
Pregnancy Apps:
Are You Using the Best One?
Mama Natural

Helwan University

Faculty of Computer and Artificial Intelligence

Medical Informatics Program

” Pregnancy follow-up”

A graduation project dissertation by:

Aya Ahmed Elsaied(20208052)

Amena moustafa saad(20208038)

Bassma Mohammed Fathy(20208070)

Nada Essam Mohammed(20208254)

Yasmine Safwat Abdulrahman(20208293)

Submitted in partial fulfilment of the requirements for the degree of Bachelor of Science in Computers & Artificial Intelligence, at Medical Informatics Program, the Faculty of Computers & Artificial Intelligence, Helwan University

Supervised by

Prof. Dr. Hala Abdulgleel

February 2023

"PREGNANCY FOLLOW-UP"

Abstract

You bought the books, took the pamphlets home from the doctor's office, and printed out every possible checklist and chart you could find on the internet, and now, you're left staring at a massive pile of stuff.

If that sounds familiar, you're not alone. Parents-to-be are eager for information about the next nine months, in any form they can get it. That's why it's not uncommon to see every pregnancy-related publication stacked a mile high on the nightstand or kitchen table of an expecting mom or dad.

Unfortunately, sifting through all of that paper takes time. And more than likely, time is, and will continue to be, in short supply. The good news? There is a simple solution to your current situation, and it's called a pregnancy follow-up app.

Chapter 1: Introduction

Overview

- The world suffers from the high cost of health care, and when we talk about technology and computer science, it will be the best way to solve many of the problems of the age, as well as health and health care problems.

- The pregnancy follow-up program is one of the most important programs that a pregnant woman needs in all months of her pregnancy. It is a special doctor for her and her health condition available to her at any time and anywhere.

- A pregnant woman can make it an assistant in all aspects of her life during the months of pregnancy, because the program serves her as follows:

- It is an ml model that responds to her questions in terms of symptoms, drug doses, and even the dates of her visit to the doctor

- The mother can create her own account on the program, and her data and medical history are recorded, and they are saved in her own medical record.

- The application saves and copies all patient data so that the doctor can do so He can always check his patient's past data.

- This app also works with anonymous collection of data and creation of reliable datasets.

- Allows the mother to record the movement of her fetus during the day.

- Makes the mother check the symptoms she feels daily from a list symptoms.

- The app predicts risks based on that daily symptoms/medical history current state of health.

- It facilitates the process of communicating with the chat using the chat and calls over the Internet.

- The application predicts symptoms based on the patient's condition Medical history

- The mother can press the emergency alarm button that Requires going to the hospital by calling her emergency contacts, calling the the nearest emergency room to an ambulance.

- The application provides a simple medical library containing articles, videos, photos, and frequently asked questions by pregnant women and answered by gynecologists. General guidelines and prohibitions for pregnancy, general topics and books on child rearing.

- The app provides notifications to remind you of symptoms entry, upcoming appointments, library notifications, ability to decide allowed notifications.

- The app is allowed to take access to users of Veezeta / Google Maps / Online Pharmacies Pregnant area woman.

- The application provides a calendar for managing the doctor's office appointments, medications to be taken during the day, And the table for pregnancy.

- The mother can upload the results of the laboratory and radiological images and the application stores it.

- The application provides some medical terms when pressing on the word mother understand these terms by providing them with an existing medical dictionary provides quick definitions of highlighted words.

- The doctor can write prescriptions for a virtual mother at a remote location

Objectives:

Support Pregnancy

- The mother creates a new account containing all information about her health, and her medical history to store them in the private medical record.
- The application saves and backs up all patient data so that the doctor can always check on his patient's past data.
- Will also work on the anonymous collection of data and the creation of reliable datasets.
- Pregnancy follow-up is a supported Pregnancy app for busy moms dealing with some serious pregnancy brain.
- Available for Android, the Support app also comes with the ability to capture belly photos and pair them with your ultrasounds to create a digital record.
- Can also use the support app to log appointment reminders, questions for her doctor, and milestones she reaches along the way.
- The mother should upload the lab results and radiographs and the application must store them in her medical record.

Accurate diagnosis

- The application must predict potential diseases based on the patient's medical history.
- The application must Predict the risk to the mother, Based on the daily/weekly symptoms, her medical history taken by the doctor, and her current health state.

Gide Pregnancy

- The application has an excellent reputation for its medical accuracy and up-to-date facts about pregnancy.
- In addition to the daily and weekly guides, tracking ability, and health information, you also get some pretty amazing images of the baby's development.
- The application provides a simple medical Library containing articles, videos & images, and Common questions asked by pregnant women, and answered by Gynecologists. , General dos and don'ts of pregnancy, General topics, and Books about child upbringing.
- Help the pregnant woman stay organized and educated about all of the developments and changes happening in her body.
- Provide the possibility of permanent translation of some medical terms when clicking on the word to help the mother understand these terms by providing her with a medical dictionary present in the library and providing quick definitions of highlighted words.

Improved efficiency and speed

- The application can enhance healthcare delivery with more efficiency, as it can handle multiple queries and requirements at a time.

Reduction in healthcare costs

- The cost associated with the healthcare consultation is reduced significantly with the usage of apps as the maintenance cost is less.
- The application will help her reduce her hospital visit costs, the mother needs to go to the hospital more than the number of visits allocated to her, in order to suspect any symptoms she has, so she would like to know that she is fine, as this is considered an extra cost to her.

Easy to use and convenient

- Monitor vital stats such as blood pressure, heart rate, glucose levels, stress management, sleep quality, nutrition tracking, and several other important activities.
- Record her fetus' movement during the day.
- The mother checks the symptoms she feels daily from a list of symptoms.
- The application predicts the risk to the mother, Based on the daily/weekly symptoms, her medical history taken by the doctor, and her current health state.
- Similarly, telemedicine is improving the accessibility of healthcare information to remote areas.

Save time

- The patients can easily connect with the healthcare provider for consultation.
- The doctor may write virtual prescriptions to help the mother in a remote way
- It saves traveling time between home and the healthcare center and also requires fewer visits as compared to the traditional approach.
- The application saves the mother time and, she can ask the application at any time about her symptoms and make sure of her health at any time by interacting with the doctors present in the application.
- It helps to reduce overcrowding in hospitals and to allow time for the doctor to assist in emergency cases only.
- The doctor shall make Easy communication with the mother by using chat and online calls.

Seamless exchange of data

- Come with an inbuilt option to share and transfer health data across the healthcare system.
- The app provides an option for secure and hassle-free process payment options with different gateways for medical bills and subscriptions. If the pregnant woman forgets to pay the bills, these apps send notifications as a reminder.

Support Comprehensive services

- Provide one location to keep all of her baby bump information.
- The app is packed full of useful tips on every pregnancy topic you can imagine.
- he pregnant woman logs on to find out info about where you are in her pregnancy or watch videos about how her body is going to change over the course of nine months.
- Regardless of where you're at on the pregnancy knowledge continuum, there's a good chance she will find some valuable tidbits in this comprehensive app.
- The mother must click on the Alarm button for emergency situations that require going to the hospital by calling emergency contacts, calling the nearest emergency room for an ambulance.
- The application must provide notifications for Reminders for symptom entry, Upcoming appointments, Library notifications, Ability to decide which notifications are allowed.
- The application must allow accessing the location of users, and give access to users of Veezeta/Google maps/Online pharmacies to aid the pregnant woman.
- The application should provide a calendar to manage doctor's appointments, Medicine to be taken with doses and time during the day, and a Pregnancy timeline.

Purpose:

➢ The purpose: for HealthCare providers (Doctors)

1. Patient Monitoring

- Pregnancy follow-up android-based apps allow healthcare professionals to keep track of their patient's conditions and progress during their treatment.
- The apps can store medical test results for patients, which doctors can access at any time.

2. Healthcare Reference & Database

- Physicians can keep all data on various ailments, medical conditions, drugs, and prescriptions in one place using these apps.
- These references in our app can assist clinicians in staying current on medical information.

3. Professional Connections

- The app function as a social network for healthcare workers, allowing them to share information, ask and answer questions, and communicate as a group.

4. Doctor Appointments and Clinical Assistance

- Physically keeping handwritten appointment journals is inconvenient and, in most circumstances, obsolete.
- The apps may be used to book appointments, remind patients and doctors about impending checkups, change schedules, and keep track of other important information.

➢ The Purpose for Patients (pregnant women)

From the perspective of staying healthy in Healthcare, Apps are life-changing for patients and general users keen to live a healthy lifestyle. Our Android app comes loaded with features like:

Patient Health Education

- The app can educate patients about different health conditions by sharing useful, up-to-date information.
- The application provides a simple medical Library containing articles, videos & images, and Common questions asked by pregnant women, and answered by Gynecologists. , General dos and don'ts of pregnancy, General topics, and Books about child upbringing.

Diagnosis

- The app is beneficial for prevention since it helps patients understand their symptoms and seek care when necessary.
- The mother can check the symptoms she feels daily from a list of symptoms.
- The application can Predict the risk to the mother, Based on the daily/weekly symptoms, her medical history taken by the doctor, and her current health state.
- The application must predict potential diseases based on the patient's medical history.
- The app shall record her fetus' movement during the day.

Reminder

- Android-based pregnant follow-up app provides reminders to take medicines, rest, follow healthy practices, and lead an active lifestyle.
- They are also used for tracking and forming healthy habits like staying hydrated, getting enough rest, etc.
- The application must provide notifications for Reminders for symptom entry, Upcoming appointments, Library notifications, Ability to decide which notifications are allowed.

Health Monitoring

- Our App helps patients with chronic health conditions such as type 2 diabetes, and cardiovascular diseases to monitor their conditions around the clock and take necessary precautions.

Mental Health

- Include Psychological aspects for meditation, self-care, stress relief, and good sleep that people use to take care of their mental health.
- Our health app development has taken leaps in the last few years and the future looks more promising than ever.

Healthy Living

- These include weight loss, fitness, exercise, and wellness apps that help people lead healthier lives.

Nutrition

- These include diet and weight loss applications, and they usually come with features like healthy recipes, trackers, and healthy eating guides.

Women's Health

- These include diet and weight loss applications, and they usually come with features like healthy recipes, trackers, and healthy eating guides.

Fetus health

- The app shall record her fetus' movement during the day. Calculate the number of his movements to ensure his health
- In addition to the possibility of calculating the age of the fetus.

Tracking

- Monitoring the patient's vital indicators, such as blood pressure, heart rate, blood sugar levels, pulse, calorie intake, and so on, is the most important element of any patient app.

Scheduling & Reminders

- This feature offers hassle-free doctor appointments.
- It can also schedule reminders for medicine intake, sleep, water intake, daily calorie consumption targets, etc.
- It provides notifications for Reminders for symptom entry, Upcoming appointments, Library notifications, Ability to decide which notifications are allowed.

Social Media Sign-In

- You can do a quick social media sign-in on the patient app.
- Many users, though, are wary of sharing personal information with third-party social media applications, so you'll need to spell out the extent of social media access to personal accounts in your app's privacy policy.
- In the process of healthcare app development privacy needs to be given special consideration, any infringement of privacy can lead to customer dissatisfaction.

Physician Information

- Our Healthcare mobile application development integrates features like physician information through this feature, medical app users can look up doctors by specialty, availability, location, and other parameters.
- They can also research a doctor's profile in detail before booking an appointment.

Patient Information Database

- Enable the software to store prescriptions, medical history, reports, and other sensitive data that both patients and physicians access at any time.
- The application saves and backs up all patient data so that the doctor can always check on his patient's past data. This will also work for the anonymous collection of data and the creation of reliable datasets.
- Our mobile app development also integrates cloud base systems to make data storage more convenient.

Real-time Chats

- Through this feature, patients can engage with their physicians in real time and get the timely assistance. This feature facilitates easy access to healthcare and can establish trust between doctors and patients.

Geolocation

- Imagine a patient is away from his usual healthcare clinic and needs immediate assistance. This feature with integrated map services (Google Maps or any other 3rd party map service) can inform patients about nearby hospitals.

- Medical mobile application development can also help healthcare providers find a patient in case of an emergency.

- The mother can click on the Alarm button for emergency situations that require going to the hospital by calling emergency contacts, calling the nearest emergency room for an ambulance.

- The application must allow accessing the location of users, and give access to users of Veezeta/Google maps/Online pharmacies to aid the pregnant woman.

Reviews & Ratings

- Through these features, the app can provide valuable feedback and share their treatment experiences with others.

- This will help patients decide better and build credibility and patient loyalty for the healthcare service.

Payment Gateway

- Our mobile health application development integrates phone payments with the latest digital payment features (wallets, credit/debit cards, net banking, etc.) enabling patients to safely and conveniently pay for treatment and/or insurance.

- Patients can also access copies of bills for documentation purposes.

Secure

- Our Healthcare apps store and process a lot of personal data such as patient history, address, contact information, payment details, etc.

- It needs to comply with strict privacy and legal regulations, which vary from region to region.

- All data inside the system or its part will be protected against malware attacks or unauthorized access.

- The application shall enforce access privileges that enable anyone to modify or delete the medical data of patients.

- Defining the login flow and different user roles as system behavior or user actions to protect the admin panel from unauthorized access.

- The application shall encrypt patient data, and privet records and store them in encrypted format using an industry–approved encryption algorithm.

- The application protects the personal information of each patient and provides strict privacy related to his medical history, medications, and test results.

Extra features in our app:

- Photo Gallery
- Analytics
- Prescriptions
- File-sharing capabilities
- Voice & video calls
- Access to information (medicines, patient history, diseases)
- Access to EHRs/EMRs
- Lab Appointment Booking
- Push Notifications
- Wearable Integration
- One-Click Emergency Service
- Report Management

Scope:

1. Creation of the idea and its topics:

- The team members met and decided that the subject of their project should serve the medical field and its problems and solve these problems.
- They are determined to bring modern technology to the service of healthcare.
- And how to reduce its cost and save time, effort, and money spent on it.
- Their plan was to help pregnant women reduce the number of visits to the doctor, to follow up on the development of their pregnancy, the development of their fetus, and periodic check-ups.
- The team noticed that these women need very careful care in their homes, even with the availability of treatment methods in hospitals and health units, but the pregnant woman needs someone who follows her condition at home periodically, tells her medical advice about her condition, checks on the movement of her fetus, and puts a plan for her to change From her behavior and habits in sports, food, and health.
- She also needs something to remind her of the dates of important medications, the dates of her visits to the doctor, in addition to the dates of her periodic medical examinations.
- The team members were able to create an idea that combines medical science with technological science to help this pregnant woman, and that this service fulfills all the requirements of users to the fullest, and this idea was under the name of **"pregnancy follow-up"**.

