



MUHAMMAD WALEED SETHI
01-134181-049
OSAMA UMAR
01-134181-054

Impact Analysis of COVID Vaccine

Bachelor of Science in Computer Science

Supervisor:
Dr. Kashif Naseer

Department of Computer Science
Bahria University, Islamabad

January, 2022

Acknowledgement

We'd want to express our gratitude to all intellectuals who guided us during our Bachelor's degree. We would like to thank Dr. Kashif Naseer, our supervisor, firstly. We were able to finish this project because of his expertise and practical recommendations.

We want to appreciate Bahria University and its whole professors and staff for providing us with the required education and the opportunity to prepare this report. We'd also like to thank our family and friends for their everlasting support and encouragement during our education.

MUHAMMAD WALEED SETHI & OSAMA UMAR
ISLAMABAD, PAKISTAN

January, 2022

Abstract

As the vaccination process has commenced in all parts of the world, a need has risen to keep a check on the impacts of all the vaccinations. It has been noticed that each vaccine has different impacts on people of different age groups. A vaccine that proved successful on an individual of a certain age had negative impacts on the person of another age group. Therefore, this issue has been solved by COVAC app which is aimed to provide proper analysis of every vaccine through proper valid data and success rates along with its impacts on people of every age group. Moreover, COVAC also helps the general public in choosing a suitable vaccine according to their age group and certain medical information.

COVAC is to be provided to the vaccination centers for the use by medical staff first and is made available for the general public for their use. It not only improves the quality of the vaccination and make it efficient and effective but also quick. It has been noticed that many people have not decided whether they want to get vaccinated or not because of their fears about the products or chemicals being used in the vaccines. COVAC helps those people as well and so the threat of the spread of COVID can be reduced to a considerable amount.

To achieve this goal, we have trained the application using machine learning and provide it with necessary data sets so that it is able to recommend a vaccine that is more suitable for the person and has less side effects and more positive impacts. The post-vaccination symptoms are recorded and stored in the database which will keep the data updated and hence keep improving the results as well as provide updated information about the vaccination impacts to the medical teams and vaccination centers.

Contents

Acknowledgement	i
Abstract	ii
1 Introduction	1
1.1 History of COVID-19	1
1.2 Impact Analysis of COVID vaccination	1
1.3 Project Background	2
1.4 Project Description	2
1.5 Project Scope	2
1.6 Project Objectives	2
2 Literature Review	3
2.1 Background	3
2.2 Existing System	3
2.3 Proposed System	4
3 Requirements Specification	5
3.1 Application Perspective	5
3.2 Functional Requirements	5
3.3 Non-functional requirements	6
3.4 Use Case Diagrams	6
3.5 Use Case Description	13
4 Design	18
4.1 System Architecture	18
4.2 Current Issue	18
4.3 Design Methodology	19
4.4 Data Flow Diagram	19
4.5 Activity Diagram	20
4.6 Sequence Diagram	22
4.7 GUI Design	23
4.8 Class Diagram for Project	27
5 System Implementation	28
5.1 Tools and Technology	28
5.2 Deployment Structure	28
5.2.1 Components	28
5.2.2 Advantages	28

5.2.3	Disadvantages	29
5.2.4	Deployment Design Diagram	29
6	System Testing and Evaluation	30
6.1	Introduction	30
6.2	Reasons behind testing	30
6.3	Test Cases	31
6.4	GUI Testing	34
7	Conclusion	40
7.1	Description	40
7.2	Future Goals	40
7.3	Conclusion	40
	References	41

List of Figures

3.1	Patient Sign Up Use case	7
3.2	Doctor Sign Up Use case	8
3.3	Doctor Login Use case	9
3.4	Patient Login Use case	9
3.5	Vaccine Information Viewing Use case	10
3.6	Vaccine Recommendation Viewing Use case	11
3.7	Appointment Use Case	12
3.8	Vaccination Use Case	13
4.1	Tiered Architecture	18
4.2	Flow Diagram	19
4.3	Login or Signup Activity Diagram	20
4.4	Vaccine Information Viewing Activity Diagram	21
4.5	Vaccine Recommendation and Appointment Activity Diagram	21
4.6	User Login Sequence Diagram	22
4.7	Appointment Verification Sequence Diagram	22
4.8	Home Page	23
4.9	Sign-Up and Medical Info	24
4.10	Sign-In Page	25
4.11	Vaccine Recommendation	26
4.12	Class Diagram	27
5.1	Deployment Design	29
6.1	Splash Screen	34
6.2	Sign Up Screen	35
6.3	Sign-In Screen	35
6.4	Home Layout	36
6.5	COVID NEWS	36
6.6	Medical Info	37
6.7	Vaccine Information	37
6.8	Recommend Vaccine	38
6.9	Appointment	38
6.10	User Profile Page	39

List of Tables

- 3.1 Patient Sign Up Use Case description 14
- 3.2 Doctor Sign Up Use Case Description 14
- 3.3 Doctor Login Use Case Description 15
- 3.4 Patient Login Use Case Description 15
- 3.5 Vaccine Information Use Case Description 16
- 3.6 Vaccine Recommendation Use Case Description 16
- 3.7 Appointment Use Case Description 17
- 3.8 Vaccination Use Case Description 17

- 6.1 Patient Sign Up Test Case 31
- 6.2 Doctor Sign Up Test Case 32
- 6.3 Doctor Login Test Case 32
- 6.4 Patient Login Test Case 32
- 6.5 Vaccine Information Test Case 33
- 6.6 Vaccine Recommendation Test Case 33

Chapter 1

Introduction

1.1 History of COVID-19

In the year 2019, a deadly virus took birth in the Wuhan city of China. This virus could not be recognized sooner because of its behaviour and impacts and caused a lot of havoc around the world later. Initially it was only identified as a normal viral disease like cough or flu which would eventually wear off in a couple of days but that did not happen. Soon, many different impacts were being noticed in the people who carried the virus. Starting from the initial impact of the virus, the infected lost their sense of taste and smell. After a few days they would experience breathing issues and the virus would have a direct impact on the lungs which would soon cause the patient to be taken to a ventilator where from, the chances of survival depleted a lot.

The first wave was a huge challenge for everyone especially China itself because the virus had spread around the country and many people had travelled outside China carrying the virus which resulted in a global spread of the virus. The whole world had to impose quarantine and everything starting from businesses, offices, schools etc. had to be closed. Things were expected to get better somehow however, the waves of the deadly virus did not cease. All these waves have created a lot of unrest among the general masses, has greatly affected the stock markets and international trades and businesses and has put many countries including Pakistan, in extreme debt.

Although many vaccines have been created and distributed worldwide, it is still an ongoing process to finish off the virus for good although it can not be seen happening for now.

1.2 Impact Analysis of COVID vaccination

Keeping in view the growing concern about the deadly virus and how it has impacted the economic system of Pakistan, it is extremely important to provide a solution to this problem. We live in an age of computational solutions, every problem in the world has been solved through machines and artificial intelligence which has maintained its pace in growing and making an impact in our daily lives. Hence, it is very much possible to solve this issue with the help of machine learning.

A machine learning based android application capable of recommending vaccines to the users according to their age and some minor medical information, which will also aid the medical teams and the vaccination centers in keeping a track of all the vaccines and their impacts on the vaccinated individuals through numerical information including success rates and graphical information including graphs and charts showing the impacts of the vaccine

and public opinion about the certain vaccine(in terms of positive or negative).

1.3 Project Background

As the vaccination process began, it became important with time to keep a track of all the vaccines and their impacts on the public in order to maximize the effectiveness of the vaccination process and avoid any negative impacts on the public. However, there has been no action in this regard and the same vaccines are being given to the public even though every vaccine has different impacts on people of different age groups. This is the reason we felt the need to pursue this project.

1.4 Project Description

This project is aimed to provide updated information about every vaccine to the people as well as to the vaccination centers so that they can provide suitable vaccines to every individual based on his age group. Moreover, if people want to choose a vaccine for themselves, this application will also help them with that based on their age and medical information through the recommendation system.

1.5 Project Scope

This project is aimed to provide assistance to the vaccination centers and also help the general public regarding the vaccination and the vaccines along with detailed information about each vaccine and its impacts on the individuals of different age groups. This will be achieved through machine learning techniques for the recommendation system and for the updated information of the vaccines stored in the database. The application will be introduced in the medical centers and the vaccination centers for the staff first and then it will be made available for the public.

1.6 Project Objectives

The two main objectives of this project are:

- Providing updated information about the vaccines and their impacts on the people of different age groups
- Recommending a vaccine to the user based on his provided medical information.

Chapter 2

Literature Review

2.1 Background

Since the advent of COVID-19, numerous platforms and applications have been created and designed in order to provide information to the general public regarding the spread of the virus, and how people should quarantine themselves in order to keep themselves and their families safe. Much thanks to the efforts by different scientists and doctors around the world, the vaccines have been created and have been supplied to all the countries across the globe.

Now the new phase has begun i.e., the vaccination phase. It is as important as the quarantine phase. Every vaccine has been engineered in a different way and thus, has a different impact on people of different age groups. It is very important that every age group of people are provided with the suitable dose of the vaccine that causes the minimum side effects and protects the person against the virus.

Although, in the beginning there was no check and balance of it due to which many people got weaker and some died or caught severe COVID which greatly impacted the public views about getting vaccinated. Although after a while, the views did change to some extent but there is yet a considerable population that refuses to get vaccinated just because of the rumors being spread about the vaccinations and their impacts.

Considering all these conditions, we have decided to design an application that helps in increasing the effectiveness of the vaccination process and provides the public with the detailed analysis of the impacts of the vaccines on every age group. This will not only help the vaccination centers in being informed about the updates regarding the vaccination but also change the public's views regarding the overall process.

