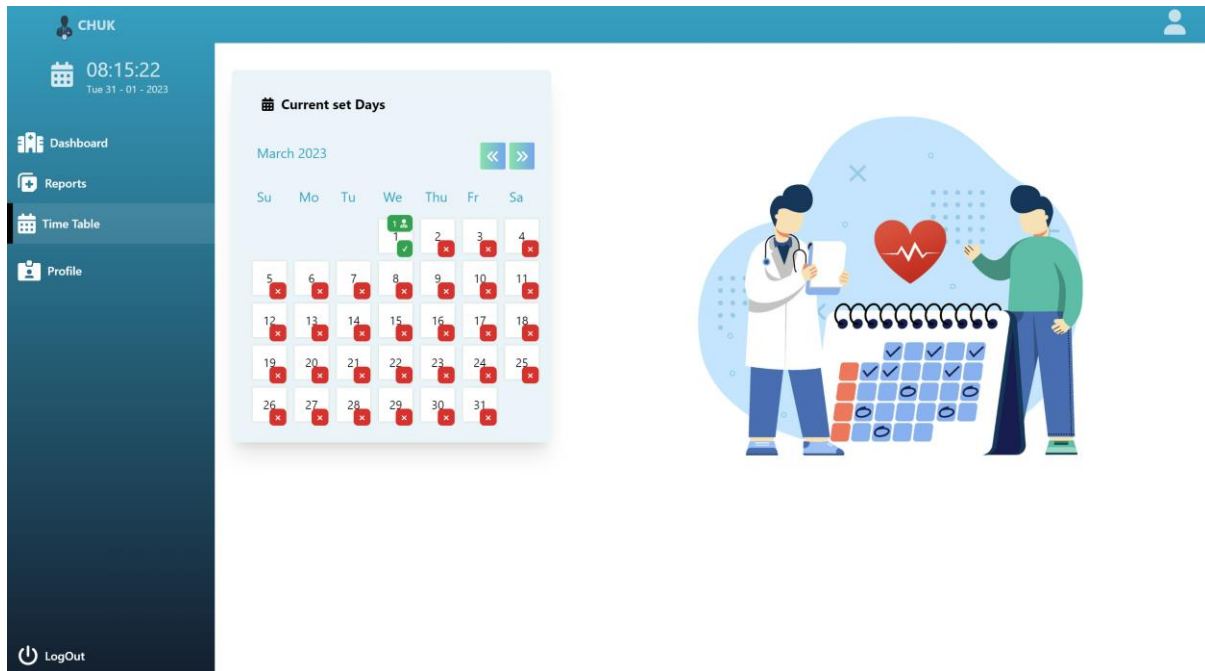


Figure 29: Confirmation for setting timetable



*Figure 30:Result page after setting timetable*

#### **4.2.9. Approval or denial of an appointment**

Appointment must be approved or deny by the receptionist depend on the department.

Receptionist first login into the system click on dashboard in his/her account, the system display calendar. The date showed by green tick and red sign means that there is a patient who request appointment on that date. when receptionist click on that date, directly the system display pending, approved and declined appointment on that date.