2. Collect user requirements

The team members created a questionnaire to collect the needs of female users, and the questionnaire contained several questions, including:

- Have you ever been pregnant or not?
- What are the problems that a pregnant woman faces?
- What are the symptoms that you felt during your pregnancy that were not understood by you?
- What are the serious symptoms that you encountered in pregnancy?
- What was annoying in the doctor's visits?
- What problems did you encounter in communicating with the doctor?

And that there are several other questions for doctors specializing in the field of obstetrics and gynecology and for health care officials, including:

- What are the main problems that the doctor faces from direct dealing with the pregnant woman?
- What are the normal symptoms that appear in a woman during her pregnancy?
- What are the risk factors that a pregnant woman may notice and then realize that it is an emergency and that she must require an ambulance?
- What are the basic data that you as a doctor require from her and through which you follow up on her condition?
- What data do you collect from the pregnant woman at each follow-up visit?
- Are pregnancy symptoms and risk factors that can affect the mother and fetus different in each month of pregnancy, or are they the same?
- What is your problem as a doctor in giving information to pregnant women, or your problem in communicating with them?
- What are the common mistakes that pregnant women can make during their pregnancy from the point of view of a doctor?

3. Choose the platform

After collecting opinions and voting from many users, the most appropriate way to present this idea is to be a mobile application, especially Android.

Advantages of android:

- Android is totally open because it is a Linux based open source
- Multitasking
- Excellent software support
- It gives you a better notification
- It lets you choose your hardware
- It has a better app market
- Frequent OS updated
- A more mature platform
- Android type of phone can also function as a router to share the internet
- It will be more secure than iPhone OS
- All applications are treated equally
- Easy to access the android the market
- Can be installed and modified RAM
- An Android-based product will be cheaper than its propriety
- Support all google services
- With google chrome, you can open many windows at once

4. Planning and analysis

- The data analyst examined the questionnaires, performed the analysis on them, and then developed the basic requirements for the mobile application.
- Then the data analyst presented these requirements to the members of the technical team and discussed them with them in detail and accurately
- so that they understand these requirements and imagine the form of the program and how to use it and the interaction between users and convert these requirements into a system design
- He also developed a feasibility study for the project and determined the estimated cost.
- so that we have a complete picture of the application before applying it in the actual form

These requirements include:

- User requirements
- System Requirements
- Domain Requirements
- Functional Requirements
- Non- Functional Requirements

5. Data collection

- Data were collected from some cases in some **government hospitals**, **private clinics**, and **some health units**
- And the main factor that the team members used in collecting data was some of the **cases** in the environment surrounding them, including relatives and friends.
- They also used **some data sets**, which show a good number of cases

5. Software Design

- After the team understood the requirements of the program, they represented these requirements in the form of a system design, which includes many diagrams that explained how users interact with each other in the program, some of the program's functions, in addition to its features.

Among these diagrams:

- Design of database (ERD) Diagram
- Use case diagram
- Sequence diagram
- Activity diagram

General constraints:

➢ Data collection problem

- There is a problem with health care in governmental hospitals, as there was a lack of health data for pregnant women.

- After searching and moving between more than one government hospital, private clinics, and health units, we found that some hospitals do not give a full medical report to the pregnant woman, and do not give her a detailed report of her health condition, so we could not collect enough cases to train the machine learning model due to the lack of availability.

- Some private clinics do not print follow-up cards for their pregnant women, so it was very difficult to obtain accurate data.

- Some doctors and health care officials refused to help with the data collection process.

- Some hospitals refused to view some of the data of pregnant women, considering this data as very sensitive data.

➢ Problem of self-learning

- The faculty members of the Department of Gynecology refused to supervise the application or provide the project team with some of the required medical information.
- Team members had to collect data themselves from external sources, and they had to go to some government hospitals, private clinics, and some health units, which increased pressure on them and they spent a lot of time, effort, and money.
- The lack of free, reliable sources to obtain medical data led to an increase in learning time when searching for free sources.

➢ The small number of team members

- The small number of team members made more pressure and load on them.
- Many of them were forced to do a number of tasks that were not compatible with their main specialization.

➢ Loss of specialization

- Causes a very big problem in the efficiency of the application.
- A team of doctors must be available to provide the technical team with all the information and medical terminology they need.
- The unavailability of a team of doctors became an excessive burden on the members of the team, so instead of taking the information from a specialist directly, they were forced to research and self-learning, which took them excessive time and effort.

Chapter 2: Project "Planning and analysis"

➢ *Project planning:*

1. Feasibility Study

❖ Financial feasibility

Being android app software will have an associated hosting cost.

- The system will follow freeware software standards.
- No cost will be charged to the customer. Besides that there is no cost to the customer, the app will help in rescuing a pregnant woman in case of danger to avoid abortion or crowded hospitals with just fear from the pregnant women(not real danger).
- Bug fixes and maintenance tasks will have associated costs later.
- From the previous, it's clear that the app is financially feasible.

❖ Technical feasibility

Our app will have these as the main technologies and tools

1. SQL
2. Python
3. Android Studio
4. MongoDB server
5. MYSQL Database
6. Machine learning
7. Diagram drawing tools
   8.1 Excel for Gantt chart
   8.2 visual paradigm for sequence diagram
   8.3 Draw.io for use case diagram
   8.4 Visio 2013

Each of the technology is freely available and technical skills are required and manageable.

Time limitations for product development and the ease of implementing using these technologies are synchronized.

Initially the application host in a free app host space, but for later implementations, it will be hosted in a paid app hosting space with sufficient bandwidth. The bandwidth required in this app is very low since it does not incorporate any multimedia aspect.

From these, it is clear that the app is technically feasible.

❖ Resources feasibility

Resource feasibility

- Programming device(laptop)
- Hosting space
- Programming tools
- Programmers

From these, it is clear that the app resources are available.

❖ Risk feasibility

In risk feasibility, there are several contexts to be discussed

1-Risk associated with the size

-The estimated size of the product in the line of codes:

- Being an application with many numbers of stakeholders, the app will contain a significant amount of code lines. As the system does not contain any multimedia (videos, audio, graphics, animation aspect, the file sizes, and the complete project size will not exceed 200MB).

- Estimated size of product in the estimate programs:

- Through the application support of many stakeholders, it will be constructed as a single app with a single login interface rather than having many interfaces for the user.
- Depending on the access rights, the contents will be showed or hidden.

-Size of database created or used by the product:

- Database size will not exceed the values supported by MySQL (65526 entries per table).
- The number of relations and entities is minimized by using best practice of normalization theories.

-Users of the product:

- Pregnant women
- Doctor of obstetric, and Gynecology

-Amount of reused software (as libraries):

- Though the main logics are implemented throughout the project, we will use some libraries to incorporate additional functionalities to support file uploads, training of the model, etc…

2-business impact risks

- Effect of this product on hospital revenue:

- The pregnancy follow-up app can be implemented either as an individual system or can be integrated into an existing system such as a hospital system with its different departments.
- Since it automates some key features for patients the users can increase their revenue.

- Reasonableness of delivery deadline:

- Being a 20 weeks project, the application will have to sever deadlines and deliverables that are scheduled successively.
- Depending on the coding and the design cost and effort, the deadlines are quite reasonable.

- Number of customers who will use this product and the consistency of their needs relative to the product:

- As mentioned above, we can categorize stakeholders into 2 main categories.
- This system can support any number of users simultaneously due to the low bandwidth requirements.

- Number of other products with which this product must be interoperable:

- This product can be integrated with the current hospital management system with slight modifications (from the android app to the desktop app).
- Doing so will add significant value to both systems. But our app can operate independently.

- Sophistication of end users:

- This application is designed while maintaining the complexity at a very low level.
- Usability is highly improved by providing help documents and making interfaces easy to use.

3-Development environment risks:

- Is a software project management tool available?

- Microsoft Project will be used as the main project management tool.

- Are tools for analysis and design available?

- The app will require several designs
    - Excel for Gantt chart
    - visual paradigm for sequence diagram
    - Draw.io for the use case diagram
    - Visio 2013

-Are software configuration management tools available?

- Configuration management will be done using GIT which is freely available.

-Are all the software tools integrated with one another?

- The main deliverables will be packaged under a single project.
- All stakeholders will have a single login interface.

4-process issue risk:

- The app will follow the agile software development process.
- This provide the flexibility to accommodate changing software requirements.

5-Technical issue risks

- **Are specific conventions for code documentation defined and used?**

- Software code and documentation code will be freely available and provided.

- **Are configuration management software tools used to control and track change throughout the software process?**

- GIT will be used throughout the software implementation process.

6-Technology risks

- Is the technology to be built new?

- All the technologies are very well established and old enough (not obsolete).

-Do the system requirements demand the creation of new algorithms, input, or output technology?

- The app will have several algorithms to detect if this pregnancy is risky or not.

❖ Social/Legal feasibility

- The app uses freely available development tools and provides the system as an open-source system.

➢ Estimated Cost

Software development costs vary depending on the project.

Software development prices can range from a few pounds to thousands of pounds depending on the features you require, the technologies to be used, and the programming languages to be used.

We will use the techniques below to estimate the price of our project and potentially save time and money on software developer costs.

The ideal software development cost estimate will take into account the fact that we do not live in a perfect environment and that unforeseen events can occur frequently.

The project's timing and cost will be influenced by factors like the time of launching the app and the cost of each (staff training, the platform, the scope of work, the provided place to work, hardware provided, software provided, training and, any later updates).

The following elements are the most crucial to investigate:

1-the platform

- Our mission is to create a native app for one of the two platforms, which entails creating a separate codebase for Android.
- However, why not cross-platform? We could always follow the example of most people and concentrate on one platform until we reach a certain level of success and then increase our spending.
- After that, building the same software for all other platforms won't cost us anything. Maybe later increase the bandwidth of the server.

2-Evaluate the scope of work (time that after the app will able to be launched)

-Only six features at least which are:

1) The mother is required to regularly compare her symptoms to a list of symptoms.

2) Based on the mother's daily/weekly symptoms, the doctor's record of her medical history, and her present state of health, the application must forecast the risk to the mother.

3) The doctor will use internet calls and chat to easily communicate with the mother.

4) The program must offer notifications for upcoming appointments, symptom entry reminders, library notifications, and the ability to control which messages are permitted.

5) A pregnancy chronology, medicine to be given with doses and times throughout the day, and a calendar to organize doctor's visits should all be included in the app.

6) The mother must click on the Alarm button for emergency situations that require going to the hospital by calling emergency contacts, calling the nearest emergency room for an ambulance.

3- Outdoor work

- The estimated cost for renting a place to work in is 12,000 EGP during the whole duration of work.
- Taking in consideration the cost of traveling from one place to another.

4-hardware provided

- As the team consists of 5 members using different technologies like machine learning, android app development, and database development there is a deadly need for at least 5 hardware (laptops) with suitable specifications, each of the devices costs at least 20,000 EGP, then the budget totally will be 100,000 EGP

5-Software provided

- As all the IDEs used are free, there is a cost or license of the operating system that the developer works on, the total estimated cost for the 5 operating systems is 1000 EGP taking into consideration the operating system is windows 10

6-training cost

- It is considered as helping by knowledge, resources, more understanding of certain things, provide data for machine learning, gynecologists' consultations and others.
- The budget for all of those during the whole duration of the project is approximately 3000 EGP.

7-Team cost

- As the internet is essential in our project and it is limited, our project consumes at least 250 GB/month which is 750~900 EGP.
- Cost of entertainment methods is 1000 EGP.
- Many roles the 5 member team is responsible for which make it highly cost like (interface design, data analysis, ML engineering, android development, database engineering, and testing).
- Development process that included (Discovery phase, collecting data, integration, maintenance, testing, etc…..) costs.

9- Technologies cost

- Cost of course to train our team in machine learning is 2000 EGP.
- Cost for training android around 2000 EGP.
- If needed later to increase the server size it will cost.

"So the estimated cost finally is 122,750 EGP".

➢ Gantt Chart

4	task	start date	end date	duration(days)
5	data collecting 1	5-Jan	7-Jan	2
6	overview	8-Jan	11-Jan	3
7	objectives	9-Jan	11-Jan	2
8	purpose	10-Jan	12-Jan	2
9	scope	13-Jan	15-Jan	2
10	general constraints	16-Jan	18-Jan	2
11	feasibility study	21-Jan	24-Jan	3
12	estimated cost	20-Jan	21-Jan	1
13	data collecting 2	4-Feb	5-Feb	1
14	limitation of system	26-Jan	28-Jan	2
15	need for new system	4-Feb	5-Feb	1
16	user requirments	5-Feb	7-Feb	2
17	system requirements	5-Feb	7-Feb	2
18	domain requirements	8-Feb	9-Feb	1
19	functional requirments	10-Jan	12-Jan	2
20	non functional requirments	10-Jan	13-Jan	3
21	advantage of system	1-Feb	2-Feb	1
22	risk and risk management	29-Jan	31-Jan	2
23	estimated cost	1-Feb	2-Feb	1
24	ERD	3-Feb	6-Feb	3
25	data collecting 3	5-Feb	10-Feb	5
26	use case	15-Jan	18-Jan	3
27	sequence	20-Jan	22-Jan	2
28	activity	21-Jan	24-Jan	2

➢ Analysis and Limitations of the existing system

Limitations that make your system operate slowly?!

1-The quality of network (network or internet) connectivity is something you can't really control as an app owner but you can still improve the app's performance in case of poor connectivity. (Web app).

2-On average, a mobile app processes great amounts of data on a regular basis. Hence, if an app tries loading a huge chunk of data at once, chances are high that it will impact the app's performance which is out of our control (Low bandwidth).

3-When there are millions of sessions going on at the same time, it significantly slows down the application performance. (Sessions in the same web app)

4-Another possible problematic area with your slow app is its user interface and its components.

While interactive and rich UI is a trend, it can significantly slow down the work of your app. So we should balance between attractive design and good performance. (designing android app).

5-Image (and overall content) compression is one of the most common ways to improve the app's performance.

We can also cache certain images so the app won't have to load them, again and again, each time they are requested.

(Android designing app)

6- An app usually contains many data templates and every time they are needed, the app has to load them.