2.2 Existing System

Although there is an application regarding COVID-19 but it is only limited to providing information about the COVID hot zones, the number of daily cases, total cases, total recoveries and deaths. There is no application regarding the vaccination, which is why we believe it is important to keep the public updated about the information of vaccination across the country and help people with getting a vaccine as well. Numerous other platforms including news agencies also have been providing information about the spread of the virus and how it has affected different areas of the country.

Since the vaccination has been started, it is important that this phase should be handled smartly and effectively and a system which can be a good helping tool for the general masses

and the medical teams can come in handy.

As we already know that currently, there are various variants of the COVID-19 virus, it is essential that the vaccination process should be carried out effectively and smartly in order to reduce the possible damage which can be caused due to the new variants of the virus.

2.3 Proposed System

The system that we have proposed is an android application that provides updated information about the vaccinations and the vaccines inside Pakistan. The application will be showing updated information about every vaccine individually including its success rates, impacts on the individuals of every age group and public opinion about the vaccine and its acceptability rate.

This information can be of great use for not just the general public but also for the vaccination centers which, currently, lack all this information. The current information that they have is about the general overall impacts of every vaccine on every age group but were they provided with detailed analysis, vaccination process can be made much more effective and the side effects on the masses could be reduced to a great extent. We believe that with COVAC, we can provide a solution to this challenge. Moreover, COVAC will also help the person, who wants to be vaccinated, choose a vaccine according to his age and certain medical information. This process has been commenced in the European Union although they don't use a mobile or any application for it, rather a pen and a paper. Forms are filled out and the vaccine is provided according to the information entered in the form. Here, we can improve this process using a mobile application and make it more useful and effective for the general public.

Through Machine Learning techniques, COVAC is aimed at providing the best results and analysis of the vaccines and the people getting vaccinated. In due time, if it gets accepted across the country, it can also be exported and enhanced to incorporate the impacts of the vaccines in other countries as well wherever COVAC is used, not only ensuring a smart vaccination process in Pakistan but in the whole region in our neighborhood as well.

Chapter 3

Requirements Specification

3.1 Application Perspective

In this application, every user will be divided into a doctor and a civilian. The doctors and the civilians will be given their unique ids with which they will have their accounts and information stored including the post-vaccination impacts which will be recorded through a survey which will be conducted for 3 days after the vaccine has been provided. Both, the doctors and the civilians will be able to view the impacts and information about every vaccine.

3.2 Functional Requirements

The functional requirements of our project are as follows:

- **Vaccine Information:** The complete information about every available vaccine in Pakistan should be available in the application. The information will include the success rate of the application, the aftereffects of the vaccination on different age groups and the public opinion about the particular vaccine.
- **Vaccine Recommendation:** The application will be designed in a way so that it cannot only be used to view information about the vaccines but also help the person in choosing a vaccine, which the application will do for the user based on his age group and medical information.
- **Appointment:** Once the vaccine has been chosen by the person, recommended by the application, the next thing the application will do is ask the user if he wants an appointment made in the nearest vaccination center, and based on the person's ID given to him by the application, the appointment will be made and a time and a digital receipt will be issued to the person.
- **Feedback:** The next step after the vaccination will be asking the user for his feedback regarding the post-vaccination condition. It will be done through a survey form which will be taken for 2-3 days after the vaccination has been done. The feedback will be used to update the database and update the information about the vaccines and their impacts.

3.3 Non-functional requirements

The non-functional requirements for our project are:

- **Availability**
The system is online and provides maximum availability to users.
- **Efficiency** The system should be efficient and perform all required user tasks
- **Usability**
The system should provide and user-friendly interface which will allow all the user to interact with the system even if they just basic knowledge of using a smart phone
- **Reliability**
The system should be reliable
- **Adaptability**
The system should be complete customizable which will allow the user to customize the application according to their preferences
- **Security**
The information of the users such as Email, Name and Passwords should not be compromised hence our system will provide a secure gateway for users to interact with the system.

3.4 Use Case Diagrams

Use case diagrams describe the work flow of the system. In these diagrams below, each segment of the application has been explained separately through the use case diagrams:

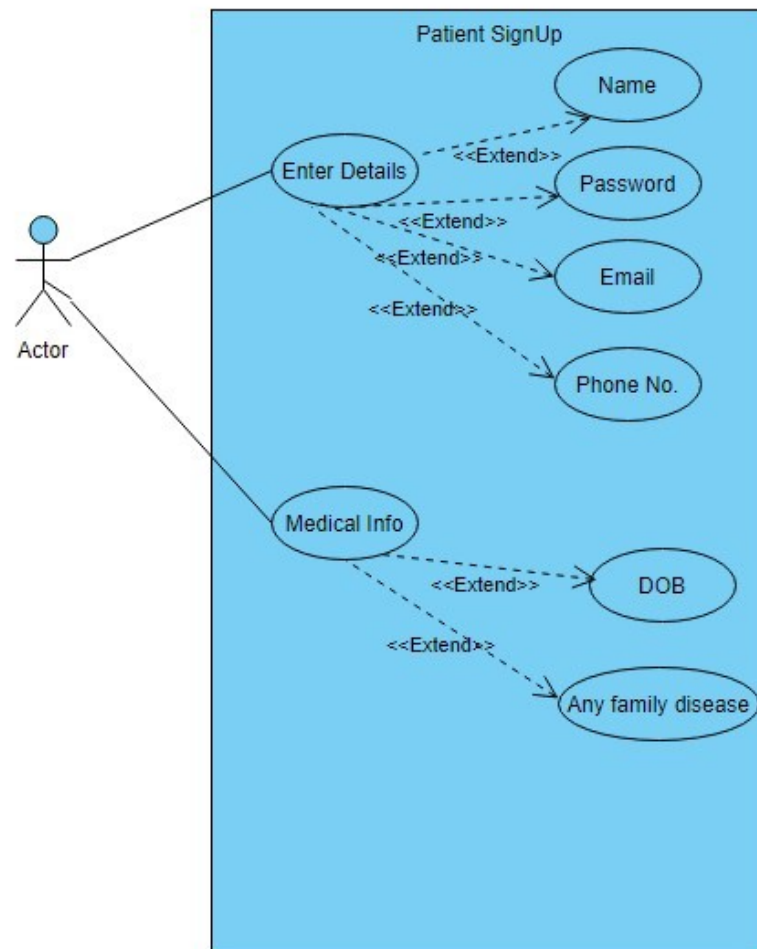


Figure 3.1: Patient Sign Up Use case

In the above figure 3.1, the sign up of the patient has been shown in which the user will be entering his general details including a name, email and a phone no. The user will be asked for some medical information as well, after the entrance of which the user will be asked to set a password and the patient's account will be created.

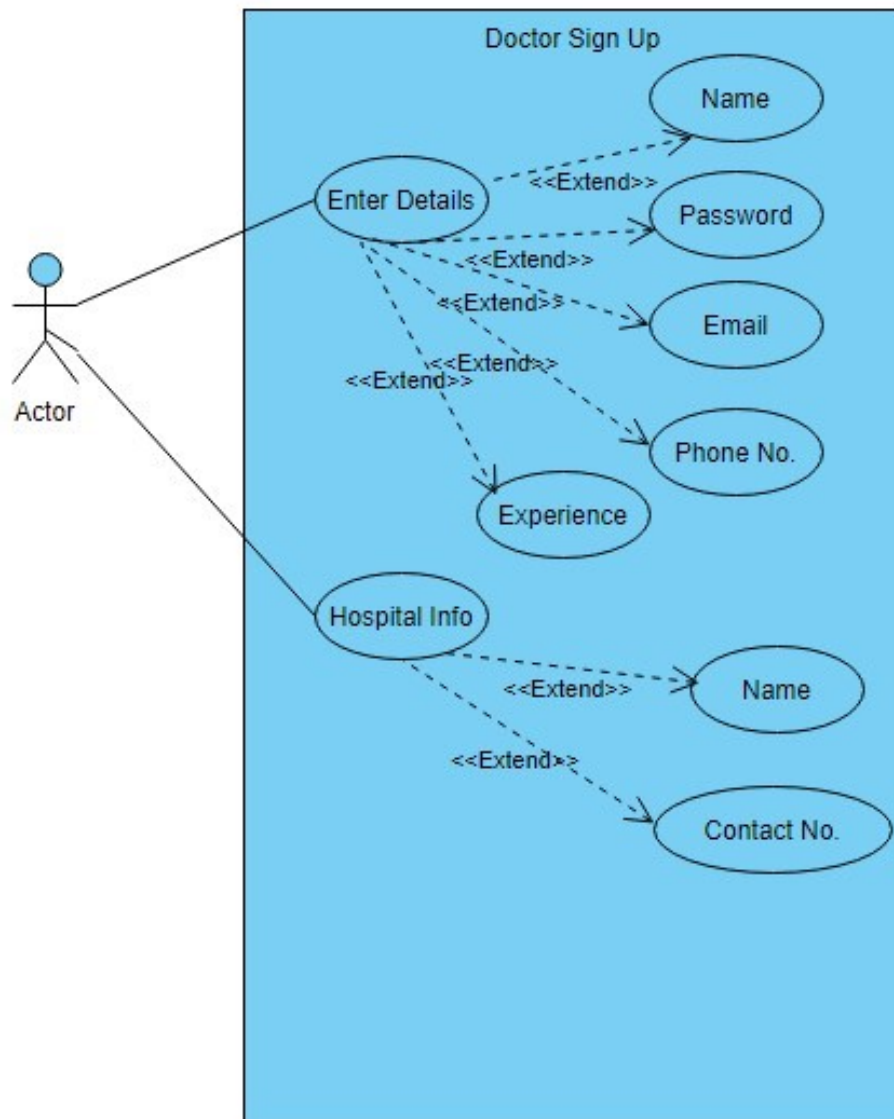


Figure 3.2: Doctor Sign Up Use case

In the above figure 3.2, we cover the second module of COVAC which is the Doctor's Signup case. Just like the patient's sign-up case, the doctor will be required to enter his details i.e., name, email, contact no., and work experience, followed by the name of clinic/hospital information where the doctor works. After all this information has been entered, the doctor will be required to enter the password and will be registered into COVAC.