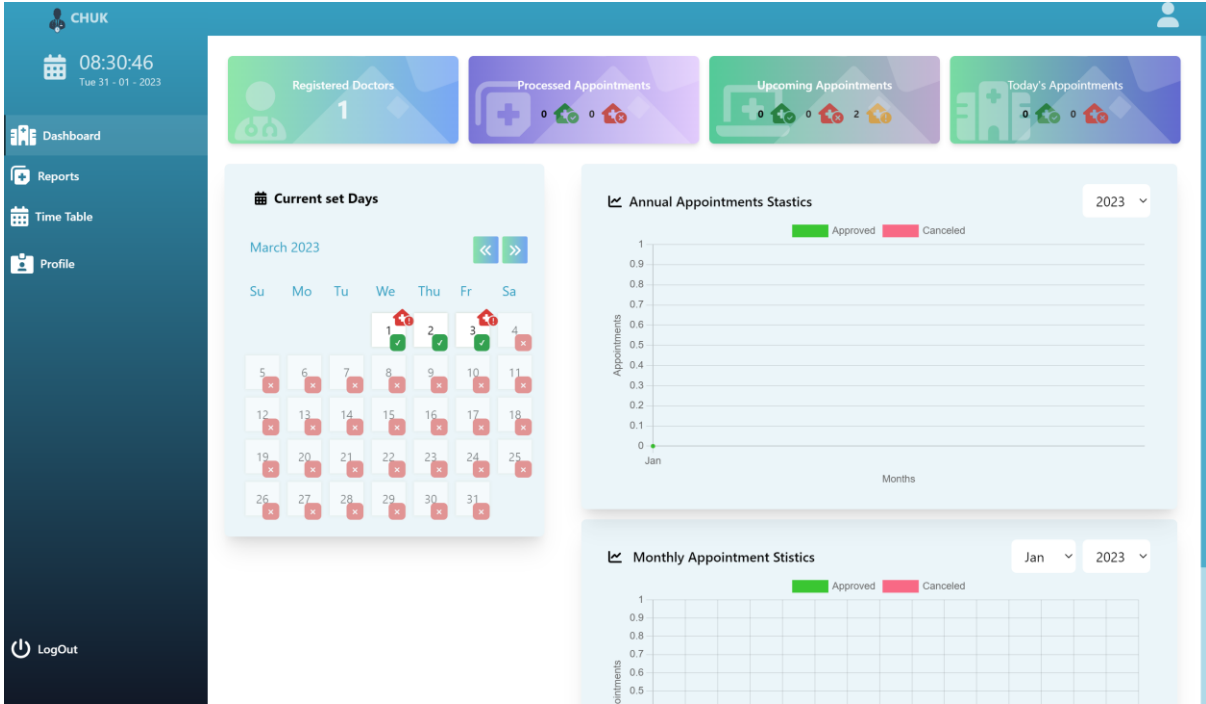


Figure 31: Approve or deny appointment page

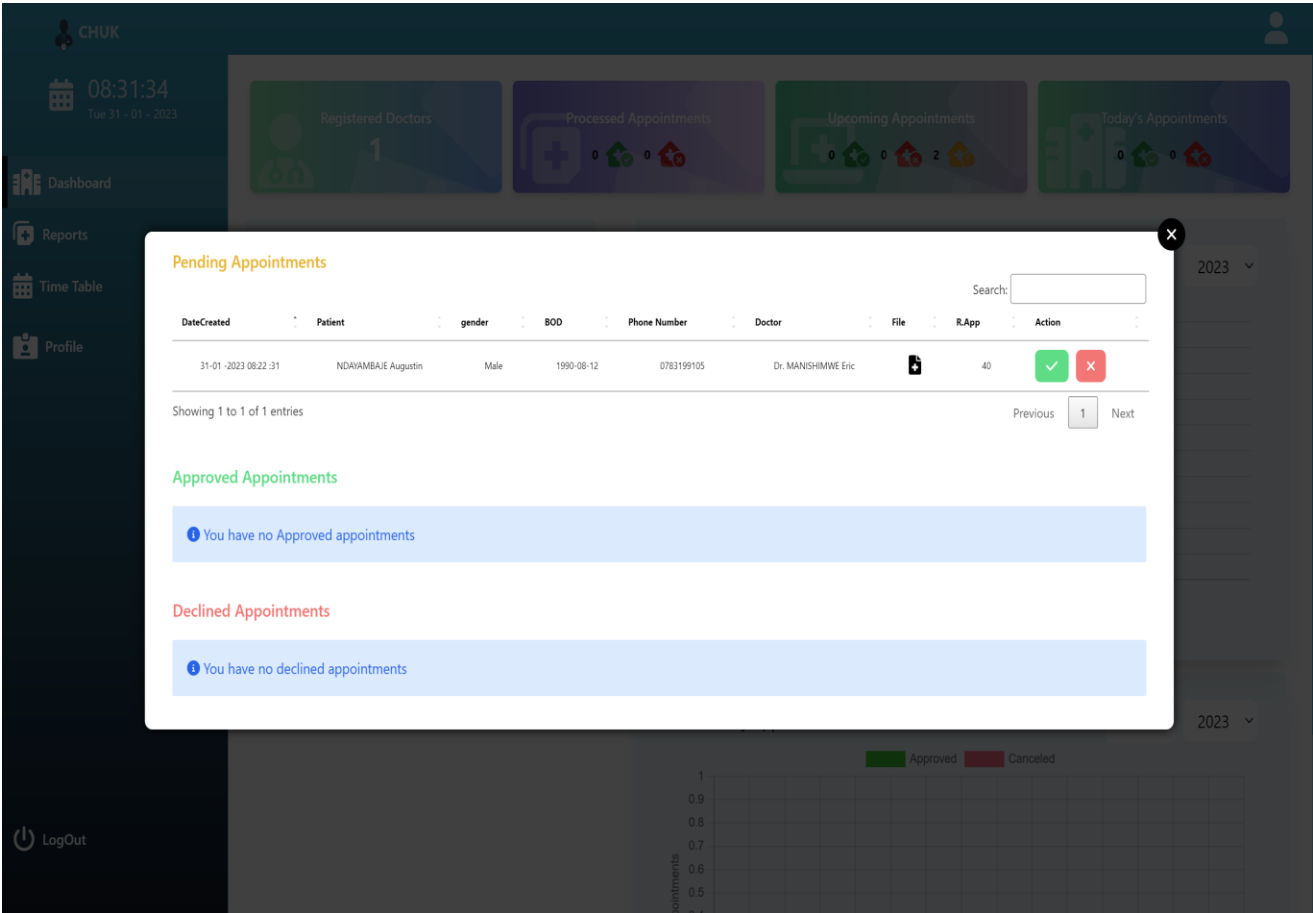


Figure 32: Pending, approved or declined appointment page

Receptionists approve appointment by click on a green tick or deny appointment by click on red sign on figure 32. After approving or deny appointment the system generate a message to the patient who requested that appointment.