So obviously, this impacts the app's performance and slows it down. (Android app).

7-Issues with a server are usually among the most common reasons behind a slow app. (Web and android app).

9-The performance of your application can be severely hampered by a slow network. Instead of the network itself, it involves the tools that the majority of network-based applications rely on.

You should constantly monitor the network speed and see whether the app is slowing down if you want to solve this issue although that is not your problem. (Web app).

10-The term "code efficiency" is used to describe the consistency, speed, and programming approach employed when writing programs for an application.

It continues to be the primary component in assuring high performance because of its direct relationship to algorithmic effectiveness and the speed of runtime execution for software.

Therefore, in order to speed up the execution of the program, it is essential that the developers have a strong understanding of algorithms and always use the optimum method. (Using the wrong algorithm that may slow down the app).

11-Without the magic of Android libraries, creating an Android application is usually a tiresome task.

The time, money, and effort needed to create an Android app are reduced with the aid of libraries.

However, the developer has no control over issues that may arise with the libraries and Software Development Kit offered by the trader.

To check for defects or problems, developers must examine the code of third-party libraries. If the libraries are not carefully examined, the application could be slow.

Make sure you're using libraries that are widely used, dependable, and secure. (Libraries from the android app must be secure and trusted).

12-The main thread of the application can be overloaded with tasks (rarely happens). What this actually means is that the code is processing more slowly and frames are skipping as a result.

This could be caused by developers performing intensive work at the application's core, a database query, or anything else that causes the thread to pause for a while. (Android app from developer).

13-A performance problems might be caused by a limitation of your device hardware. (User phone).

14-client-end sluggishness: The client-end application might be slow for many reasons, be it competitiveness between the programs for resources, including CPU, bandwidth, memory, and low disk space, to name a few. (Users, phone).

➢ Need for the new system

The weaknesses of the old system that let you think it is a good idea to develop a new system

1. Some data privacy risk

In the old applications, there are many security holes through which the threat of exposing personal information to hackers and sharing it with third parties is a major concern.

Some of the guidelines considered in the new app include:

• Disaster recovery:

- If a breach occurs, a disaster recovery plan ensures that employees and IT teams know the next course of action.
- It's aimed at reducing the amount of time that users are offline, thereby ensuring that your operations resume as soon as possible.

• Promote information security principles

Integrity:

-All data inside the system or its part will be protected against malware attacks or unauthorized access.

-The application shall enforce access privileges that enable anyone to modify or delete the medical data of patients.

-defining the login flow and different user roles as system behavior or user actions to protect the admin panel from unauthorized access.

Confidentiality:

-The application shall encrypt patient data, and privet records and store them in encrypted format using an industry

-approved encryption algorithm.

-The application protects the personal information of each patient and provides strict privacy related to his medical history, medications, and test results.

Availability:

-application shall monitor the status and location of system components that may contain unencrypted patient data.

• Access control/management:

- This policy highlights the parties that can access sensitive information, reducing the risk of unauthorized access.

- Make sure your access management policy specifies which stakeholders are allowed access to what and under which circumstances they can share this information.

• Security testing:

- The policy should state the frequency of your cybersecurity tests. This allows you to uncover vulnerabilities before it's too late.
- Some of the security tests that you should conduct include; vulnerability scanning, security posture assessment, penetration testing, ethical hacking, cybersecurity assessments, etc.

2. Resistance from doctors.

In the old application, there was resistance from doctors and miscommunication due to:

-A perceived loss of control over the care process.

- Technology as the interface of care can cause confusion and frustration and can result in confusion, treatment plans not being understood properly, or patient non-compliance.

-Sometimes the patient does not understand some medical terminology, so the patient sometimes misunderstands what the doctor means.

In the new app:

-The doctor shall make Easy communication with the mother by using chat and online calls.

-The application provides the possibility of permanent translation of some medical terms when clicking on the word to help the mother understand these terms by providing her with a medical dictionary present in the library and providing quick definitions of highlighted words.

-Apart from inspecting the patient's condition using high-definition cameras, mobile apps can also be used for real-time collaboration, consultation, and information sharing with doctors globally.

-This benefits the patients as doctors from across the globe can learn and share knowledge in real-time.

-Moreover, regular real-time communication between patients and doctors also - improves monitoring by keeping a constant check on health.

3. Poor Implementation

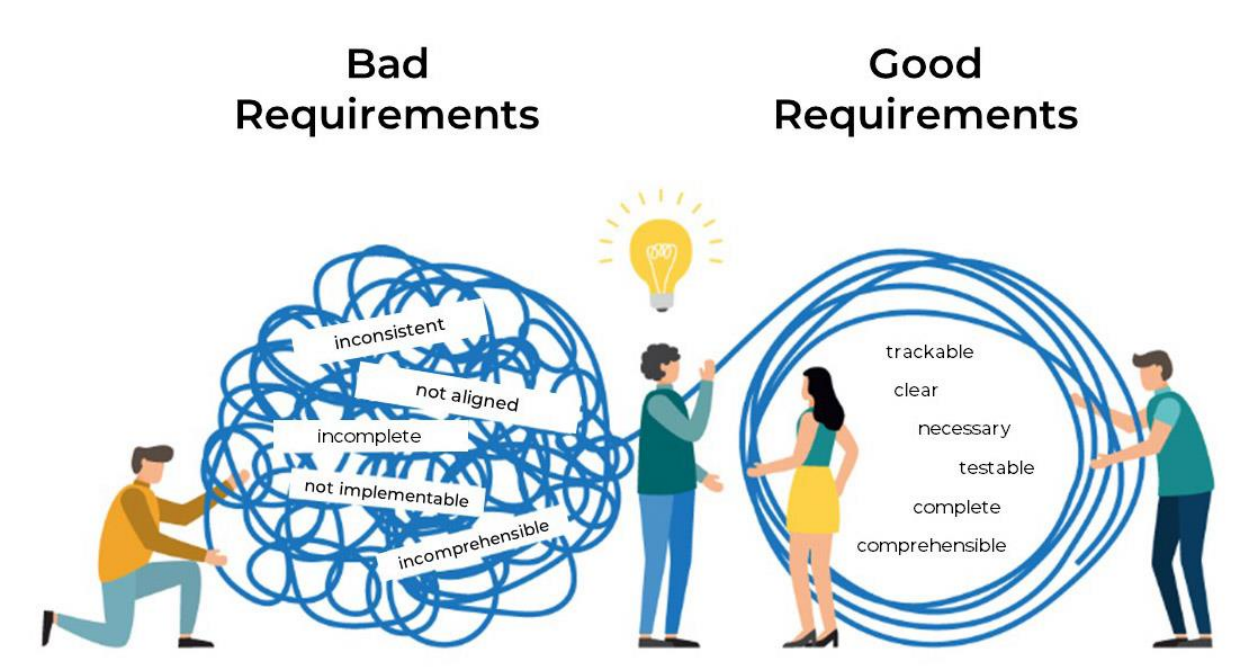
In the old apps the difficulty of using the application, the inability of some people to use how to use the application program, and how to deal with it.

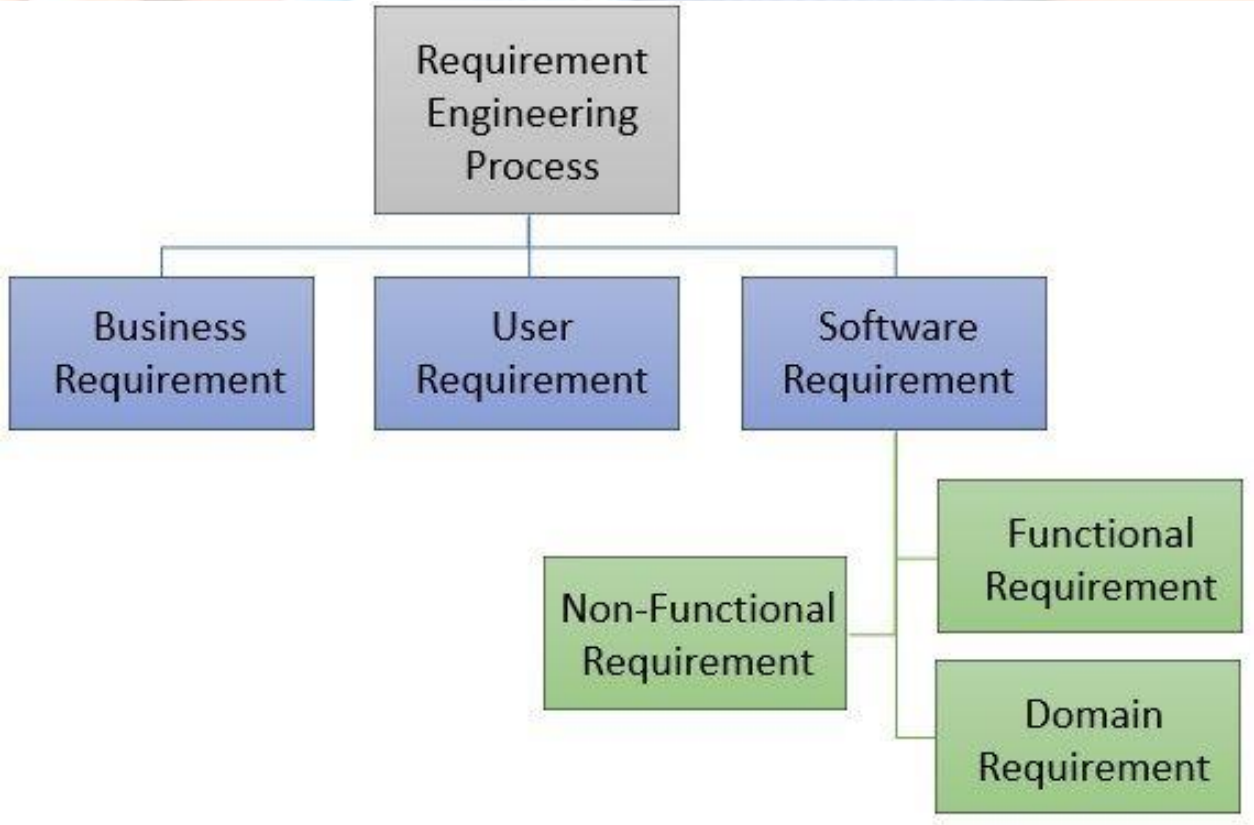
In the new app:

-The application is more accurate, easy to use, and ultimately.

- Improve the existing methods of patient care. For clinicians and doctors, ensuring that the technology that they are using is easy to manage and understand, rather than a burden, is critical.

➢ Analysis of the new system





Functional requirements:

- The mother must create a new account containing all information about her health, and her medical history to store them in the private medical record.
- The mother must log in to the application with a unique username and password.
- The application must save and back up all patient data so that the doctor can always check on his patient's past data. This will also work for the anonymous collection of data and the creation of reliable datasets.
- The mother shall record her fetus' movement during the day.
- The mother must check the symptoms she feels daily from a list of symptoms.
- The application must Predict the risk to the mother, Based on the daily/weekly symptoms, her medical history taken by the doctor, and her current health state.
- The doctor shall make Easy communication with the mother by using chat and online calls.
- The application must predict potential diseases based on the patient's medical history.

- The mother must click on the Alarm button for emergency situations that require going to the hospital by calling emergency contacts, calling the nearest emergency room for an ambulance.

- The application must provide a simple medical Library containing articles, videos & images, and Common questions asked by pregnant women, and answered by Gynecologists. , General dos and don'ts of pregnancy, General topics, and Books about child upbringing.

- The application must provide notifications for Reminders for symptom entry, Upcoming appointments, Library notifications, Ability to decide which notifications are allowed.

- The application must allow accessing the location of users, and give access to users of Veezeta/Google maps/Online pharmacies to aid the pregnant woman.

- The application should provide a calendar to manage doctor's appointments, Medicine to be taken with doses and time during the day, and a Pregnancy timeline.

- The mother should upload the lab results and radiographs and the application must store them in her medical record.

- The application should provide the possibility of permanent translation of some medical terms when clicking on the word to help the mother understand these terms by providing her with a medical dictionary present in the library and providing quick definitions of highlighted words.

- The doctor may write virtual prescriptions to help the mother in a remote way.

Non Functional requirements:

1. (Usability)

The efficiency of use:

-Goals are easy to accomplish quickly and with few or no user errors.
- The system must be efficient for the frequent user.

Intuitiveness:

-Users can easily navigate its interface.
-The interface is easy to learn and navigate; buttons, headings, and help/error messages are simple to understand.

Low perceived workload:

-The view makes the system easy to use.
-The interface appears easy to use, rather than intimidating, demanding, and frustrating.

Ease of learning:

-The system must be easy to learn for both novices and users with experience from similar systems.

Ease of remembering:

-The system must be easy to remember for the casual user.

Understandability:

-The user must understand what the system does.
-They can understand how the application organizes its content.

2. (Localization)

-The application has features that match the **geographical location** of its users **including** languages, currencies, interests, purpose, and needs.

-The application must adapt the software to both the **culture and language** of an end user, from standards of measurement and design.

- It **involves** not only translation but also design and UX changes to make the software look and feel natural to the target user.

-It **involves changing the language** of a few key sections so that users know which buttons to click.

- Planning the application accordingly for software localization, so that the software can be translated into other languages **without** causing extra work or time.

-**Using** industry-related or complicated words and phrases in user interface and documentation may appeal to a select audience, failing to elicit positive responses in other languages or another culture.

-**Providing integrated translation providers** to manage medical terminology, so you don't have to spend time creating and managing a team of translators.

3. (Availability)

-The percentage of time that the application is **accessible for users and operation is very high.**

- The application may be **available 98%** of the time during **a month.**

-The application must **be ready all the time** to answer patients' inquiries and questions.

-The application shall be more prepared for **emergency** situations, develops effective solutions, available for the Prediction of potential diseases based on a patient's medical history, and has a **continuous** ability to make decisions **permanently** and **at any time.**

-The dashboard interface must be available to users **99.98 percent** of the time **every month** during opening the application.

-The solution and response should be available for application maintenance purposes **from 02:00 to 22:00 hours every day.**

-**Availability for Notification**s to Reminders for symptom entry and Upcoming appointments **at any time.**

−The application must allow the user to communicate with the doctor through chat or calls **periodically** and **continuously** even on official holidays in which it is possible that there is no doctor or hospital available in real, through the application, **it is as if there is a doctor who is always available at any time.**

4. (Security)

Integrity:

-All data inside the system or its part will be protected against malware attacks or unauthorized access.