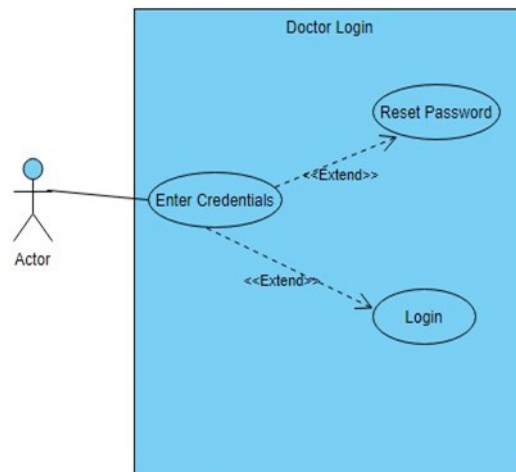


Figure 3.3: Doctor Login Use case

Above figure 3.3 shows the Login use case for the doctor. The credentials of the registered doctors will be stored in the firebase connected to the application. After entering the email or mobile no. and password, the entered info will be matched by the pre-existing one in the firebase and if correct, the doctor will be logged into the application. In case the doctor has forgotten his password, he will be able to reset the password by clicking on the reset password option. He will be required to enter the code which will be sent to him via email or SMS, and through that the password can be reset.

Figure 3.4 shows the patient Login use case. Identical to the doctor's Login use case, the

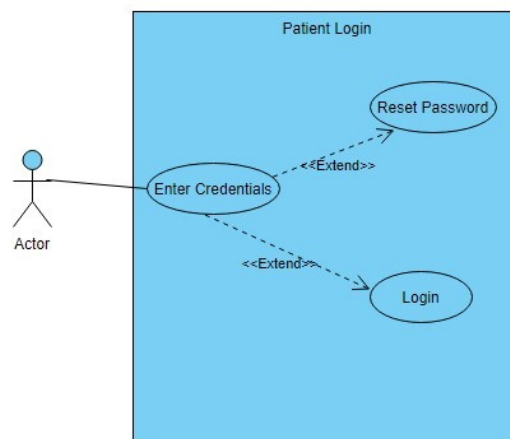


Figure 3.4: Patient Login Use case

patient Login use case also shows that the patient will be required to enter his email/phone no. and password in order to login to the application. The provided information will be matched with the pre-existent information in the firebase database and in case of correct information entered, the patient will be logged into the application. In case the patient is not able to enter the correct password or has forgotten his password, he will have the option to reset his password which will work just like it does in the doctor's use case. The patient will be provided with a code via email or SMS and through entering the code in

the application, the patient will be able to create a new password. Figure 3.5 shows the

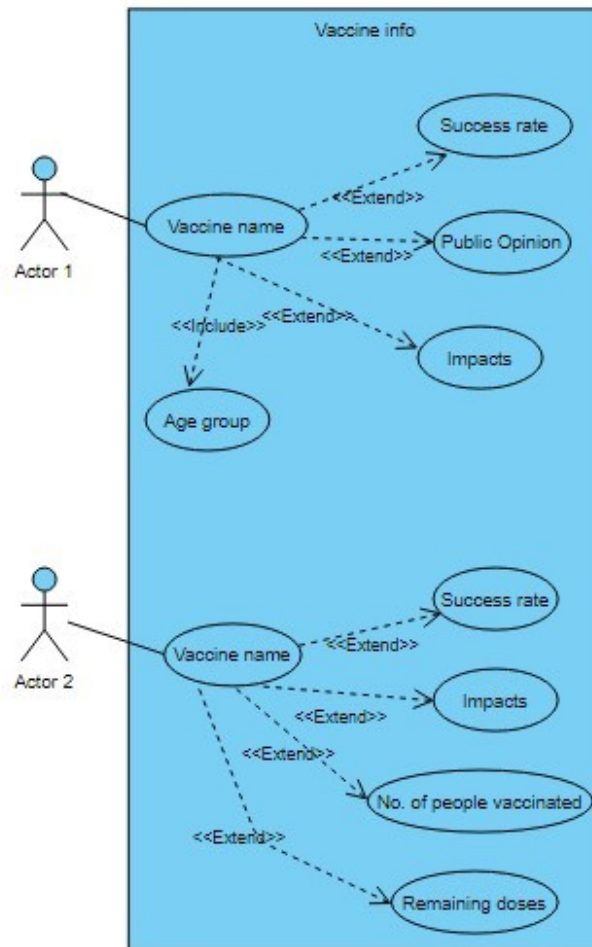


Figure 3.5: Vaccine Information Viewing Use case

vaccine information viewing use case in which there are two actors i.e., the patient and the doctor respectively, since they both will be needing the information viewing of the vaccines. The information viewed about the vaccines will be same to both, however, the provided options will be different. The patient will be able to view the vaccines and their impacts on the different age groups along with the public's opinion on them. The doctor will be able to view the impacts of the vaccines, their success rates on different age groups, amount of people that have been provided with that particular vaccine and the remaining doses of that particular vaccine.

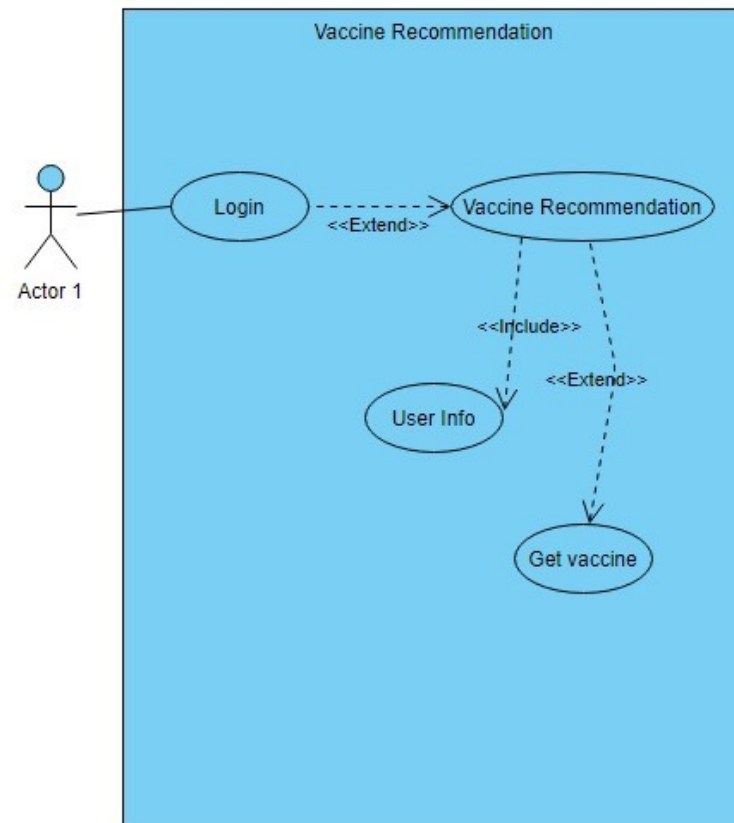


Figure 3.6: Vaccine Recommendation Viewing Use case

The vaccine recommendation use case is meant for the patients. In this use case, as shown the figure 3.6, the user will be required to login to his account and select the Vaccine recommendation option. The system, through the user's entered information during the sign-up will use the data and recommend a vaccine through the machine learning algorithm built into COVAC. After the vaccine has been recommended, the user can proceed by selecting the Get Vaccine option and make an appointment.