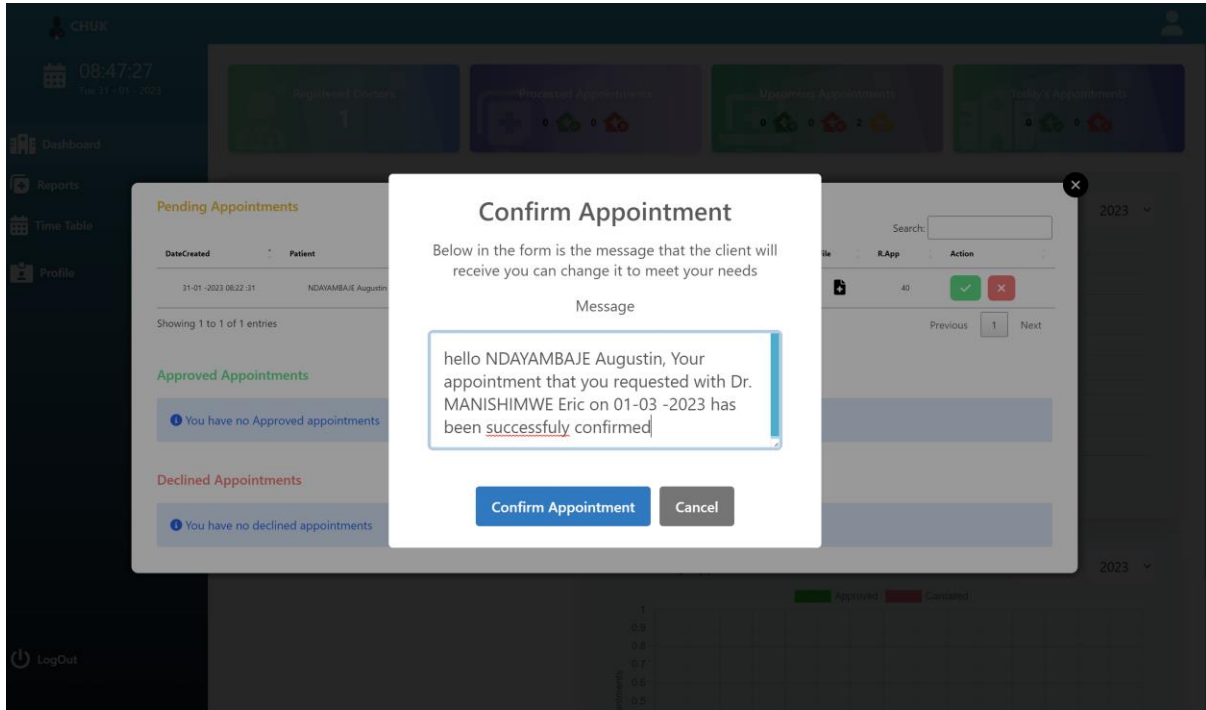


Figure 33: Patient message

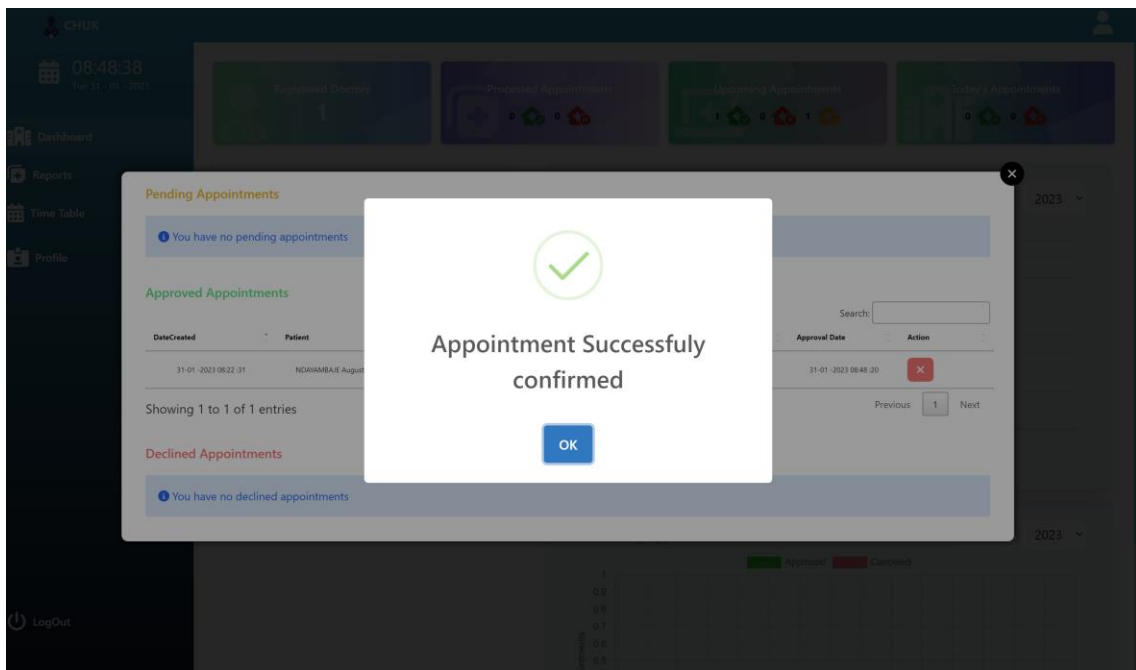


Figure 34: Confirmation of sending patient message

#### 4.2.10. Making Report page

This page helps the admin or the receptionist to print the report depending on the date with corresponding activities. This page will display the state of booking appointment with accepted, denied and pending appointments. The user has option of downloading this report.

CHUK

08:50:14  
Tue 31 - 01 - 2023

Dashboard

Reports

Time Table

Profile

LogOut

03/01/2023

**Unconfirmed Appointments**

You have no pending appointments

**Approved Appointments**

Search:

DateCreated	Patient	gender	BOD	Phone Number	Doctor	Approval Date
31-01-2023 08:22:31	NDAVAMBAJE Augustin	Male	1990-08-12	0783199105	Dr. MANISHMWWE Eric	31-01-2023 08:48:20