-The application shall enforce access privileges that enable anyone to modify or delete the medical data of patients.

-defining the login flow and different user roles as system behavior or user actions to protect the admin panel from unauthorized access.

Confidentiality:

-The application shall encrypt patient data, and privet records and store them in encrypted format using an industry–approved encryption algorithm.

-The application protects the personal information of each patient and provides strict privacy related to his medical history, medications, and test results.

Availability:

-application shall monitor the status and location of system components that may contain unencrypted patient data.

Privacy:

-Actors must understand and control how their information is used.

5. (Reliability)

-The **percentage of probability of failure** must be low, and the system functions normally most of the time.

-The system must perform without failure in **95 percent** of use cases during a month.

6. (Maintainability)

-The mean time to restore the system following a system failure must not be greater than 10 minutes.

- The application includes all corrective maintenance time and delays time.

- The application shall have 75 percent maintainability for 24 hours, this means that there's a 75 percent chance the component must be fixed in 24 hours.

7. (Compatibility)

-The software tools and resources that are used very efficiently.

-The system must coexist with another system in the same environment.

-The application that is installed on an operating system must be compatible with its firewall or antivirus protection.

-The application must support android devices running on different versions.

8. (performance)

-The system must be quite fast, and the system shall not take much time to return the results.

-The program should support minimum 1000 users and must provide 6 seconds or less response time.

-The application should load in less than 3 seconds at all times.

- The application must be: Flexible, easy, sufficient, safe, adequate, user-friendly, usable, appropriate, fast, portable, lightweight, small, quick, easy, and clear.

System requirements:

-The Application must have order for hardware and software requirements to run smoothly and efficiently, these requirements include:

Software system requirements:

Android version: 6.0.1

Resolution: 1080x1920

Baseband version: 20234, 20234

Custom version: CUSTC185D002

Hardware system requirements:

Processor type: Octa-core

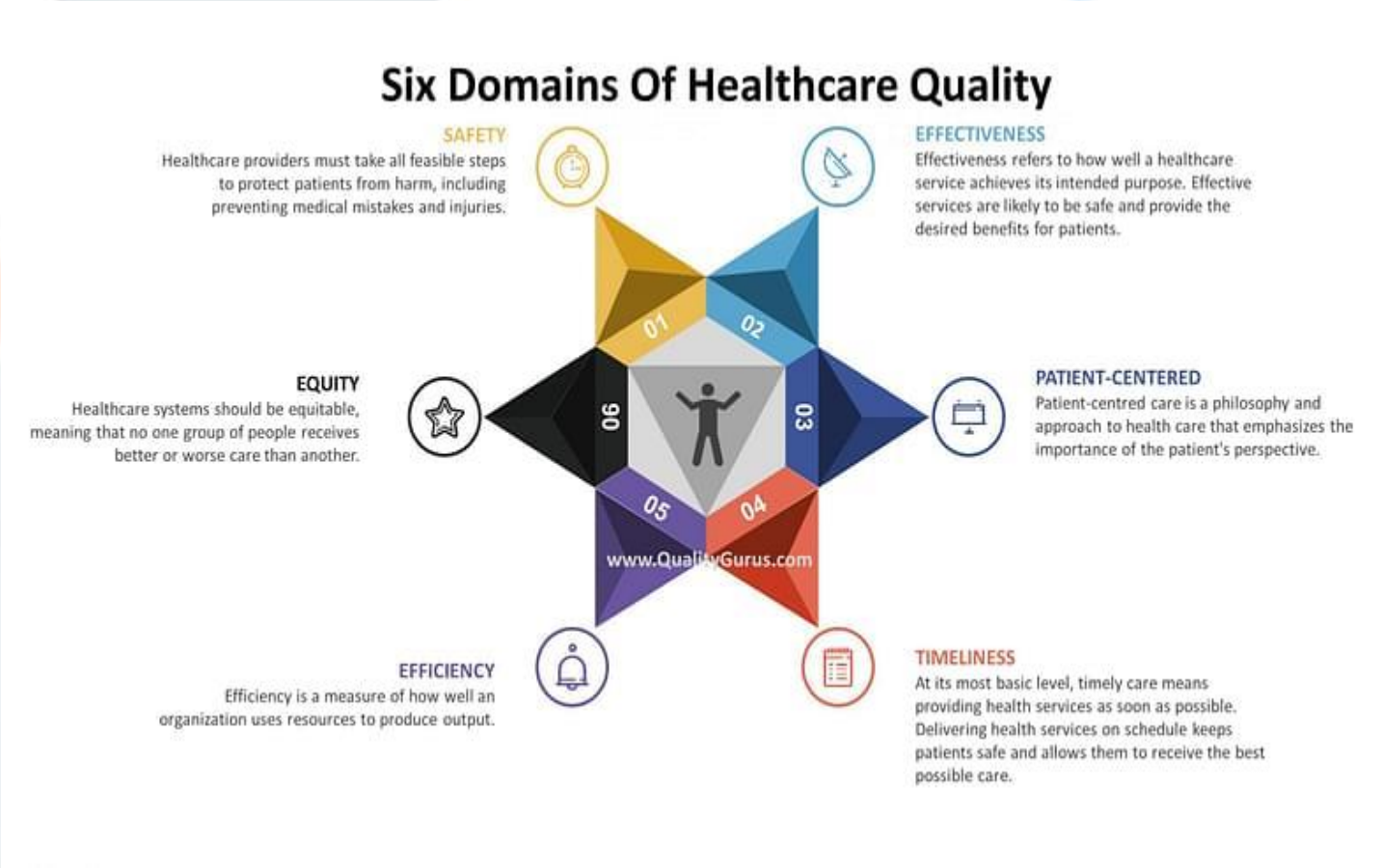
CPU: Octa-core 1.5GHz

Memory size: 16.00 GB

Free space: 2.2 GB

RAM: 2.0GB

Domain requirements



-The six domains of healthcare quality outlined by the Institute of Medicine are patient safety, effectiveness, patient-centered, timeliness, efficiency, and equity.

-Each of these is important for ensuring that patients receive high-quality care.

-Efforts to improve healthcare quality must be coordinated and strategic to achieve maximum impact.

1. Patient Safety

- The application must ensure that people who receive healthcare services are treated with respect and understanding.
- Patients must be able to trust the healthcare system to provide them with safe, high-quality care.
- Healthcare providers in the system must take all feasible steps to protect patients from harm, including preventing medical mistakes and injuries.

2. Effectiveness

- A healthcare service must achieve its intended purpose very well.
- The app must provide the desired benefits for patients and ensure to be safe.
- Healthcare providers must use the most appropriate treatments and procedures to achieve the desired results.

3. Patient-centered

- The app must work with patients to identify their needs and ensure that their concerns are taken into account when planning and delivering health services.
- The app must promote an individualized approach to healthcare and strives to ensure that patients have control over their healthcare decisions.

4. Timeliness

- The app should provide timely care which means providing health services as soon as possible.
- Providing it when it comes to emergency services, which must be available whenever and wherever they are needed.
- The app must care about timely routine medical care, such as check-ups and treatments.
- Delivering health services on schedule keeps patients safe and allows them to receive the best possible care.
- The app must avoid delays in care that can have serious consequences for patients:
  - Delayed treatments can cause serious harm or even death.
  - Delays in diagnosing a serious illness can lead to severe complications

Efficiency

- The leader must measure how well the developers use resources to produce output.
- The tech team should effort to improve efficiency and aim to identify ways to reduce unnecessary costs or increase production while maintaining or improving quality standards.

Equity

- Our Healthcare systems should be equitable, meaning that no one group of people receives better or worse care than another.

- All members of society should have access to appropriate healthcare regardless of age, gender, ethnicity, religion, sexual orientation, socioeconomic status, physical ability, Geographic location, or other factors.

- The application must care about the definition of “equity” as "the absence of systematic differences between groups of individuals within a population based on socially determined characteristics. These characteristics include gender, age, race, ethnicity, religion, socio-economic status, disability, sexual orientation, geographic location, and other factors.

User requirements

The pregnancy follows up application provides daily and monthly care for pregnant women from that filled up by the pregnant woman itself.

- It eases the communication between the doctor and the patient through a chat and a call.
- You can check your safety and the baby's safety from home there is no need for reservation of an apportionment with the doctor and waiting for just checking your health.
- Early rescue in case of danger that is may be unknown for the mother (the most reason for abortion).
- By only one click you can call ambulance, emergency contact or your doctor to serve you in case of labor or anything else.
- Provide psychological support through articles
- You can make sure of your baby safety by counting number of movement during the day
- Enrichment you as a user with sufficient basic medical information that may help you
- Provide sports that fit you in this time of your life
- Defend against common rigors about pregnancy through articles written by doctors
- At the start of each months the app will notify you with expected symptoms that normally appear
- remembering you of your appointments and drugs through notification
- collecting all important data to avoid forgetting or losing it by backup

➢ Advantages of the new system

- **Mobile health apps** are defined as medical and public health practices supported by smartphones, tablets, or other mobile communication devices. They provide a new, innovative way to deliver healthcare services outside traditional care settings. They are expected to be a potential resource to enhance healthcare professionals' productivity and improve patients' health outcomes.

- Mobile healthcare is the future and whether you're the patient or the doctor, you will definitely be able to enjoy countless benefits from using **mobile health apps** in daily life.

These benefits include:

1. Improved Patient Engagement

- Our Health apps facilitate engagement through patient-focused care, personalized experiences & knowledge sharing between providers and patients.

- Patients can access and monitor their medical records/prescription details from the convenience of their own homes without visiting hospitals.

2. Minimize Risks of Misdiagnosis

- Managing patients' records manually is prone to diagnostic errors, inaccuracies, and time-consuming. But the health apps nullify all such potential challenges that might prove fatal for the patient.

- Helps store an accurate report of the patient's health condition digitally in the app this assists doctors to prescribe the right medicine with the correct dosage and chemical compositions. In situations when a patient hops from one healthcare provider to another, this data can be extracted easily to make quick medical decisions.

3. Immediate Access to Care – Anytime, anywhere!

- Inefficient traditional telephone access to doctors and healthcare organizations, mobile health apps make it easy and secure for patients to send messages, schedule appointments & connect to care providers 24/7 for telemedicine visits.

- Patients can ask their questions via video calls, chats, or call to avoid offline visits for minor issues. This makes the process super-efficient.

4. Hassle-free Payments

- Traditionally dealing with bills was a hefty process for both patients and hospital staff. With mobile healthcare applications, people don't need to wait in long queues for hours to make payments.

- Highly secured payment gateway integration in the app facilitates users to make instant payments securely with a few clicks.

- They can also select their preferred payment method, pay online (debit or credit card,) and connect to their insurer (if required) via apps.

5. Improved Prescription Alerts

- Various health apps include set-up electronic reminders that alert patients about their medication, upcoming appointments with specialists, renew prescriptions, and more. This gives patients a lot more control over their therapy without worrying about missing a therapy session.

- Eliminates a major chunk of tedious & repetitive administrative work and provides a better experience to patients with automated reminders.

6. Enhanced Data Management

- Healthcare organizations process tons of personal information every day. So, it is necessary to properly organize it. When integrated with EHR, healthcare apps automatically record valuable patients' information from connected devices in the system or wearables.

- This enables healthcare providers to create a comprehensive profile of each patient and become HIPAA compliant.

7. Cost-Effective

- While healthcare mobile apps offer convenience to the user, it also eases the burden on their pockets reducing medical bills. For instance, a regular clinic visit in the US costs between $100 - $ 200 for the initial consultation while Health Tap - a mobile app, charges less than $119/year for 24x7 virtual healthcare from trusted doctors. Hence, some tasks like face-to-face consultations or doctor prescriptions can be done through a healthcare mobile app. This reduces the burden on your wallet and is simply cost-effective.

8. Delivering Patient Care at Home

- Considered a blessing for doctors, nurses, and other healthcare workers, the healthcare mobile application updates doctors about the symptoms and ailing health conditions of the patient. These applications can be designed to check ailing symptoms and create a report. Following the report, the doctor may take apt decisions even offering prescriptions that could be accessed through the app.

- It was found that 93% of doctors favored health apps to improve patients' health while 40% believe it could reduce clinic visits. Another report suggests that the majority of physicians (around 80%) use smartphone apps to deliver patient care. Such instances prove the importance of healthcare mobile applications. These mobile apps can be customized to treat each patient.

9. Timely care even at remote locations

- Rural locations or remote areas with limited healthcare facilities nearby could use healthcare mobile applications. With the use of mobile apps, these areas can avail of timely care by scheduling video calls with doctors offering prescriptions (if any) digitally, the majority of residents at faraway locations could get better care without having to travel to a hospital.

- Regular clinic visits could be collectively avoided as doctors monitor their patient health through the smartphone app. Moreover, users can get important health tips through push notifications.

10. Accurate Patient Diagnostics

- Healthcare mobile apps with their intelligent health diagnostic approach minimize errors that may prove fatal for the patient. With accurate health

11. Secure Payment Options

- Standing in a queue waiting to pay your medical bill is a thing of the past. With secure payment gateways integrated into healthcare mobile apps, bill payment becomes a hassle-free process. Choose between your preferred payment mode (debit card, credit card, or mobile payment gateway) to pay bills timely.

- Also, if you forget to make a payment, these apps will send a notification as a reminder. For instance, Cedar Pay - a premier tech firm partners with healthcare service providers to take care of billing. With a seamless payment experience on mobile, Cedar Pay increases patient satisfaction making businesses healthy.

12. Power to monitor your health

- One of the biggest benefits of using healthcare mobile apps is the power to track and monitor your health every day. Brands like Fitbit with its line-up of smartwatches, trackers, and other wearable devices offer individuals access to monitor and improve their health on a daily basis.

- By leveraging powerful healthcare apps in wearables, patients can measure: Blood pressure Sugar level weight, Cholesterol level Heart rate and more Individuals can also take timely action when the parameters increase or decrease.

13. Real-Time Communication

- Apart from inspecting the patient's condition using high-definition cameras, mobile apps can also be used for real-time collaboration, consultation, and information sharing with doctors globally.
- This benefits the patients as doctors from across the globe can learn and share knowledge in real time.
- Moreover, regular real-time communication between patients and doctors also improves monitoring by keeping a constant check on health.