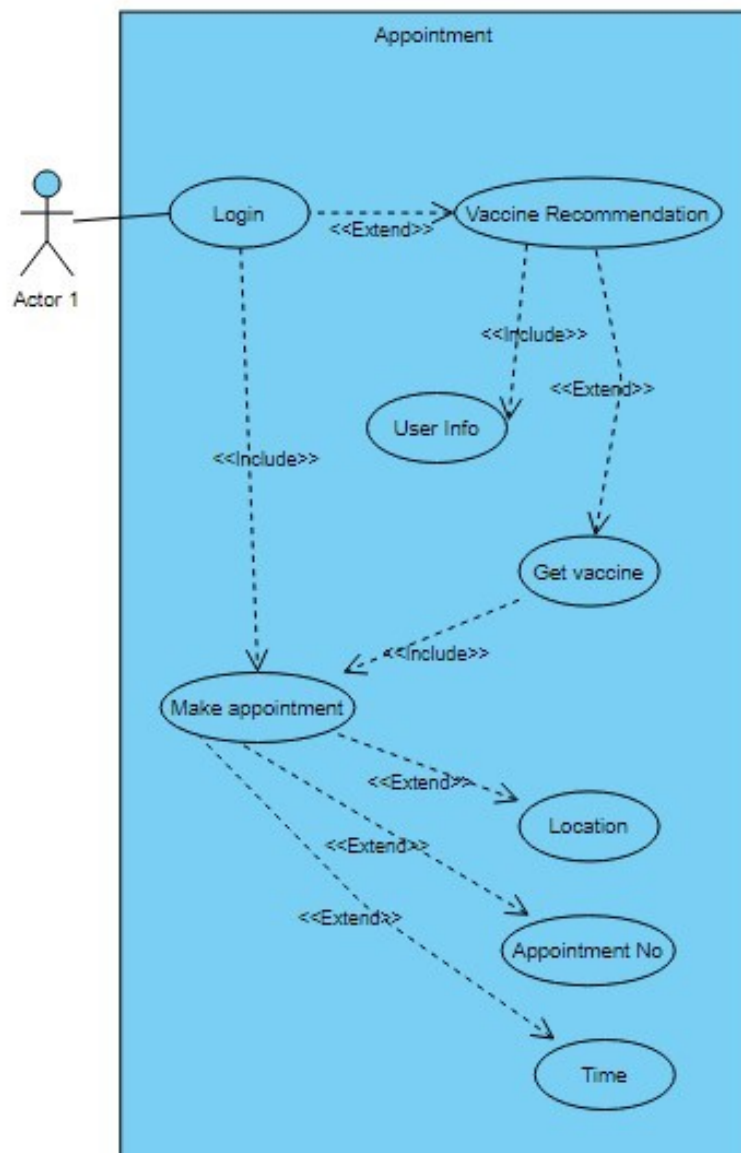


Figure 3.7: Appointment Use Case

After the vaccine has been recommended to the user, the next use case will be as shown in the figure 3.7 where the user has to make an appointment to get the vaccine. In order for that, the user will have to login to his account, get the vaccine recommendation and then proceed through “Get Vaccine” and click on the “make appointment” option. If already logged in, all the user needs to do is to click on the make appointment option and the system will make the appointment for the user in the nearby vaccination center. The user will be provided with the Time, location and the appointment number for the vaccination.

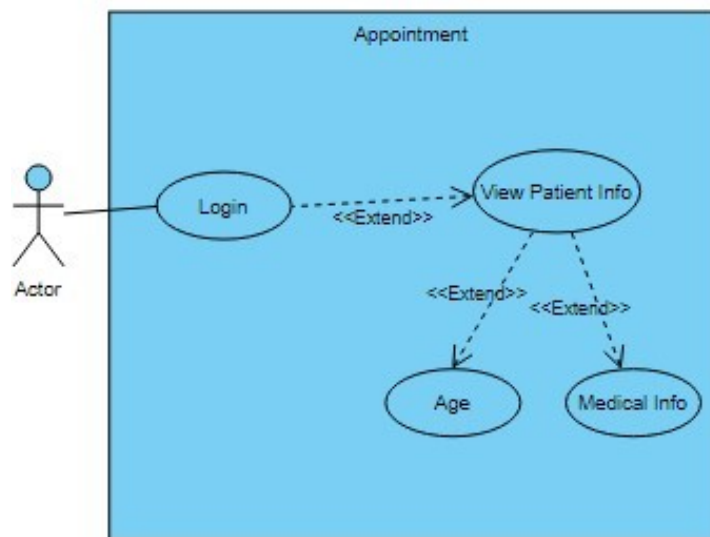


Figure 3.8: Vaccination Use Case

In the above figure 3.8, the vaccination process' use case has been shown. This is meant for the doctor who will be providing the vaccine to the patient who made the appointment through COVAC. The doctor will be required to login to COVAC and will be provided with the option of viewing the patient's information (personal and medical). After the patient's information has been confirmed by the doctor, the vaccination dose will be given to the patient.

3.5 Use Case Description

This table 3.1 describes the complete use case of the patient's signing up into the application.

Table 3.1: Patient Sign Up Use Case description

Use Case 1	Patient Sign up
Actor	New Patient
Description	A new patient has installed the application onto his mobile phone and now wants to create an account on the application to benefit from it. The signup method will be used by the new patient to make an account and a profile which will store his information and provide him an ID.
Pre-Condition	The application must be installed on the mobile phone
Post Condition	Patient has successfully registered and now continues to use the application
Basic Flow	First enter the personal details, and then enter the medical information required.
Data	Name, email, phone number, DOB, medical information, any history of family disease.
Stimulus	Click on the Sign-Up button
Response	The patient is navigated to the dashboard of the application
Comments	Patient is registered in the application.

Table 3.2: Doctor Sign Up Use Case Description

Use Case 2	Doctor Sign up
Actor	New Doctor
Description	A new doctor has installed the application and now will be registered in the application through the sign-up method which will provide the doctor with a profile and an ID.
Pre-Condition	The application must be installed on the gadget
Post Condition	Doctor has successfully registered with the application the application
Basic Flow	Enter personal details, work experience and the information of the clinic/hospital
Data	Name, email, contact number, experience, hospital name, hospital contact number.
Stimulus	Click on the Sign-Up button
Response	The doctor is navigated to the dashboard of the application
Comments	Doctor is registered in the application successfully.

This table 3.2 describes the complete use case of the doctor's signing up into the application.

Table 3.3: Doctor Login Use Case Description

Use Case 3	Doctor Login
Actor	Doctor
Description	Doctor will be logging into his account.
Pre-Condition	The doctor must be registered
Post Condition	The doctor will be navigated to the application dashboard
Basic Flow	Enter the ID/CNIC along with the password
Data	Doctor ID, Password
Stimulus	Click on the Login button
Response	The doctor is navigated to the dashboard of the application
Comments	The doctor has logged into his profile.

This table describes the complete use case of the doctor logging into the application. The pre-condition is the main goal to be achieved in this use case and post condition is the functioning after the goal has been achieved. This table ?? describes the use case of the

Table 3.4: Patient Login Use Case Description

Use Case 4	Patient Login
Actor	Patient
Description	The patient will be logging into his account
Pre-Condition	The patient must be registered with the application
Post Condition	The patient will be navigated to the dashboard
Basic Flow	Enter Patient ID/CNIC and password
Data	Patient ID, Password
Stimulus	Click on the Login button
Response	The patient is navigated to the dashboard of the application
Comments	The patient has logged into his profile.

patient logging into the application. The main goal of this case is the patient logging into the application and being taken to the home page after being logged in

Table 3.5: Vaccine Information Use Case Description

Use Case 5	Vaccine Information
Actor	Doctor, Patient
Description	The doctor and the patient (users in general) will be viewing the information about the vaccines
Pre-Condition	Both users must be logged into their accounts, have an internet connection
Post Condition	The users will be able to view the complete information about the vaccines
Basic Flow	Log in to the account, view vaccine information
Data	Patient/Doctor ID, Login details, vaccine name
Stimulus	Click on the View details button
Response	The users will be able to see the complete details about the specific vaccine that they have selected
Comments	The users will view the vaccine information.

This table 3.5 shows the use case of the viewing of vaccine information. The main goal of this use case is that the users must be able to view the information about the vaccines but in order for it to be so, they must be logged into the application. This table 3.6 shows

Table 3.6: Vaccine Recommendation Use Case Description

Use Case 6	Vaccine Recommendation
Actor	Patient
Description	The application will help the patient in choosing a suitable vaccine based on the user's provided medical information
Pre-Condition	The user must be registered and logged in.
Post Condition	The user will be able to view the vaccine that the system has chosen and proceed to making an appointment
Basic Flow	Enter medical details, if already entered, click on the Recommend vaccine button
Data	Patient information
Stimulus	Click on the Get recommendation button
Response	The patient will be recommended a vaccine suitable according to his age and other medical factors.
Comments	Patient's work will be made easy by the recommendation process.

the use case of the Recommendation system inside COVAC. The main goal of this use case is that a suitable vaccine should be recommended to the user. However, the user is required to be logged in and should have provided his medical information in order for this use case to complete.

This table 3.7 shows the use case of the appointment phase once the vaccine has been recommended. The main goal of this use case is that an appointment of the user should be made and a receipt should be provided to the user for confirmation. This table 3.8 shows the use case of post-appointment phase when the user has gone to get the vaccine. This use case will be checked for the doctors and the main goal of this is that the patient should be vaccinated and the provided information through the application should be correct.

Table 3.7: Appointment Use Case Description

Use Case 7	Appointment
Actor	Patient
Description	After getting a recommendation, the user will be asked if he wants an appointment. If agreed, an appointment will be made on behalf of the patient in the nearest vaccination center.
Pre-Condition	The user must be logged in, a vaccine must be recommended by the application.
Post Condition	An appointment will be made and a receipt will be printed for the patient
Basic Flow	Enter medical information, get recommendation according to the information, make an appointment, save the receipt
Data	Patient Information, Patient location
Stimulus	Click on the Make Appointment button
Response	An appointment will be made on behalf of the patient in the nearest vaccination center
Comments	An appointment will be made automatically which will save the patient from the trouble of finding a vaccination center and then getting an appointment and waiting for it.

Table 3.8: Vaccination Use Case Description

Use Case 8	Vaccination
Actor	Patient
Description	After the appointment, the user has arrived at the vaccination center and now his information will be checked before giving him the vaccine
Pre-Condition	The patient must have made an appointment
Post Condition	The patient will be vaccinated
Basic Flow	Patient receipt will be checked for appointment, patient information will be checked for verification
Data	Patient medical information
Stimulus	Click on Confirm patient arrival and provide the dose
Response	The user will be vaccinated and will be asked to fill out the post- vaccination symptoms through a survey that the application will be providing for 2 days after being vaccinated
Comments	The patient has been vaccinated.

Chapter 4

Design

4.1 System Architecture

The architecture that we are using for this project is Two-tier architecture. In 2-tier architecture, there are two layers involved namely

- Presentation Layer
- Data Layer

In this architecture, the user directly communicates with the system through the database and the database management services are also done through a server. The user resides on the first tier and the database and web server reside on the second tier.