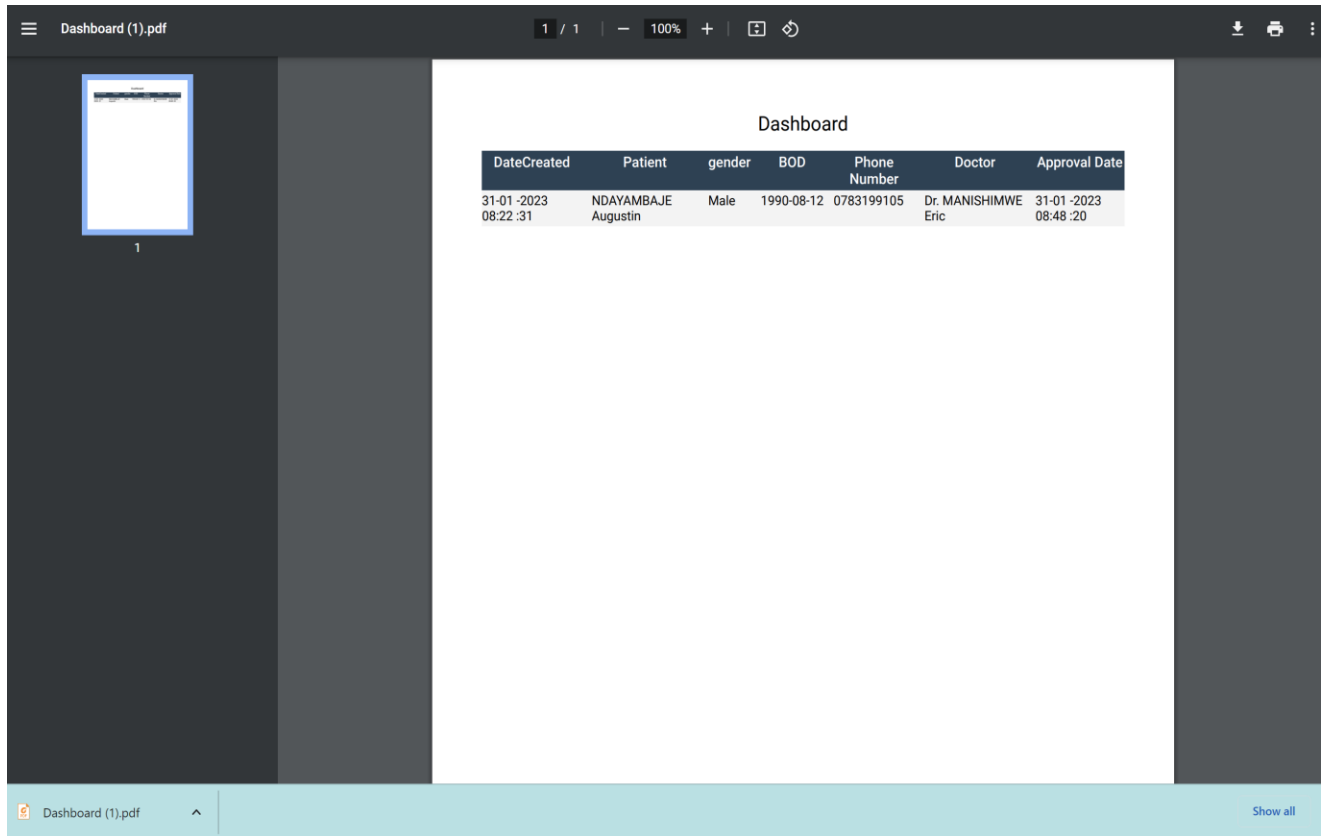
Showing 1 to 1 of 1 entries

Previous 1 Next

**Declined Appointments**

You have no declined appointments

Figure 35: Report Page



*Figure 36:downloaded report*

### 4.3. Testing

After software design, testing is very important to verify if our system is effective and is playing the intended role.

#### **Key aspects to take into consideration in software testing:**

When testing, the following points are considered:

- Does the application meet the requirements that guided its design and development?
- Does the software perform as expected?
- Can the application be implemented with the same characteristics and satisfies the needs of the stakeholders?

Testing is done to make sure that the system works smoothly. Table 1 shows the testing done during the development of an application for requesting medical appointment online case study CHUK.

**4.3.1. Table of successfully functioning tasks in Medical Appointment Request Online Application at CHUK.**

Module Tested	Expected Result	Final Result
Login	Allow the users of the system to access the system by using username and password	Success
Account creation	Allow the users of the system to fill the needed information for registering	Success
Appointement Booking	Allow the patient to choose the department where he/she wants to be treated and select the preferred date and Doctor and then submit the request for appointment.	Success
Setting timetable of Doctor's availability	Allow receptionist to create a timetable showing the date of doctor's availability and the number of patients that each doctor can treat at that date	Success
Approval or denial of an appointment	Allow Receptionist to approve or deny appointment and sending notification message to the patient	Success
Account Management	Allow Admin to create, update or delete the account of	Success

	the receptionist or the doctor in the system	
Viewing Appointment	Allow Doctor to know the patients who have request appointment to meet him	Success
Making report	Allow the receptionist and admin to print report	Success

*Table 1: Functioning Tasks in our system*

## **CHAPTER 5. CONCLUSION AND RECOMMENDATION**

### **5.1. Conclusion**

As we are living in the age of high technology development, the health system can't be left behind because it is one of the sectors that have a big impact on the human living. This research is intending to continue qualifying Rwanda as the Hub of technology in East African Community. Our objective is to contribute to the improvement of the health sector, technically, economically and socially.