14. Encourage a healthy lifestyle

- As more and more people are becoming conscious about maintaining a healthy lifestyle, healthy life apps are the most popular Health apps right now.
- With the popularity of advanced digital accessories such as smartwatches and fitness trackers, healthy life apps are mainly designed to enable people to stay in shape, follow strict diets, or improve their sleep cycle.
- They allow users to track their sleep, body mass, food intake, heart rate, blood pressure, calorie intake, and other personal data.
- Having such data will help individuals set safe and reasonable fitness goals. Additionally, with the help of these apps, they can increase their chances to attain the healthy lifestyle they want. Moreover, users can share these data with their personal trainers or friends to obtain more advice and support.

Our app considers a Healthy Living & Wellness app which includes many features and characteristics that have the ability to help a pregnant woman, follow up on her pregnancy and the status of her fetus, and help her make the right decision regarding her health condition.

These features **include:**

- For pregnant people that may have experienced a previous pregnancy loss and need additional support navigating any subsequent pregnancies.
- The Nurture Pregnancy day-by-day app is a standout option, as it features miscarriage support, including trackers for unusual symptoms and emotional well-being.
- The app includes social and partner support as well as a feature that allows users to upload pregnancy symptoms, weight, medication, and other health data.

- This app is a nurture app that has additional fun features including images and a simple medical Library containing articles, videos & images.
- Features fetal development images and updates on the baby's size.
- Includes both a baby kick counter and contraction tracking.
- Includes an "Is it safe?" feature for common activities, products, and foods.
- Includes a birth preferences form for labor and delivery that you can share with your doctor or caregiver.
- Helps users track blood pressure, weight gain, tummy growth, and baby movement, which you can save and show your doctor at future appointments.
- The app also offers a contraction counter and nutrition and lifestyle advice.
- Allows you to convert data on your pregnancy to a record to show your doctor at your next visit.
- Features checklists for each trimester so you can prepare for childbirth.
- With daily articles on pregnancy and weekly advice from obstetricians, the pregnancy follow-up app and Baby Tracker is a smart choices to keep track of all aspects of your pregnancy.
- The app features an event diary to log appointments and weekly updates on your baby's size and development.

- There's also a baby kick counter and ideas for healthy meals during pregnancy.
- Uses clinical BMI guidelines to measure weight gain and belly growth.
- The app's info is shareable on social media
- Ability to track contractions and send results to a medic…
- Includes questions to ask your doctor at particular appointments.
- Visuals of your baby in the womb are more detailed than many other apps.
- In-depth safety information about different products, foods, and, activities.

My data is safe:

- The application saves and backs up all patient data so that the doctor can always check on his patient's past data. This will also work for the anonymous collection of data and the creation of reliable datasets.

- Upload the lab results and radiographs and the application must store them in her medical record.

It protects me from the risk factors that affect my condition:

- Predict the risk to the mother, Based on the daily/weekly symptoms, her medical history taken by the doctor, and her current health state.

- Check the symptoms she feels daily from a list of symptoms.

Keep track of my medical history:

- Predict potential diseases based on the patient's medical history.

It provides me with information:

- Provide a simple medical Library containing articles, videos & images, and Common questions asked by pregnant women, and answered by Gynecologists. , General dos and don'ts of pregnancy, General topics, and Books about child upbringing.

Help me decide the best choice:

- Allow accessing the location of users, and give access to users of Veezeta/Google maps/Online pharmacies to aid the pregnant woman.

Organizes my appointments:

- Provide a calendar to manage medicine to be taken with doses and time during the day and a Pregnancy timeline.

Provides me ease of use:

- Provide the possibility of permanent translation of some medical terms when clicking on the word to help the mother understand these terms by providing her with a medical dictionary present in the library and providing quick definitions of highlighted words.

Making sure my fetus is okay:

- Record her fetus' movement during the day.

Allows me easy communication:

- Mother can make Easy communication with the mother by using chat and online calls.
- Doctors may write virtual prescriptions to help the mother in a remote way.

Helps me in cases of danger:

Click on the Alarm button for emergency situations that require going to the hospital by calling emergency contacts, calling the nearest emergency room for an ambulance.

➢ Risk and Risk Managements

Technology permeates our lives more than ever, as technological advances continuously emerge.

Every industry has been upended and transformed, including the health and medical industry.

While any innovation may seem like progress, there are certainly both advantages and disadvantages of technology in healthcare.

➢ Cybersecurity Risks in Healthcare:

- One of the biggest advantages of using technology in healthcare is the ease with which data is generated, stored, and transferred between systems and parties.

- When it works well (and when parties adhere to HIPAA compliance), this proliferation in data allows for better healthcare management: from diagnosis to treatment.

- It opens up the potential risk for data to be accessed by third parties. Whether intentionally breached by malicious actors or accidentally exposed, cases abound of patient data making its way into the wrong hands.

- And by relying on external cloud service providers to manage their data infrastructure, those without advanced expertise in cybersecurity may be opening up the patients who use their systems to risk.

- Altered Data may Inadvertently Lead to Incorrect Healthcare Decisions.

- Cybersecurity risk doesn't just pertain to the exposure of private data or the ransoms that are sometimes associated with data breaches. The risks related to altered data can have serious consequences.

- Patients and healthcare professionals that are relying on data to make treatment decisions depend on correct and accurate datasets. If data is deleted or altered it can lead to a wrong diagnosis or treatment plan, or other adverse events.

- Whether or not cybersecurity contributes to the disadvantages of technology in healthcare is yet to be seen, as thankfully, there are no documented cases of medical apps being hacked for such a purpose. That said, the risk needs to remain at the forefront.

Data privacy:

- The health apps continuously collect and analyze the health data of the person.

- The threat of the exposure of personal information hackers and sharing it with third parties is a major concern.

- Over the past few years, several stances, news, and updates regarding the leakage of health data have been reported by the reported app manufacturers.

Lack of Empathy in Patient and Doctor Interaction:

- Utilizing technology can help keep healthcare professionals and patients connected, even when they are not physically present together. For example, by leveraging data and technology, it is possible to provide and update a treatment plan on an ongoing basis, rather than via one-off consultations.

- The use of such tools has kept the healthcare system going and ensured that patients receive a continuum of care during these trying times.

- Similarly, remote patient monitoring can lower healthcare costs by identifying potential issues earlier and avoiding complications down the road. Remote monitoring and telehealth also allow for addressing the clinician shortages that have plagued many countries including here in the United States, specifically in remote areas.

- However, the way in which technology has become the interface between patients and providers has the potential to cause issues. Without responsible patient/doctor relationship monitoring, the benefits will not outweigh the negative impact of technology in healthcare.

- Patients interacting with technology instead of a live care provider dealing with dashboards on connected medical devices and computers removes the human touch of treatment, resulting in a lack of empathy toward patient care.

Risk of Miscommunication:

- Especially for the elderly and the most vulnerable patients, relying on technology as the interface of care can cause confusion and frustration, and can result in confusion, treatment plans not being understood properly, or patient non-compliance.
- Resistance from doctors due to perceived loss of control over the care process.
- Potential loss of revenue for healthcare providers.
- Lack of good-quality scientific research into e-health impacts.

Frustration with Poor Implementation

- As we continue to discuss the pros and drawbacks of medical technology in healthcare, it brings to mind the popular saying: “technology is great — when it works.”
- 80% of Americans have at least one frustrating experience with technology each day.
- The disadvantages of technology in healthcare to be outweighed by the benefits, systems must be accurate, easy to use, and ultimately, improve on the existing methods of patient care. For clinicians and doctors, ensuring that the technology that they are using is easy to manage and understand, rather than a burden, is critical.

Missing Data and Bad Data

- If you don’t migrate clean, relevant data from your old system into your new ERP, that will lead to substantial problems for your users.
- Possible consequences: Users cannot do their work in the new system. Or users learn that they cannot trust the data in the new system. Poor user adoption and errors in accounts may result.

Too Much Reliance on Technology

- As technologies such as Artificial Intelligence and Machine Learning become more prevalent, care must be taken to ensure healthcare professionals understand the limitations of these technologies.

- AI/ML systems may lead to complacency among clinicians potentially resulting in failure to cross-check or consider alternatives to the system's predictions.

- If technology is not improving healthcare – through speed, efficiency, or accuracy – then the continued adoption of technology within healthcare is not likely to last!

Accuracy of Data:

- The information and advice provided by healthcare apps is also an important concern with healthcare apps.

- Different apps use different methods and tools to analyze health data. In some cases, the data measured with the apps are found to be varying when compared with the MedTech devices.

- Internet accessibility, the high cost of smartphones, lack of regulatory approval, and the high cost of in-purchase applications are some of the other key factors hampering penetration of the mobile health apps in the market, faltering their demand.

Healthcare app is not accessible to everyone:

- As these and other smart device ownership figures demonstrate, not all adults use smart devices, meaning that mHealth is inaccessible to many consumers.

- This includes large numbers of individuals who would likely benefit significantly from helpful technology: the elderly.

Ways to Reduce Cybersecurity Risk:

1. Encrypt Your Data and Create Backups:

- Make sure all your sensitive data is encrypted. Saving your data in normal-text format only makes it easy for hackers to access.

- Data encryption, on the other hand, limits data access to parties that have the encryption key. Also ensures that even when unauthorized parties gain access to the data, they can't read it.
- Some data encryption software even lets you know when other people try to alter or tamper with the information.
- You should also conduct regular backups for your important information.

- Sometimes cybersecurity breaches can result in data loss.
- When this happens, and you don't have a reliable and secure backup, it could result in operational disruptions that could cause your organization a lot of lost revenue.
- One of the most effective data backup strategies is the 3-2-1 rule. Based on this strategy, you should have at least 3 copies of your data stored. 2 of them should be stored on different media, and one should be in an offsite location.

2. Users Training

- One of the common ways malicious hackers gain access to your database is through phishing emails sent to your users. In fact, statistics show that over 3.4 billion phishing emails are sent globally. These emails contain malicious malware in the form of links that give hackers access to user data, including login credentials.

- You should also emphasize the importance of checking email addresses before replying to them and checking links before clicking on them. Finally, don't forget to highlight the app policy when it comes to sharing sensitive information, even on social media.

3. Keep Your Systems and Software Updated

- Software and system updates highly impact your cyber security and digital safety. This is because they not only add new features but also fix bugs and help patch security flaws and vulnerabilities that can be exploited.

- Malicious hackers write code that they use to exploit the vulnerabilities. Most of the time, this code is packaged in the form of malware which can affect your entire system. So, make sure you use a patch management system to automatically manage all updates and uphold information security.

4. Use Strong Passwords

Some of the security risk mitigation strategies you should implement when it comes to passwords include:

- All passwords should contain at least 8 characters.
- They should contain alphanumeric characters.
- They shouldn't contain any personal information.
- They should be unique and never used before.

Ways to manage the risk of data privacy:

1. Integrity:

- All data inside the system or its part will be protected against malware attacks or unauthorized access.
- The application shall enforce access privileges that enable anyone to modify or delete the medical data of patients.
- Defining the login flow and different user roles as system behavior or user actions to protect the admin panel from unauthorized access.

2. Confidentiality:

- The application shall encrypt patient data, and privet records and store them in encrypted format using an industry.
- Approved encryption algorithm.
- The application protects the personal information of each patient and provides strict privacy related to his medical history, medications, and test results.

Ways to manage the risk of Miscommunication

Make a list.

- Before communicating with the doctor, patient must write down any questions or concerns she has about her health.

Ask for definitions.

- If your doctor uses a word you do not understand, ask him or her to re-explain using plain language.
- Many words sound alike or have different meanings when talked about in health care. For example, whereas the word “negative” has bad implications outside a doctor’s office, when a test comes back negative, it is good news. It is okay to say you don’t understand.

Know your goals.

- Ask your doctor to define your health care goals. For example, if your doctor tells you to check your blood pressure to make sure it is within normal range, you will need to know what “normal” means.

Do the talking.

- After your doctor has finished explaining something to you, explain it back to your doctor. This will help you remember it and help to make sure both you and your doctor understand the information in the same way.

Picture it.

A picture can be worth a thousand words. Ask your doctor to draw a picture or give you an illustration of the concept he or she is talking about. For example, a doctor might suggest certain exercises for someone with low back pain. A drawing may be far easier to understand than a spoken description.

Slow it down.

- If your healthcare provider speaks quickly, ask him or her to speak slowly so that you do not miss information.

Don't be shy.

- If you have concerns regarding treatment, tell your healthcare provider. He or she may have information that will relieve your concerns, or there may be alternative treatments.

Consider taking a partner.

- Bringing a trusted family member or friend can be a big help when it comes to understanding information and remembering instructions once back at home.

Ask for a recap.

- At the end of your appointment, ask your doctor to repeat the main points and type or write down take-home instructions.

Follow-up.

- If you get home and cannot remember instructions, contact your doctor. If your physician offers communication via secure email, you will have the added bonus of a written copy of the answer.

- Regular email does not provide complete privacy of your health information. If you have questions about whether your doctor uses secure email, be sure to ask.

Ways to manage the risk of Poor Implementation

- Systems must be accurate, easy to use, and ultimately, improve on the existing methods of patient care.

- For clinicians and doctors, ensuring that the technology that they are using is easy to manage and understand, rather than a burden, is critical.

Ways to manage the risk of Missing Data and Bad Data

- Once you've identified what data you need, make sure that data gets cleaned and properly formatted

- Migrate only the data you need.

- Clean and format all the data you migrate.

Ways to manage the risk of the accuracy of Data:

1: Create a centralized database

- Store and organize data in one place so that it can be easily accessed by whoever needs it. Within a lab environment, providing access to the results of research and experiments will avoid the unnecessary and costly duplication of work.

2: Capture and store all data results

- Capture all measurable results from research for reference. Whether relevant to the original hypothesis or not, colleagues might be able to use by-product data for other purposes. An electronic lab notebook (ELN) facilitates complete data capture, a process that isn't as practical when completed using traditional note-taking methods.

3: Don't put pen to paper

- Type notes to reduce mistakes. These days, most people actually type faster than they write, and it is easier to read than handwriting, too! According to a study, 1.5 million patients in the US are affected by medication errors resulting from illegible handwriting. So, it's easy to see how this leads to problems with clean record keeping. It's also easier to add to typed notes and you can track additions over time.

4: Assign permissions to change data

- Establish procedures for who has permission in your organization to change data. This will limit the chances of information being edited incorrectly and protect your company's intellectual property.