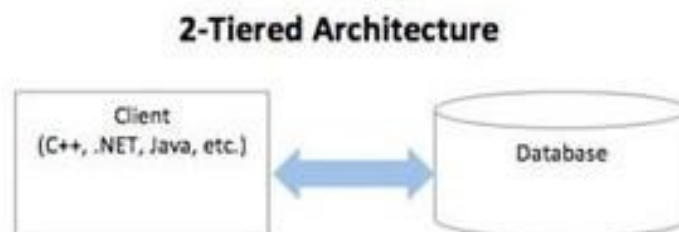


Figure 4.1: Tiered Architecture

4.2 Current Issue

As mentioned previously, there are a few COVID related vaccinations and the government of Pakistan has also made a toll-free number for vaccine booking, however, there is no application specifically regarding the vaccines and their analysis, after effects, success rates etc., which is a concern for many of the people who haven't received the vaccine yet. Moreover, this application will allow the users to make an appointment at the nearest vaccination center which will save them a lot of time.

An issue that we may face is the data collection and validity of the collected data. There are many available datasets and to distinguish the valid ones from the invalid ones seems to be a barrier but with confirmation from various sources, this barrier will be removed in no time.

4.3 Design Methodology

The design methodology that we have implemented is the Prototyping method. Through this methodology, a prototype of the project will be created first and then tested. The tested prototype will be reworked as per the requirement until an acceptable model is designed through which the final outcome can be achieved. There are a few stages involved in this methodology.

- Essentials gathering stage
- Smart design stage
- Model manufacturing stage
- Customer appraisal stage
- Model Refinement stage

This methodology will ensure the proper working of the project as proposed and will maximize positive and favorable results for the target market.

4.4 Data Flow Diagram

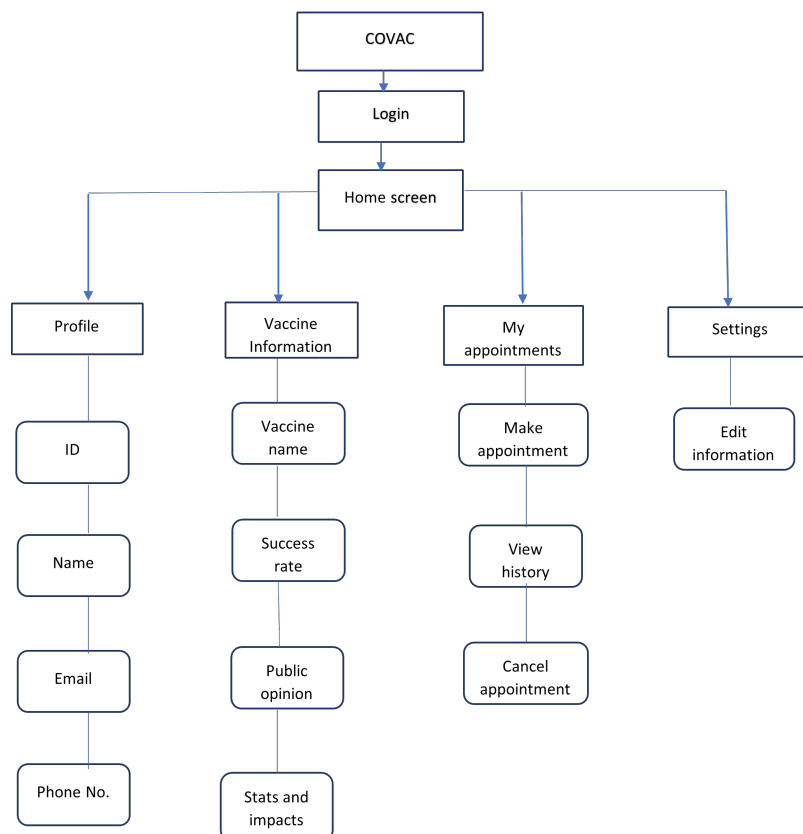


Figure 4.2: Flow Diagram

Figure 4.2 shows the general flow of the application. The 5 options that will be available for the users and the functions within them have been shown in the figure.

4.5 Activity Diagram

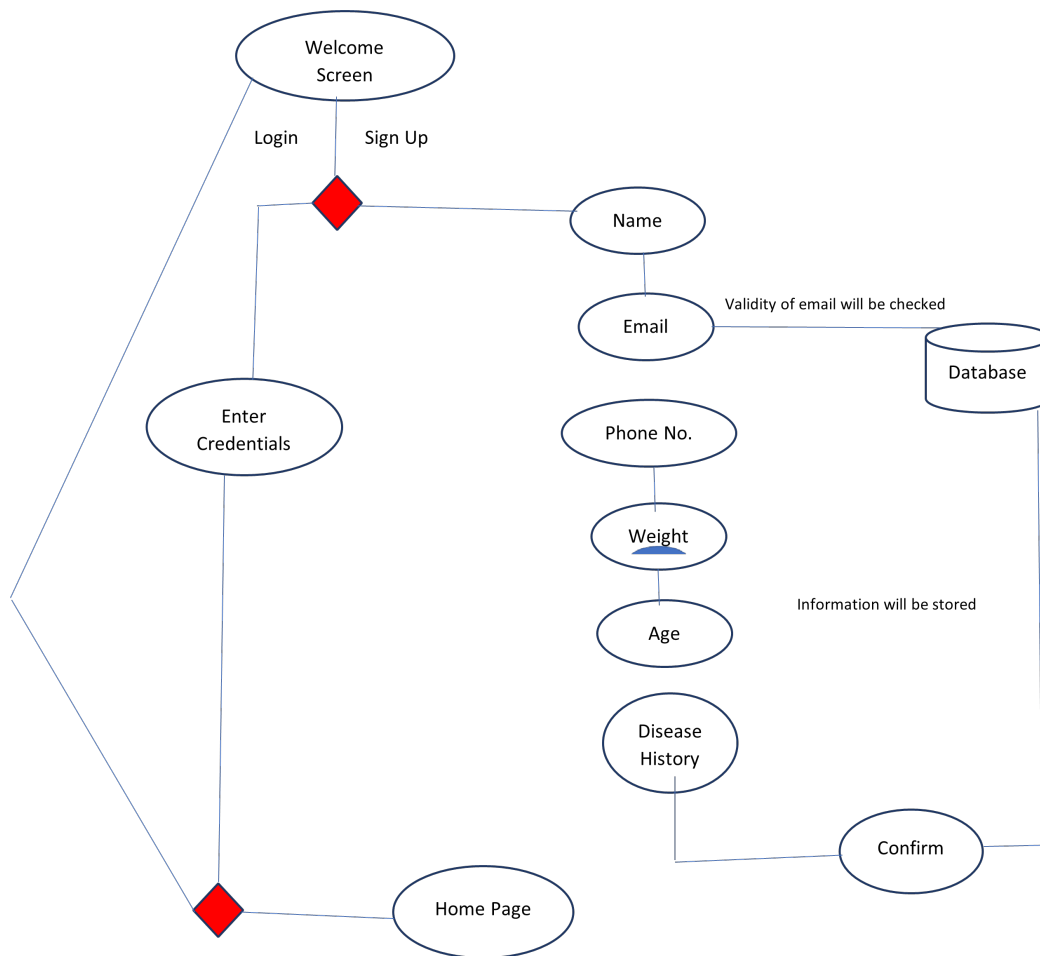


Figure 4.3: Login or Signup Activity Diagram

Figure 4.3 shows the login/signup activity of the COVAC. In case of Sign-up, the user will be required to enter his credentials which will be stored in the database. After they have been entered and saved, the user will be directed to the home page of the application. In case of Login, the user will be required to enter his credentials which will be checked in the database and after confirmation, the user will be taken to the home page of the application.

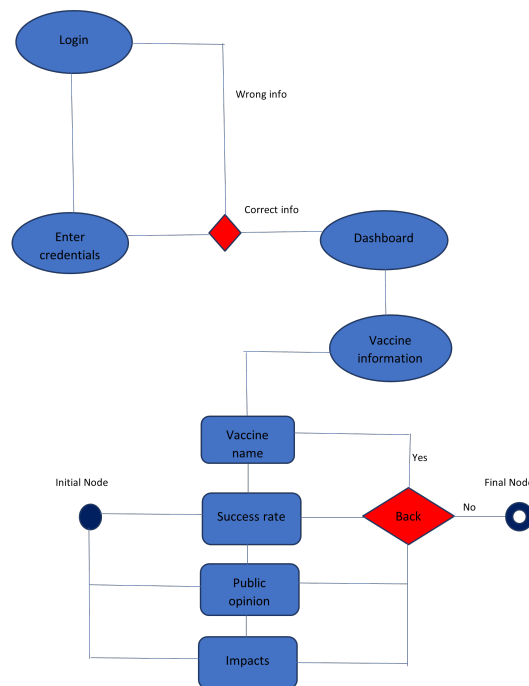


Figure 4.4: Vaccine Information Viewing Activity Diagram

Figure 4.4 shows the information viewing of the application. The user will be required to login to the application and then can view the information by selecting the vaccine information option. The information will be viewed by vaccine name, its success rate and impacts.

Figure 4.5 shows the vaccine recommendation and appointment system of the application.

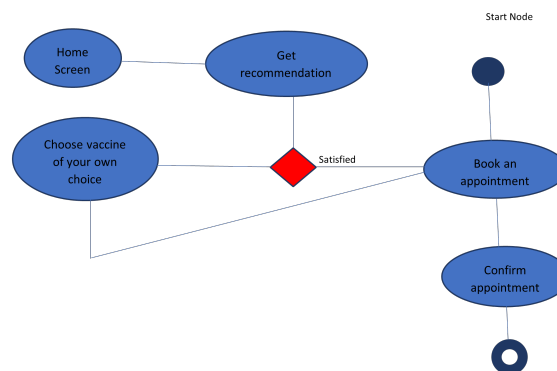


Figure 4.5: Vaccine Recommendation and Appointment Activity Diagram

The user will be required to login to the application and go to the recommendation option. If the user is satisfied with the system's choice, he can proceed to getting the appointment otherwise the user will also have the option of choosing the vaccine of his own choice and then proceed to making the appointment. After getting the appointment, the user will receive a confirmation message showing that the appointment has been made.