Development of an application for requesting medical appointment online is web-based system which will be accessed through USSD code as well. This application was designed to help patients to request a medical appointment online at CHUK and help CHUK hospital to schedule online the daily timetable of Doctors availability and patients will be scheduled accordingly. This application will also help medical professionals to manage their daily workload and doctors will also come to know the number of patients who will daily attend. Based on the effectiveness of the developed application, some of the advantages have been identified: On the side of the patients, time and money will be unspoiled and will be kept out of contracting contagious and nosocomial diseases like TB, Covid-19 etc. On the side of the hospital, the management of patients will be easy and the reception work will be simplified because the patient will have provided his identification through the system. This application will improve the technology in healthcare by increasing the quality of health.

### **5.2. Recommendation**

As we live in a world where technology is advancing at a considerable pace, I would like to ask everyone concerned by this application to play their due role at their level. I would ask CHUK to take advantage of this system to lighten and organize the work of scheduling patient medical appointments. To raise awareness and explain the merits of this system to avoid resistance to change. All end users are ought to receive a training or guidance for effective use and fully benefiting of the Application. Any suggestion for better improvement of the system from CHUK will be welcome and taken in account. While not claiming to be perfect and exhaustive in the development of the application, I invite further researchers from University of Rwanda and other

research institutions to kindly bring their contribution in order to improve this product and to correct the imperfections which could be find in this work.

## REFERENCES

- [1] V. Rallapalli, D. Menghani, H. Gallani, and G. Aasija Dashrath Mane, "Online Doctor Appointment System," *International Journal of Engineering Research and Applications* [www.ijera.com](http://www.ijera.com), vol. 12, pp. 48–52, 2022, doi: 10.9790/9622-1204034852.
- [2] "About chuk". <https://chuk.rw/about-chuk/article/welcome-note> (accessed January 20, 2023)
- [3] N. Ismail, S. Kasim, Y. Y. Jusoh, R. Hassan, and A. Alyani, "Medical App ointment Application," 2017. [Online]. Available: <http://www.actaelectronicamalaysia.com>
- [4] S. B. Choudhari, C. Kusurkar, R. Sonje, P. Mahajan, and J. Vaz, "Android Application for Doctor's Appointment," *International Journal of Innovative Research in Computer and Communication Engineering (An ISO, vol. 3297, no. 1, 2007, [Online]. Available: [www.ijirccce.com](http://www.ijirccce.com)*
- [5] A. A. Menegassi and A. T. Endo, "Automated tests for cross-platform mobile apps in multiple configurations," *IET Software*, vol. 14, no. 1, 2020, doi: 10.1049/iet-sen.2018.5445.
- [6] S. Malik, N. Bibi, S. Khan, R. Sultana, and S. A. Rauf, "Mr. Doc: A Doctor Appointment Application System Hybrid ARQ for OFDM Systems View project Limiting Distortion Compensation for OFDM View project Mr. Doc: A Doctor Appointment Application System," 2016. [Online]. Available: <https://www.researchgate.net/publication/312946008>
- [7] A. Friends, "XAMPP Apache+ MariaDB+ PHP+ Perl," *Apache Friends*, 2017.
- [8] T. Gardner, *Software development*, vol. 28, no. 1. 1995. doi: 10.1080/01615440.1995.9955315.
- [9] Overview Data Independence in Relational Databases N-tier Architectures Architectures Design Patterns ∅/The MVC Design Pattern Pattern REST Architectural Style."
- [10] Overview Data Independence in Relational Databases Databases N-tier Architectures Architectures Design Patterns ∅/ The MVC Design Pattern Pattern REST Architectural Style."
- [11] B. Ripley, "ODBC Connectivity," *Source*, 2012.
- [12] "DatabaseSystem-final".
- [13] "VisualStudioCode-TipsAndTricks-Vol.1".
- [14] "Introduction to MySQL." [Online]. Available: <https://www.google.it/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&c>
- [15] GEEK FLARE, "Apache Web Server Hardening & Security Guide," 2013.
- [16] C. Kolade, "What is PHP? The PHP Programming Language Meaning Explained," *Free Code Camp*, 2021.

- [17] “HTML Basics CS 115 Computing for the Socio-Techno Web Instructor: Brian Brubach.”
- [18] Anonymous, “What is JavaScript? - Learn web development,” *MDN Web Docs*, 2020.