5: Keep data sources in sync

- Make sure that the most recent version of a file is easy to find whenever data is being updated from multiple sources at different times – especially when the information needs to be accessed while an update is in progress. This is much easier with a cloud-based digital database, as updates are in real-time.

6: Standardize the data entry process

- Define a structured process for employees to follow when entering data. A company-wide guide to data entry and standard operating procedures will ensure consistency and data quality from the moment information is entered into each record type within the organization.

7: Simplify the data entry process

- Restrict the number of options within a field to limit potential errors and help standardize information. With digital data entry, it is as simple as providing a drop-down list of fields, where only one is available for selection. This also has the advantage of standardizing formatting in your organization.

8: Merge duplicate data

- Streamline your database by merging duplicate files. Simply deleting duplicates can lead to the accidental loss of information. A digital database allows data to be updated to the most recent version instantly while keeping a track of changes, eradicating unnecessary duplicate records.

9: Get staff on board with your data procedures

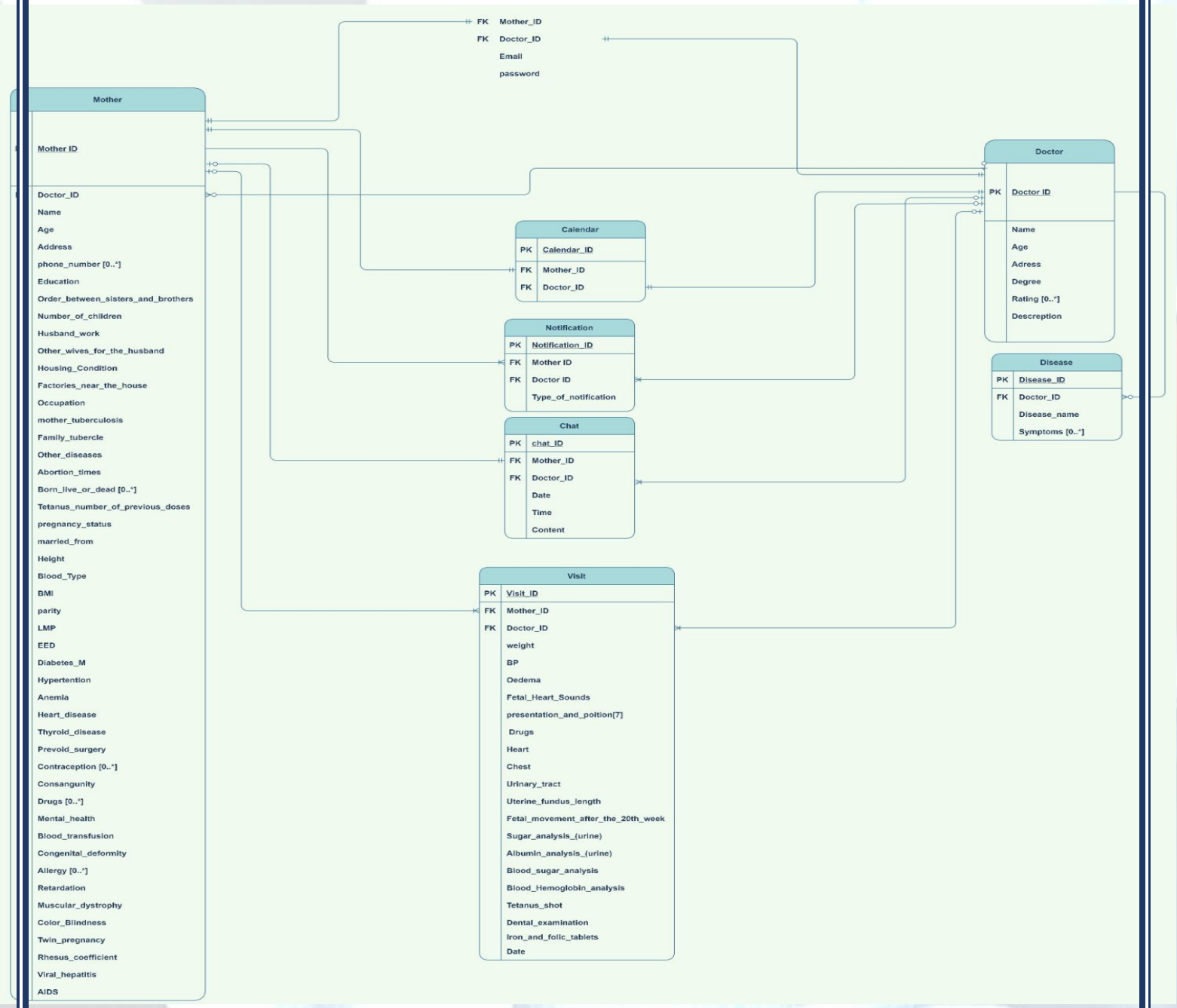
- Establish best practices for record keeping and data entry as an integral part of your employees' job roles. If you are introducing a new system, such as an ELN, provide plenty of training and ongoing support to encourage user adoption.

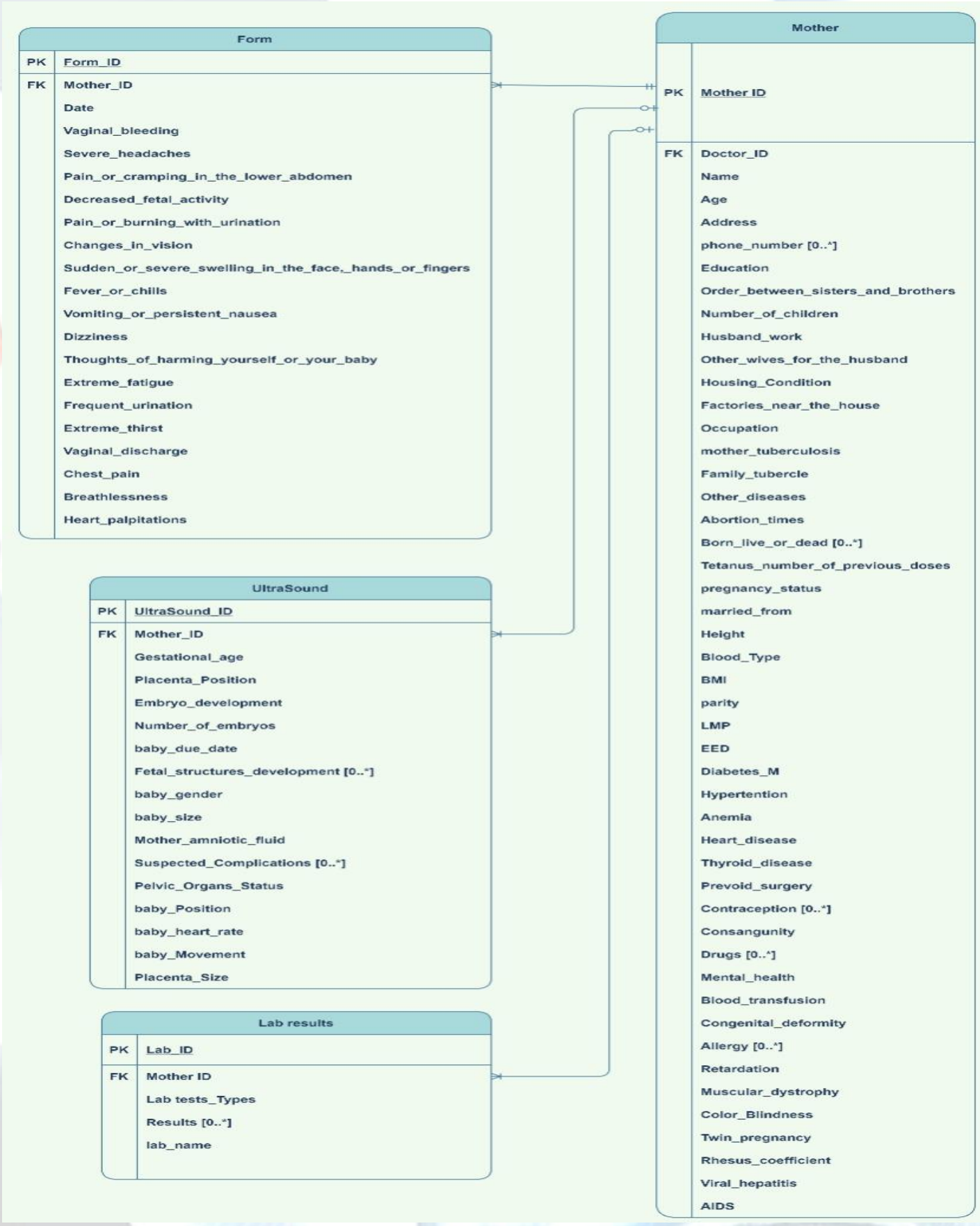
10: Audit data regularly

- Proactively perform data audits on a regular basis to see what information needs to be fixed and which areas of your data entry process need improvement. Integrating audits into your data management will help to mitigate security and compliance issues.