4.6 Sequence Diagram

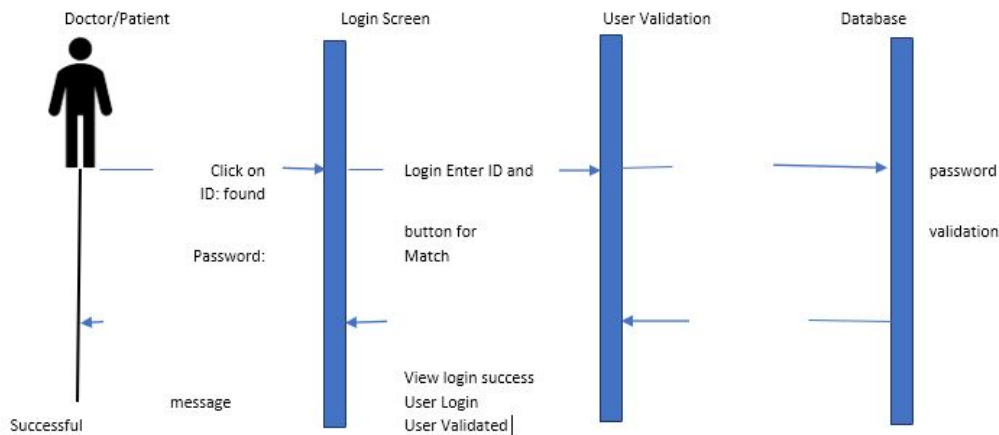


Figure 4.6: User Login Sequence Diagram

Sequence diagrams explain the sequential working of the system. Figure 4.6 shows the sequence of logging into the application. The user will enter his ID and password after clicking on the login button, the entered information will be checked in the database and then when validated, the user login successful message will be displayed to the user and he will be taken to the home page of COVAC.

The above diagram 4.7 shows the sequential working of the system after the user has made

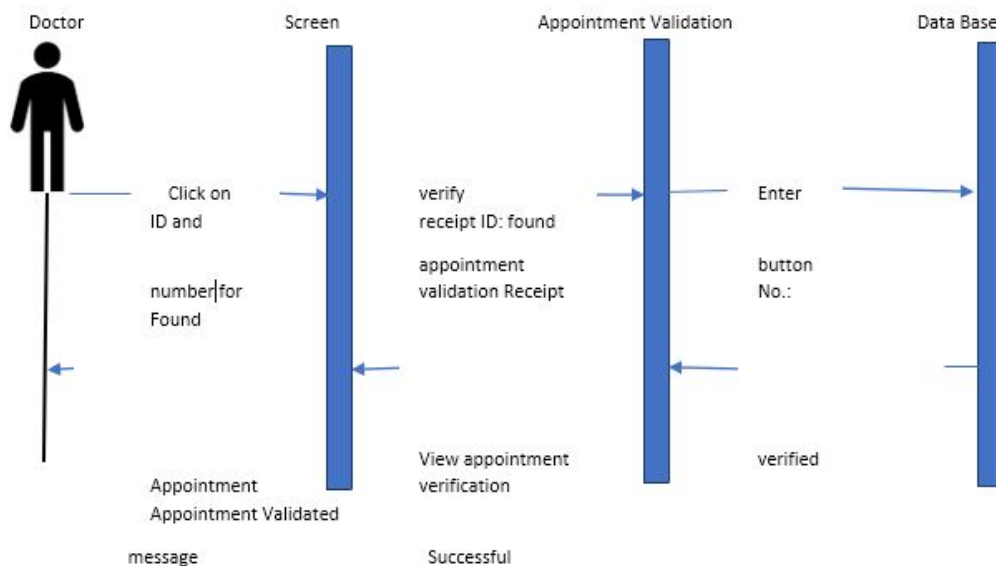


Figure 4.7: Appointment Verification Sequence Diagram

the appointment and now it needs to be verified. The user will be required to enter his ID and receipt number which will be checked in the database of the system. Once validated, the appointment's verification message will be displayed on the output screen for the user.

4.7 GUI Design



Figure 4.8: Home Page

The home page of the application through which the user will be able to navigate across the application and see the latest news, get vaccine recommendation and be able to make an appointment.

The below figure 4.9 shows the sign-up screen where the system will ask the user to enter the information which will be required to create an account to keep the data safe and ask for user's medical information in order to make COVAC useful for the user. The information will be stored in the firebase database connected to the application.

The figure 4.10 shows the Sign in page for COVAC. The user will be required to enter his email and the password with which he signed up into the application. The credentials entered by the user will be checked in the database and after their confirmation, the user will be logged into the application.

The figure 4.11 shows the vaccine recommendation system in COVAC. The application will be using the user's information provided during the sign-up phase and by using machine learning algorithm, it will recommend the most suitable vaccine to the user according to his provided medical information.

The image displays two side-by-side mobile application screens. The left screen, titled "Sign Up", features a dark blue gradient background. At the top, it says "Sign Up" in a white, stylized font. Below this is a black box with the text "Enter Your Credentials". The form includes two input fields: "Enter Email" and "Enter Password". A blue rounded button labeled "SIGN UP" is positioned below the fields. At the bottom, there is a link that says "Already Have Account? Sign In!". The right screen, titled "Medical Info", also has a dark blue gradient background. It features a series of input fields: "Enter Username", "Enter Email", "Enter Phone#", "Your Age", "Heart Condition?", "Blood Pressure", "Blood Sugar", and "Any Previous Disease?". A blue rounded button labeled "SUBMIT" is located at the bottom of the form. Both screens show a status bar at the top with the time, battery level, and network signal.

Figure 4.9: Sign-Up and Medical Info



Figure 4.10: Sign-In Page



Figure 4.11: Vaccine Recommendation

4.8 Class Diagram for Project

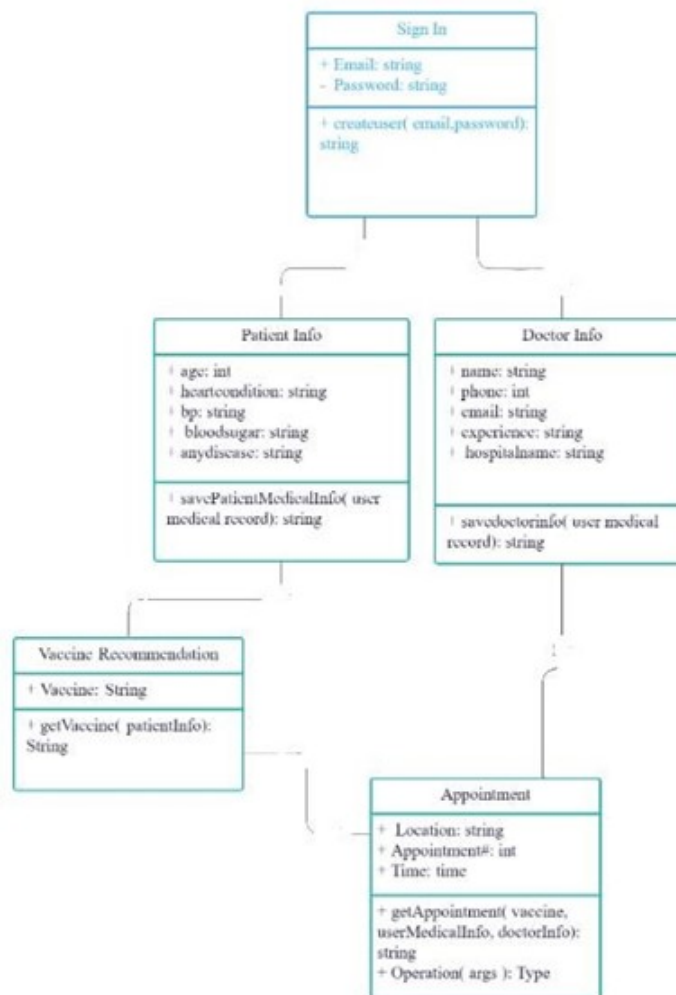


Figure 4.12: Class Diagram

Class diagram describes the relation between different classes of the project. The figure 4.12 shows the relation between different modules and classes of COVAC. As we can see, the Sign in/Sign up is related to the profiles of patient and the doctor. The patient's profile is connected to the vaccine recommendation class, which will be using information of the patient through the Patient's info class. Similarly, Doctor's info is related to the appointment class which will be using the doctor's info such as his name and the name of hospital for the appointment. The appointment class is also related to the Vaccine recommendation class as it will receive the patient's information and the selected vaccine from the vaccine recommendation class.

Chapter 5

System Implementation

In the implementation stage, we take into consideration the requirements and the design stage and apply the design. It is during this stage that the calculations are completed and the desired system is commenced.

We will be using Java for the implementation of the desired system since the desired system is to be implemented on the android and majority of the systems in android are written in this language. This stage will be started after making sure that there are no errors in the designing and testing of the system which we have performed previously and if there are any, will be identified and corrected accordingly.

5.1 Tools and Technology

For the application itself and the database, we will be requiring the following:

- Database: Firebase
- Android Studio
- Machine Learning

5.2 Deployment Structure

The fundamental thought is that the application will be kept on the network layer and the interface between the network and the server layers will remain consistent.

5.2.1 Components

Following will be the components of the system:

- User/Client
- Server
- Network

5.2.2 Advantages

The main advantage of the client-server system is that the data will be stored on the server and thus, thus client devices such as mobile phones, computers or tablets will not be required to store the large amount of information or data.

5.2.3 Disadvantages

One disadvantage of the system is that all the information is stored at a single location therefore if the system is offline, the information cannot be accessed.

5.2.4 Deployment Design Diagram

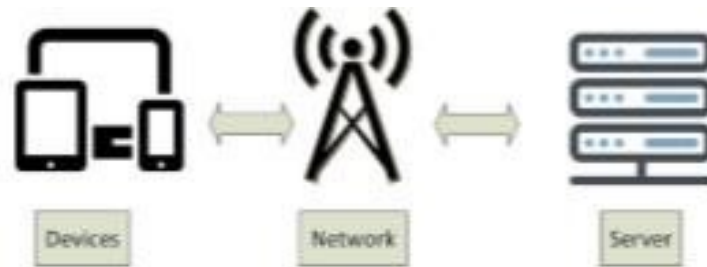


Figure 5.1: Deployment Design

The above figure shows the deployment design that we are implementing in COVAC. The device on which the application will be running will be connected to the server via network. All the information will be stored on the server which will make sure that there are no storage issues for the users and that they don't have to store a lot of data.

Chapter 6

System Testing and Evaluation

6.1 Introduction

Testing is a very vital step in the Software Development Life Cycle. All the segments of the application are tested individually and collectively in order to make sure that the application being designed works perfectly as per the proposed idea.

In order to achieve that, we shall begin with the framework testing in which specific conditions are being programmed and tested to make sure that the application works exactly as required by the users or in our case, what we initially proposed. In framework testing, the programming is also being tested and assessed according to the user's needs and requirements. Framework testing can also provide an objective and allow the stakeholders to recognize the risks being involved in the use of programming.

Testing strategies not only consolidate the path towards verifying the program execution or detecting and eradicating bugs inside the application or possible syntax errors, but they are also designed to make sure that the programming techniques being used are consistent and efficient, and do not waste more user resources like time and space and provide the results that were being defined in the initial proposal.

During this phase, Error Detection happens to be the most important step. Our basic goal is to find whether the program segments work at odd times i.e., a segment working when it should not be working or a segment not working when it should be working. There are two important aspects in the Error Detection phase:

1. Endorsement
2. Affirmation

Endorsement focuses on the precision of the system. It basically checks whether the provided information is actually what the user has required or what we have proposed or not.

Affirmation provides the answer to the endorsements. It provides the confirmation that the path we have taken will take us to our goal and provide the user with what he has demanded.

Both these aspects are very vital points in the error detection phase inside this chapter, however they both are separate processes.

6.2 Reasons behind testing

Following are the main reasons behind the need for testing phase:

1. The first main reason behind the testing phase is that we need to make sure that the implemented system is according to the desires of the customers or in this case, fits the needs as proposed.
2. It is important to eradicate any limitations and constraints in the project in due time before it is launched in order to avoid dissatisfaction of the stakeholders.
3. Testing will ensure the best outcome and results.

6.3 Test Cases

Table 6.1: Patient Sign Up Test Case

Test Case 1	Sign up
Actor	New Patient
Description	A new patient has installed the application onto his mobile phone and now wants to create an account on the application to benefit from it. The signup method will be used by the new patient to make an account and a profile which will store his information and provide him an ID.
Pre-Condition	The application must be installed on the mobile phone
Post Condition	Patient has successfully registered and now continues to use the application
Basic Flow	First enter the personal details, and then enter the medical information required.
Data	Name, email, phone number, DOB, medical information, any history of family disease.
Stimulus	Click on the Sign-Up button
Response	The patient is navigated to the dashboard of the application
Comments	Patient is registered in the application.
Results	Patient is signed up into the application.
Status	Pass

Table 6.2: Doctor Sign Up Test Case

Test Case 2	Doctor Sign Up
Actor	New Doctor
Description	A new doctor has installed the application and now will be registered in the application through the sign-up method which will provide the doctor with a profile and an ID
Pre-Condition	The application must be installed on the gadget
Post Condition	Doctor has successfully registered with the application
Basic Flow	Enter personal details, work experience and the information of the clinic/hospital
Data	Name, email, contact number, experience, hospital name, hospital contact number.
Stimulus	Click on the Sign-Up button
Response	The doctor is navigated to the dashboard of the application
Comments	Doctor is registered in the application successfully.
Results	Doctor is signed up into the application
Status	Pass

Table 6.3: Doctor Login Test Case

Test Case 3	Doctor Login
Actor	Doctor
Description	The doctor will be logging into his account
Pre-Condition	The doctor must be registered
Post Condition	The doctor will be navigated to the application dashboard
Basic Flow	Enter the ID/CNIC along with the password
Data	Doctor ID, Password
Stimulus	Click on the Login button
Response	The doctor is navigated to the dashboard of the application
Comments	The doctor has logged into his profile
Results	Doctor has been logged into his profile on the application
Status	Pass

Table 6.4: Patient Login Test Case

Test Case 4	Patient Login
Actor	Patient
Description	The patient will be logging into his account
Pre-Condition	The patient must be registered
Post Condition	The patient will be navigated to the application dashboard
Basic Flow	Enter Patient ID/CNIC and password
Data	Patient ID, Password
Stimulus	Click on the Login button
Response	The patient is navigated to the dashboard of the application
Comments	The patient has logged into his profile
Results	Patient has been logged into his profile on the application
Status	Pass

Table 6.5: Vaccine Information Test Case

Test Case 5	vaccine Information
Actor	Doctor, Patient
Description	The doctor and the patient (users in general) will be viewing the information about the vaccines
Pre-Condition	Both users must be logged into their accounts, have an internet connection
Post Condition	The users will be able to view the complete information about the vaccines
Basic Flow	Log in to the account, view vaccine information
Data	Patient/Doctor ID, Login details, vaccine name
Stimulus	Click on the View details button
Response	The users will be able to see the complete details about the specific vaccine that they have selected
Comments	The users will view the vaccine information.
Results	Information of the vaccines is displayed
Status	Pass

Table 6.6: Vaccine Recommendation Test Case

Test Case 6	vaccine Recommendation
Actor	Patient
Description	The application will help the patient in choosing a suitable vaccine based on the user's provided medical information
Pre-Condition	The user must be registered and logged in.
Post Condition	The user will be able to view the vaccine that the system has chosen and proceed to making an appointment
Basic Flow	Enter medical details, if already entered, click on the Recommend vaccine button
Data	Patient information
Stimulus	Click on the Get recommendation button
Response	The patient will be recommended a vaccine suitable according to his age and other medical factors.
Comments	Patient's work will be made easy by the recommendation process.
Results	A suitable vaccine is recommended to the user according to the provided information
Status	Pass