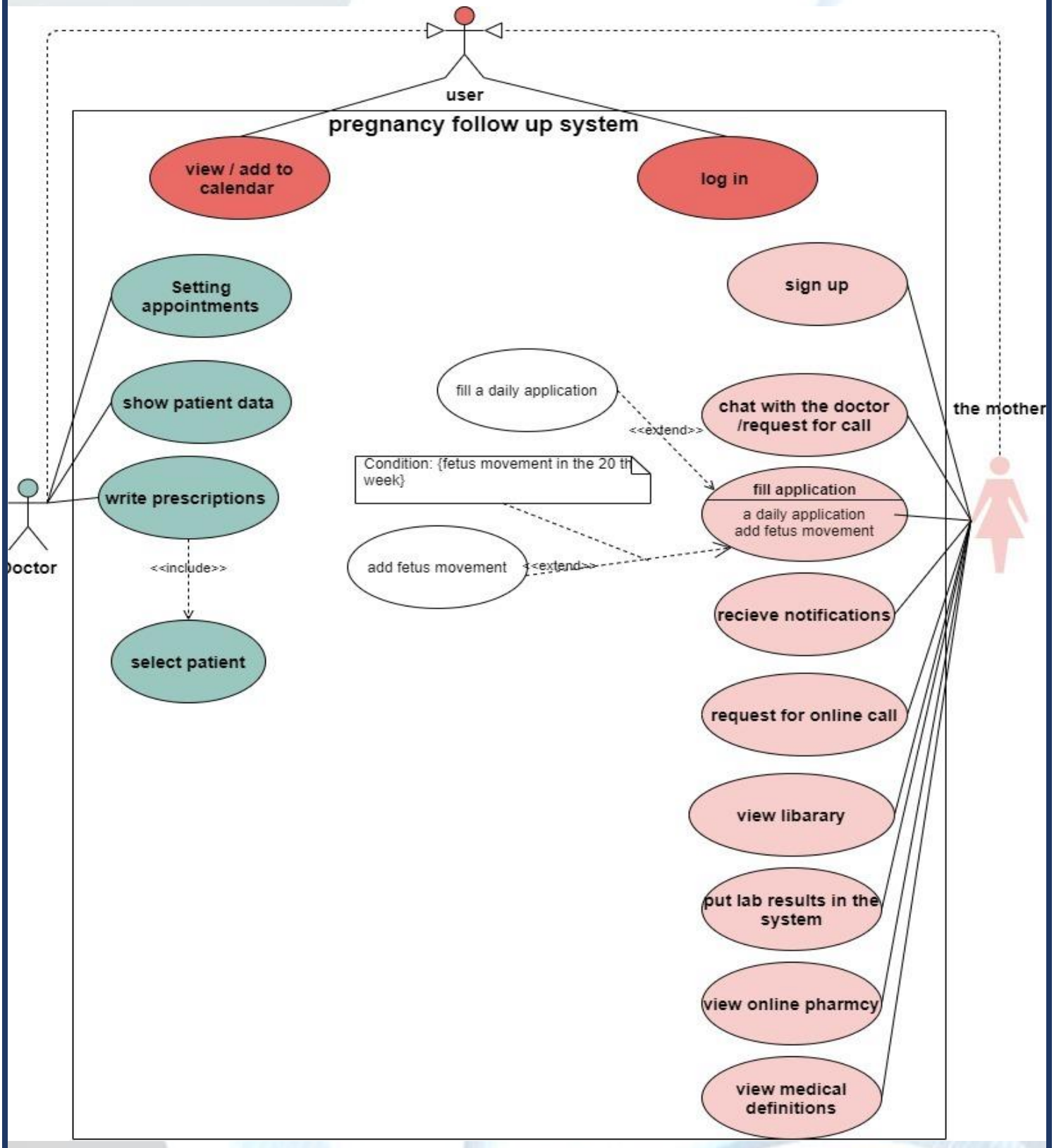
Chapter 3: Software Design

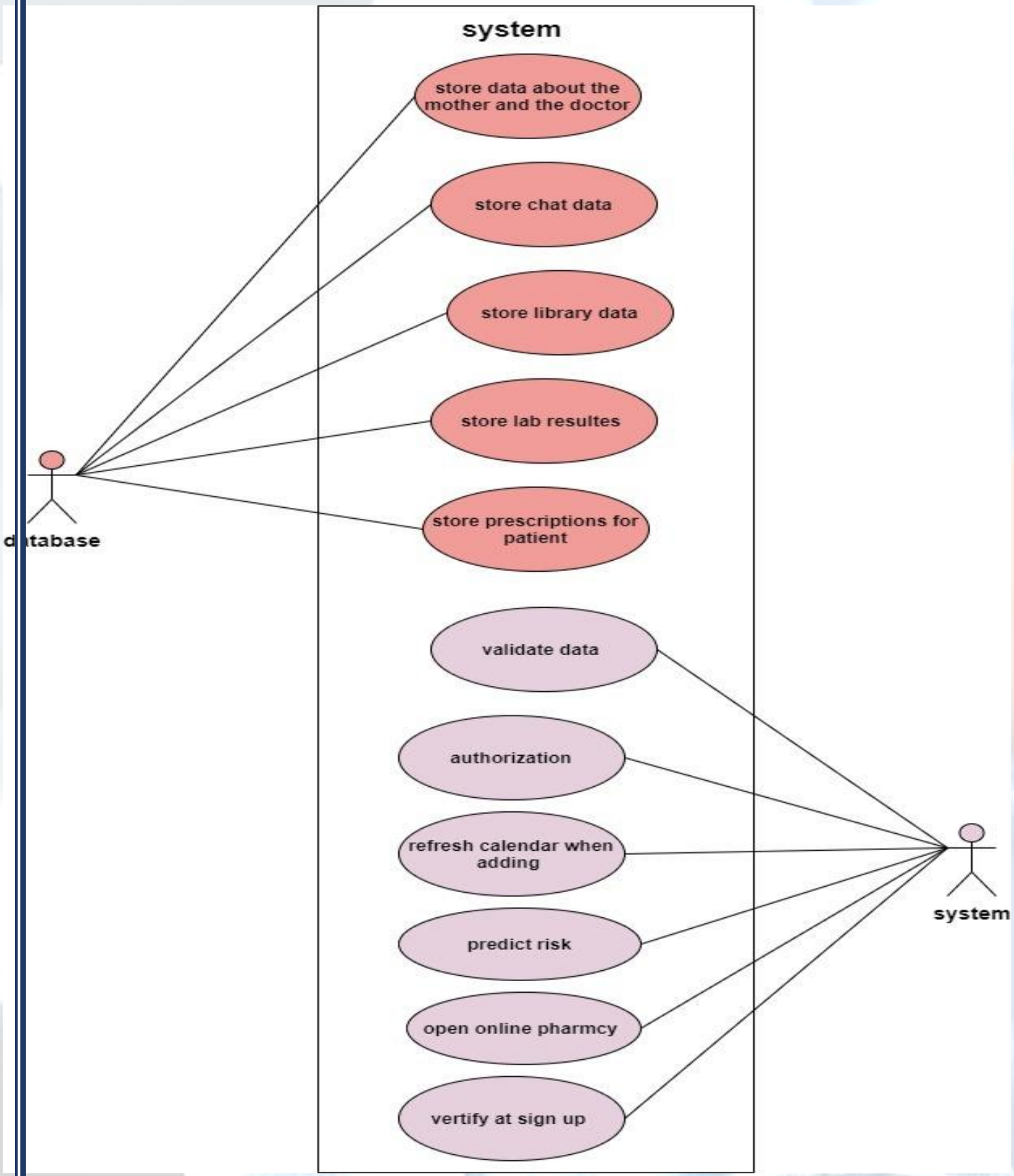
➢ *Design of database (ERD) Diagram*

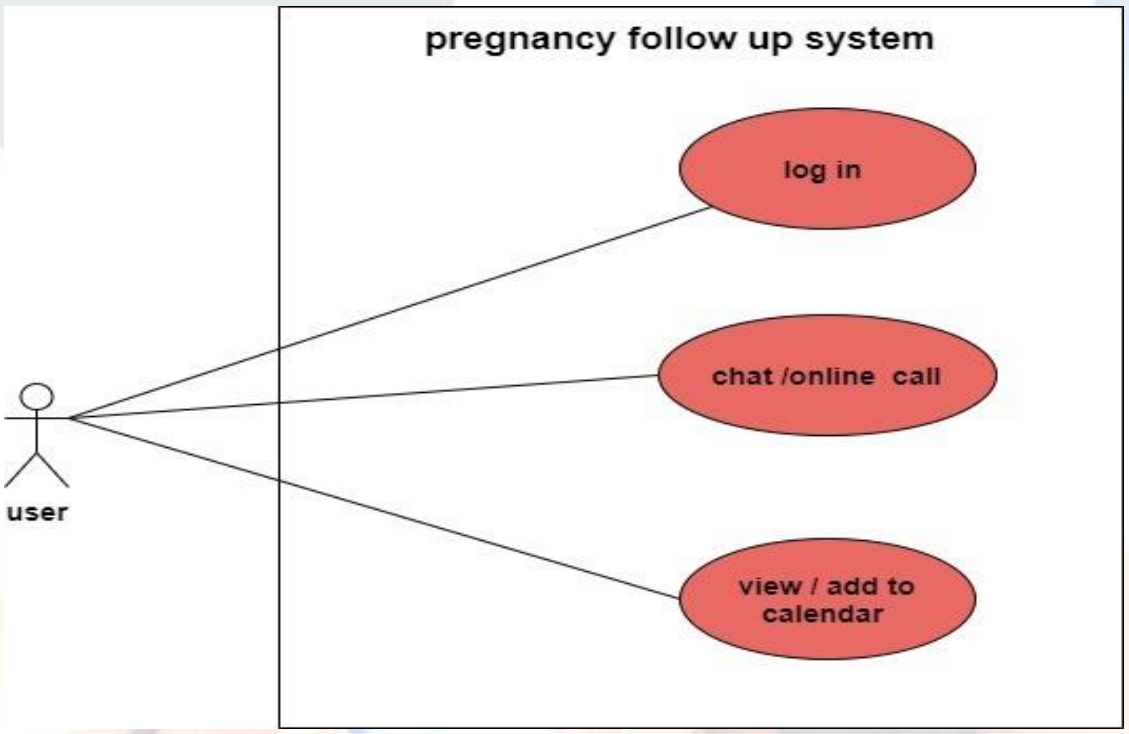


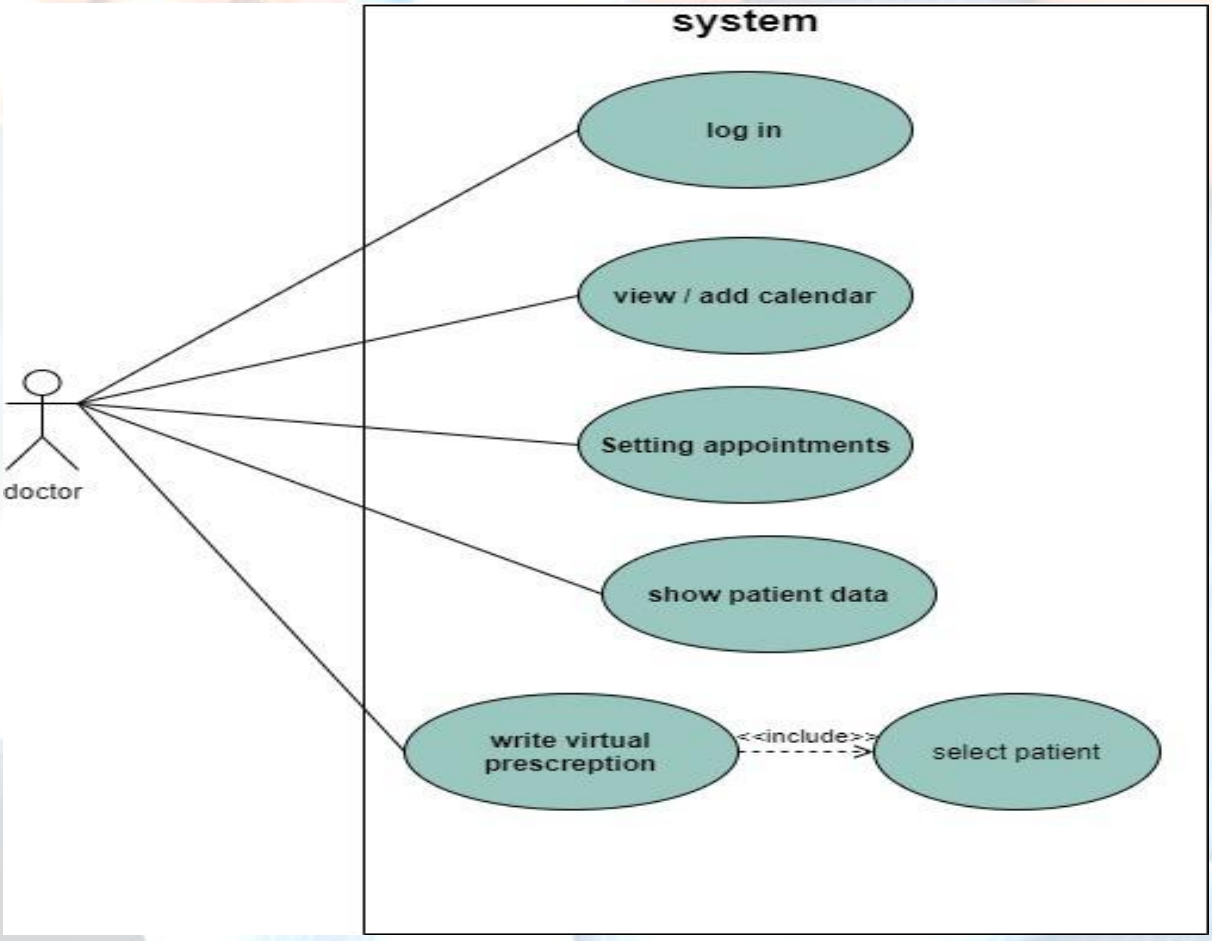

Form
PK Form_ID
FK Mother_ID
Date
Vaginal_bleeding
Severe_headaches
Pain_or_cramping_in_the_lower_abdomen
Decreased_fetal_activity
Pain_or_burning_with_urination
Changes_in_vision
Sudden_or_severe_swelling_in_the_face,_hands_or_fingers
Fever_or_chills
Vomiting_or_persistent_nausea
Dizziness
Thoughts_of_harming_yourself_or_your_baby
Extreme_fatigue
Frequent_urination
Extreme_thirst
Vaginal_discharge
Chest_pain
Breathlessness
Heart_palpitations
Mother
PK Mother ID
FK Doctor_ID
Name
Age
Address
phone_number [0..*]
Education
Order_between_sisters_and_brothers
Number_of_children
Husband_work
Other_wives_for_the_husband
Housing_Condition
Factories_near_the_house
Occupation
mother_tuberculosis
Family_tubercle
Other_diseases
Abortion_times
Born_live_or_dead [0..*]
Tetanus_number_of_previous_doses
pregnancy_status
married_from
Height
Blood_Type
BMI
parity
LMP
EED
Diabetes_M
Hypertention
Anemia
Heart_disease
Thyroid_disease
Prevoid_surgery
Contraception [0..*]
Consangunity
Drugs [0..*]
Mental_health
Blood_transfusion
Congenital_deformity
Allergy [0..*]
Retardation
Muscular_dystrophy
Color_Blindness
Twin_pregnancy
Rhesus_coefficient
Viral_hepatitis
AIDS
UltraSound
PK UltraSound_ID
FK Mother_ID
Gestational_age
Placenta_Position
Embryo_development
Number_of_embryos
baby_due_date
Fetal_structures_development [0..*]
baby_gender
baby_size
Mother_amniotic_fluid
Suspected_Complications [0..*]
Pelvic_Organs_Status
baby_Position
baby_heart_rate
baby_Movement
Placenta_Size
Lab results
PK Lab_ID
FK Mother ID
Lab tests_Types
Results [0..*]
lab_name

➢ Use case diagram




system
store data about the mother and the doctor
store chat data
store library data
store lab resultes
store prescriptions for patient
validate data
authorization
refresh calendar when adding
predict risk
open online pharmcy
vertify at sign up
tabase
system


pregnancy follow up system
log in
chat /online call
view / add to calendar
user


system
log in
view / add calendar
Setting appointments
show patient data
write virtual prescreption
<<include>>
select patient
doctor


system
fill an application for sign up
<<include>>
sign up
log in
view / add calendar
recieve notifications
<<extend>>
fill a daily application
Condition: {fetus movement in the 20 th week}
fill application
a daily application
add fetus movement
<<extend>>
add fetus movement
mother
chat with the doctor
request for online call
view libarary
put lab results in the system
view online pharmcy
view medical definitions

Use-Case Description:

Identifier	M1
Name	doctor and mother
Initiator	User
Pre-conditions	-doctor must have an existing account. -Mother's pregnancy is for sure
Post-Conditions	Mother and doctor communicate with each other in an easy way
Main success scenario	1.The mother and the doctor log in 2. the mother and the doctor will be able to view and add to their calendar 3.the mother and the doctor will have a chat together for any inquiries.
Goal	The system is helpful for both mother and doctor

Use-Case Description:

Identifier	M2
Name	Overall use case
Initiator	User
Pre-conditions	-The mother should be sure about her pregnancy -the doctor should have an account in the system
Post-Conditions	The system displays the homepage after the mother sign up and logs in the system ,then the mother will follow her pregnancy status and her fetus development , also she will have important advices about the healthy pregnancy. After the doctor logs in , he has the ability to help his patients .
Main success scenario	1.The mother and the doctor logs in the system successfully ,they both can check their calendar for any appointments when accessing the homepage ,also they can add any thing to their calendar . 2.The mother then fill her daily form to check her general health , also to check the fetus health . 3.The mother could also show articles of how to achieve a healthy pregnancy and the best exercises to do, she has access to the online pharmacies near to her , also check her medications .
Goal	-The mother could follow up her pregnancy , her baby`s health . -The mother communicate with her doctor very easily . -The doctor will be able to check his patients gradually and warns them in case of risk .

Use-Case Description:

Identifier	M3
Name	Mother and system
Initiator	The mother
Pre-conditions	The mother should be pregnant
Post-Conditions	The mother will have a good communication with her doctor ,a useful information to have a peaceful delivery for her baby
Main success scenario	1.The mother fill a form for her sign up then log in, 2.The mother could fill a daily form ,and to add a fetus movement after 20weeks of pregnancy 3.The mother have access to add and check her calendar 4.The mother receive a notification about her medications or general advices or her appointments 5.The mother have ability to chat with the doctor and also request for an online call 6.The mother can put her lab results in the system to her profile ,the doctor can check this and warn her if there are any risk 7.The mother can view online pharmacies near to her , also view medical definitions if she wants to check something
Goal	-The mother have follow up her pregnancy week by week . -the mother will be sure that she is fine and her baby is good by regular follow up by the system.