6.4 GUI Testing

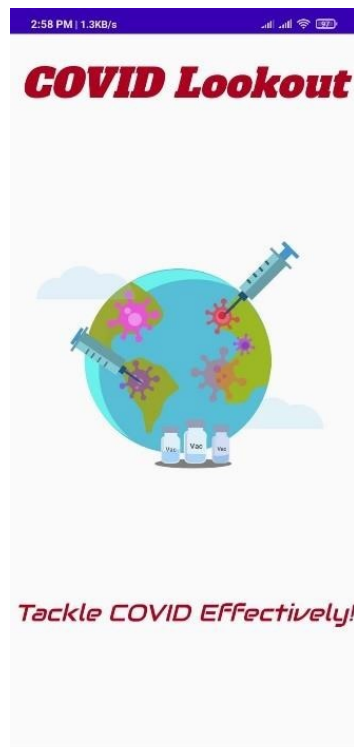


Figure 6.1: Splash Screen

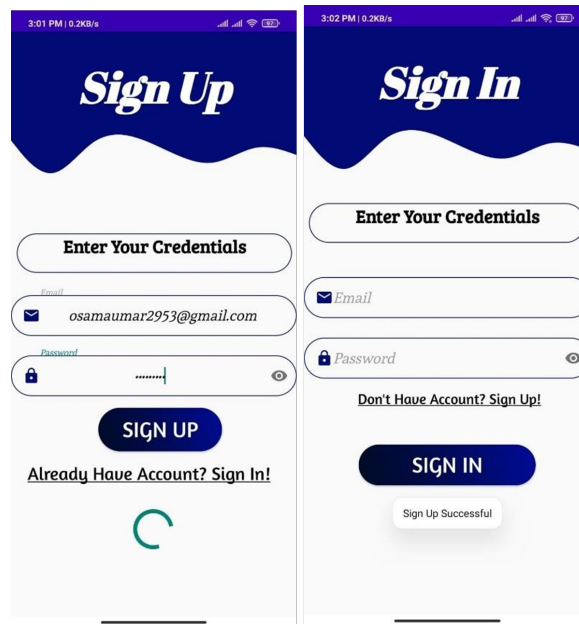


Figure 6.2: Sign Up Screen

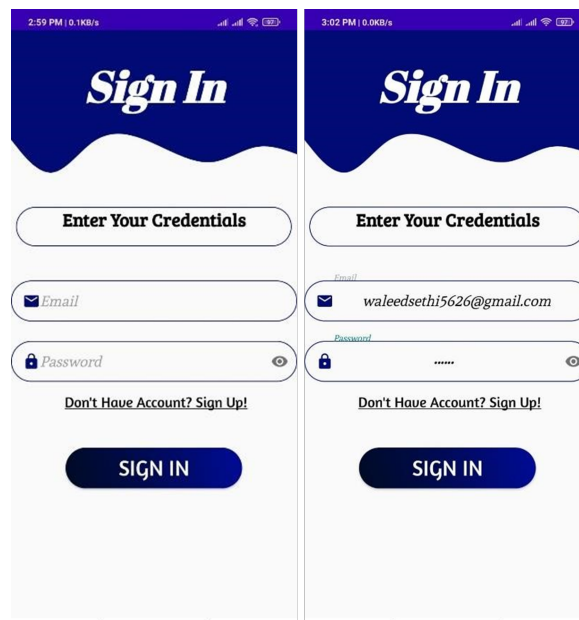


Figure 6.3: Sign-In Screen

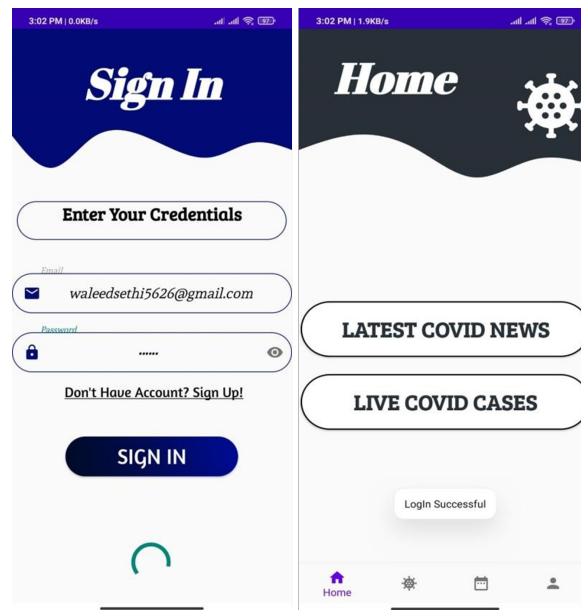


Figure 6.4: Home Layout

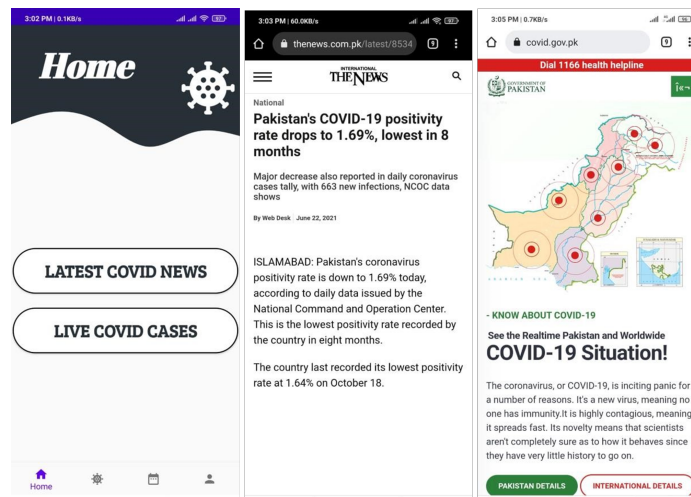


Figure 6.5: COVID NEWS

10:27 PM | 0.2KB/s

Medical Info

Name

Email

Phone

Age

Gender

Allergy

SUBMIT

Recommendation

Figure 6.6: Medical Info

3:25 PM | 1.4KB/s

COVID-19

EDIT MEDICAL INFO

VACCINE INFORMATION

VACCINE RECOMMENDER

Recommendation

3:07 PM | 0.6KB/s

ncoc.gov.pk/covid-vaccinatic

NCOC
Government of Pakistan

COVID
VACCINATION

Vaccine statistics

* Last updated: 05 Nov, 2021 - 09:49am
Islamabad/Pakistan

First Dose
73,315,751
LAST 24 HOURS: 710,366

Fully Vaccinated
43,231,870
LAST 24 HOURS: 665,361

Total Doses Administered
109,586,984
LAST 24 HOURS: 1,309,751

3:07 PM | 1.9KB/s

NCOC
Government of Pakistan

Registration/Vaccination Procedure for Eligible Citizens

All 12+ Citizens

Register yourself by sending your CNIC no to 1156 (free sms) from any mobile no or visit <http://nims.nadra.gov.pk/> and just walk-in to nearest centre for vaccination.

Only Pfizer vaccine will be administered to age group 12 to 18 years (free of Cost for unvaccinated)

*Note: Ensure that your 1st dose entry is made in NIMS by vaccination centre.

Citizens Travelling Abroad - Additional Dose

COVID-19 Vaccine will be given at special COVID-19

Figure 6.7: Vaccine Information



Figure 6.8: Recommend Vaccine

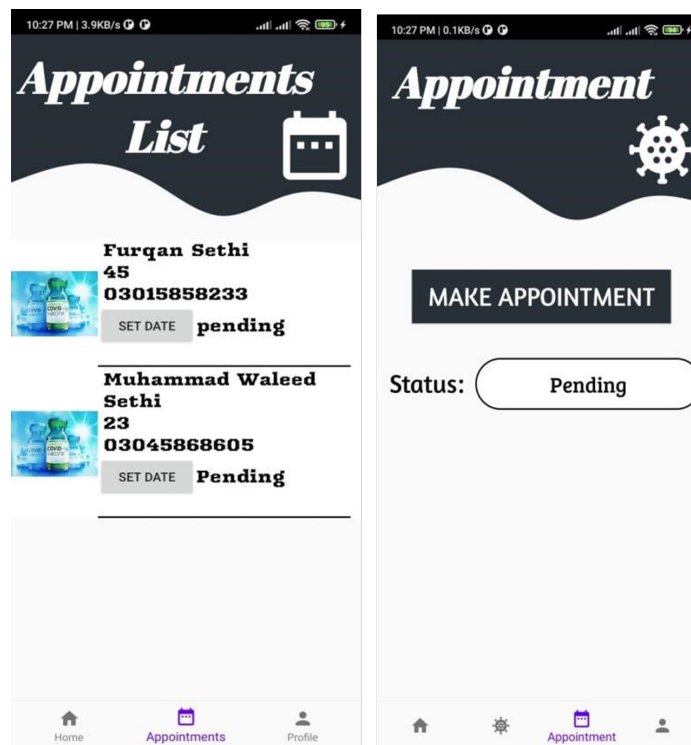


Figure 6.9: Appointment



Figure 6.10: User Profile Page

Chapter 7

Conclusion

7.1 Description

This section sums up the report of the project and also specifies the future plans that we intend to continue with this application. As testing has been performed, the current application is bound to perform its best under the time being but will be improved to much further usefulness for the users. A few new features will also be added which shall be discussed in the upcoming section.

7.2 Future Goals

A few future goals that we have already planned for this particular application are:

- Addition of Urdu language for the people who are unable to understand the English language
- The geographic enhancement of the region covered (which is currently limited to Pakistan only), shall be done in order to incorporate the impacts of the vaccines on people of different countries as well.
- Web application of this android app will also be launched.

7.3 Conclusion

The final year project with the title “Impact Analysis of COVID vaccine” has come to its end, with the application fully functional and working, aimed to provide ease to the people and the scientists and doctors. After much hard work of the students and the guidance and support of the supervisor, the application has been completed successfully.

References

- [1] Sana Abbas, Beenish Abbas, Sidra Amir, and Mehreen Wajahat. Evaluation of adverse effects with covid-19 vaccination in pakistan. *Pakistan Journal of Medical Sciences*, 37(7):1959, 2021.
- [2] Tara C Bouton, Sara Lodi, Jacquelyn Turcinovic, Beau Schaeffer, Sarah E Weber, Emily Quinn, Cathy Korn, Jacqueline Steiner, Elissa M Schechter-Perkins, Elizabeth Duffy, et al. Covid-19 vaccine impact on rates of sars-cov-2 cases and post vaccination strain sequences among healthcare workers at an urban academic medical center: a prospective cohort study. In *Open Forum Infectious Diseases*, 2021.
- [3] Dovy Djanas, Rose Dinda Martini, Hendria Putra, Adriani Zanir, Ricvan Dana Nindrea, et al. Survey data of covid-19 vaccine side effects among hospital staff in a national referral hospital in indonesia. *Data in brief*, 36:107098, 2021.
- [4] Richard Hughes, Louise Whitley, Kocho Fitovski, Hans-Martin Schneble, Erwan Muros, Annette Sauter, Licinio Craveiro, Paul Dillon, Ulrike Bonati, Nikki Jessop, et al. Covid-19 in ocrelizumab-treated people with multiple sclerosis. *Multiple sclerosis and related disorders*, 49:102725, 2021.
- [5] Edouard Mathieu, Hannah Ritchie, Esteban Ortiz-Ospina, Max Roser, Joe Hasell, Cameron Appel, Charlie Giattino, and Lucas Rodés-Guirao. A global database of covid-19 vaccinations. *Nature human behaviour*, 5(7):947–953, 2021.
- [6] Carl AB Pearson, Fiammetta Bozzani, Simon R Procter, Nicholas G Davies, Maryam Huda, Henning Tarp Jensen, Marcus Keogh-Brown, Muhammad Khalid, Sedona Sweeney, Sergio Torres-Rueda, et al. Covid-19 vaccination in sindh province, pakistan: A modelling study of health impact and cost-effectiveness. *PLoS medicine*, 18(10):e1003815, 2021.
- [7] Soma Siddique and Shaheer Ahmed. Covid-19 vaccines in pakistan: Efficacy, adverse effects and availability. *Journal of Islamabad Medical & Dental College*, 10(2):125–130, 2021.
- [8] Zhaohui Su, Dean McDonnell, Xiaoshan Li, Bindi Bennett, Sabina Šegalo, Jaffar Abbas, Ali Cheshmehzangi, and Yu-Tao Xiang. Covid-19 vaccine donations—vaccine empathy or vaccine diplomacy? a narrative literature review. *Vaccines*, 9(9):1024, 2021.
- [9] Moosa Tatar, Jalal Montazeri Shoorekchali, Mohammad Reza Faraji, and Fernando A Wilson. International covid-19 vaccine inequality amid the pandemic: Perpetuating a global crisis? *Journal of Global Health*, 11, 2021.