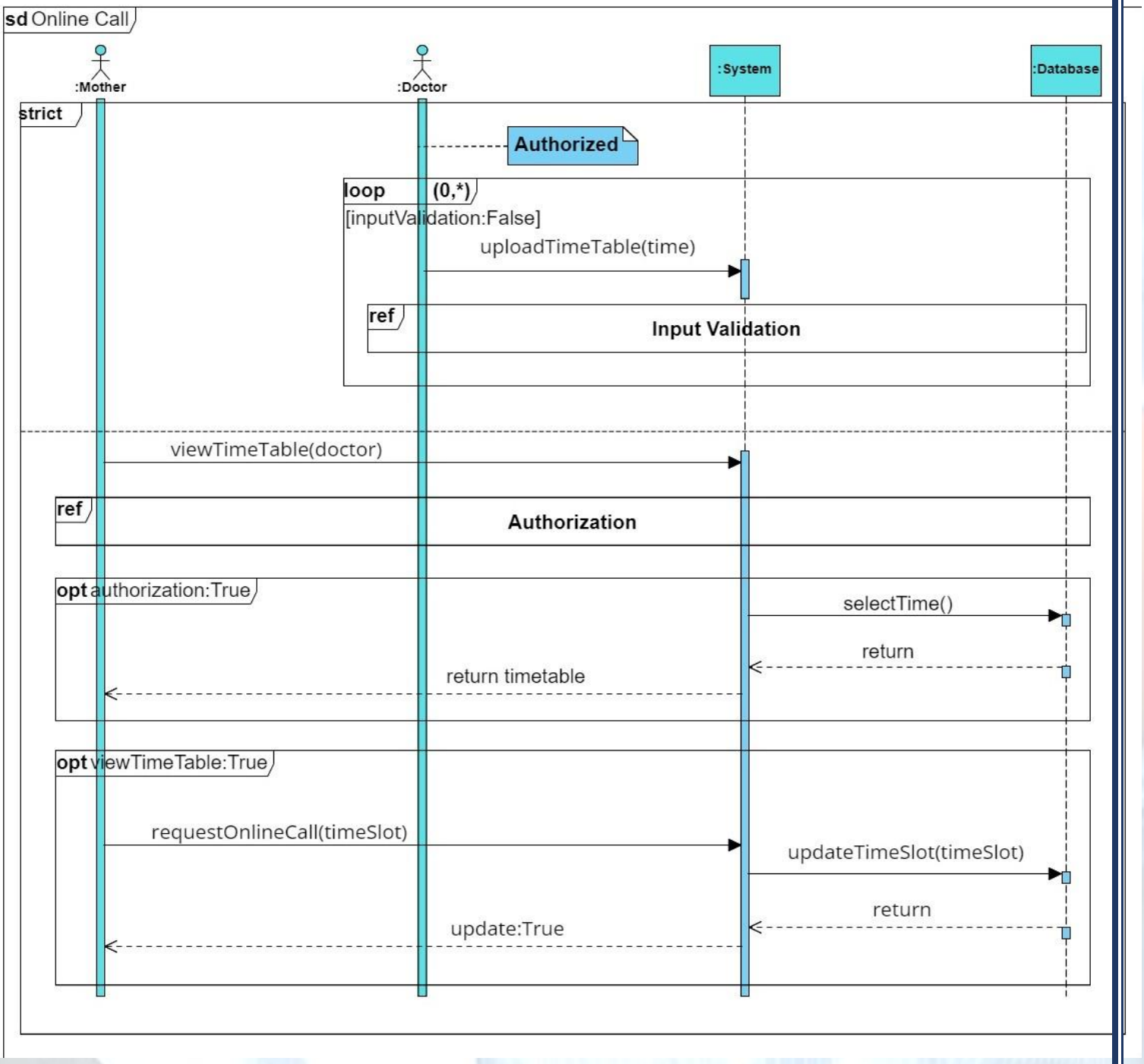
Use-Case Description:

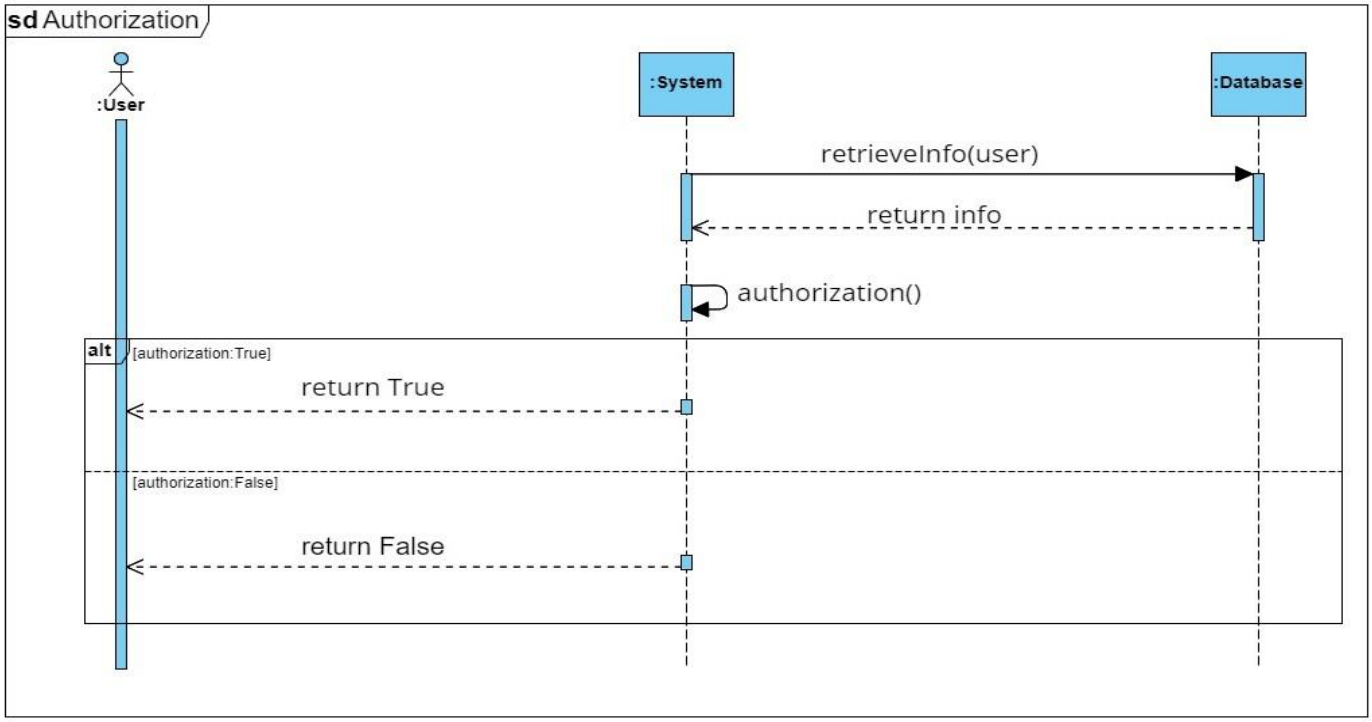
Identifier	M4
Name	doctor and system
Initiator	The Doctor
Pre-conditions	The doctor must have an account in the system .
Post-Conditions	The doctor will have followed up all his patients.
Main success scenario	1.The doctor logs in the system 2. the doctor can view and add to his calendar 3.the doctor can set appointments to be booked by patients 4. the doctor can view patient data and write a virtual prescription
Goal	The doctor will save his time and effort.

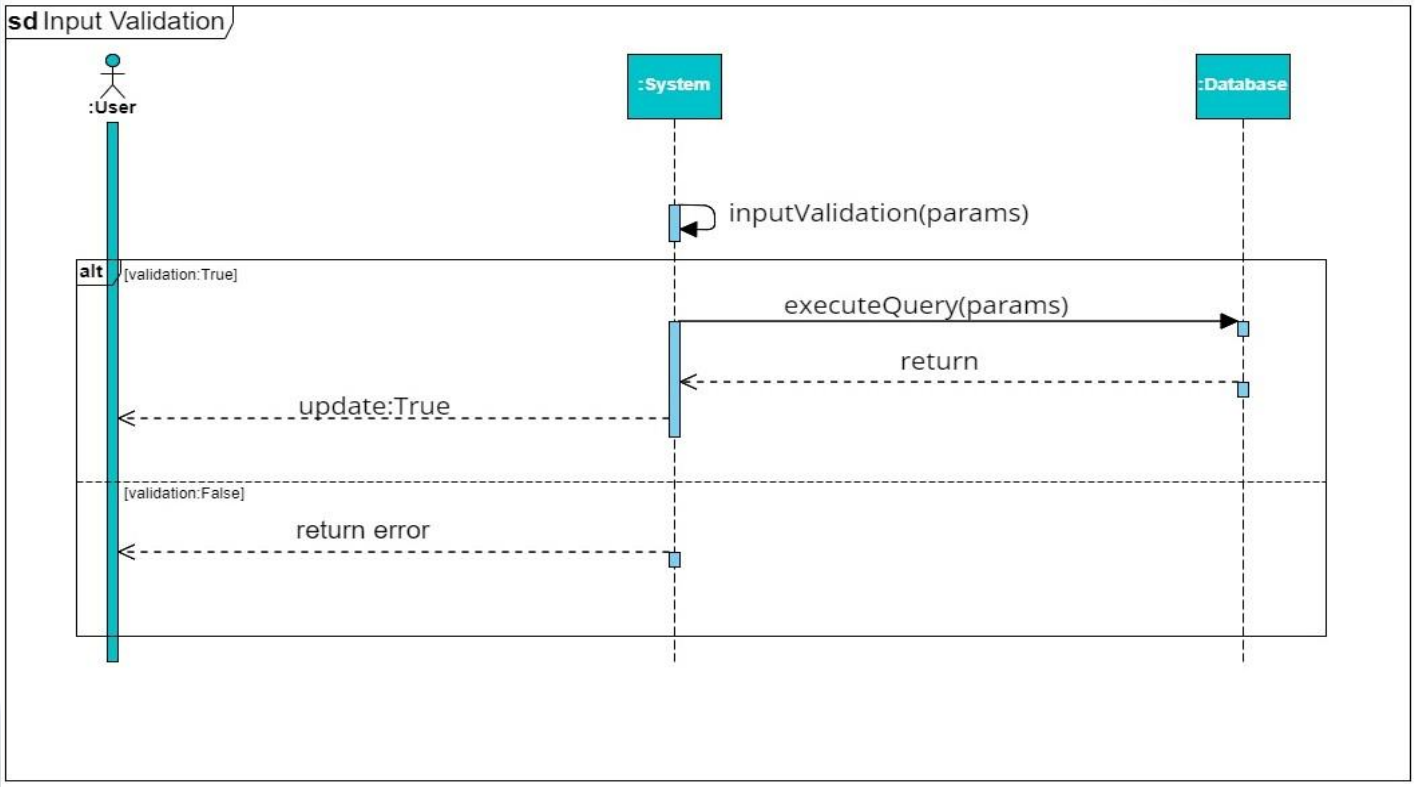
Use-Case Description:

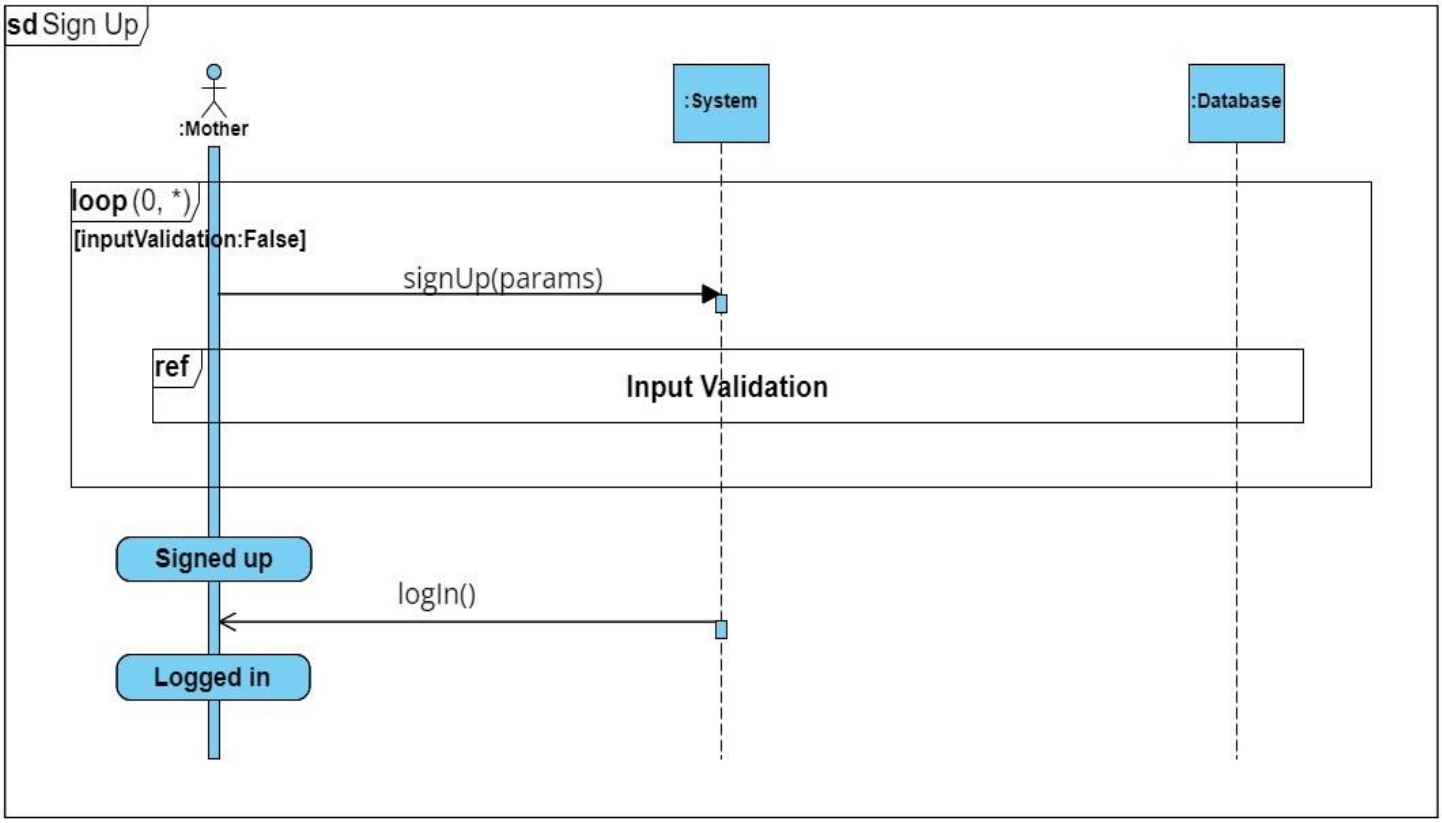
Identifier	M5
Name	Database and system
Initiator	System
Pre-conditions	Data should be stored in the database and accessed by the system
Post-Conditions	The system could predict in case of risk from the data stored in the database by machine learning
Main success scenario	1. Database should store data about the mother and the doctor , chat data ,library data, lab results , and prescriptions for patient 2. System should validate data 3. System should verify at the sign up 4. System have to make authorization 5. System could predict in case of risk 6. System could open online pharmacies for the mother
Goal	-The prediction of system will help the mother from any risks -The stored data could help the doctor and patient to remember what they have done

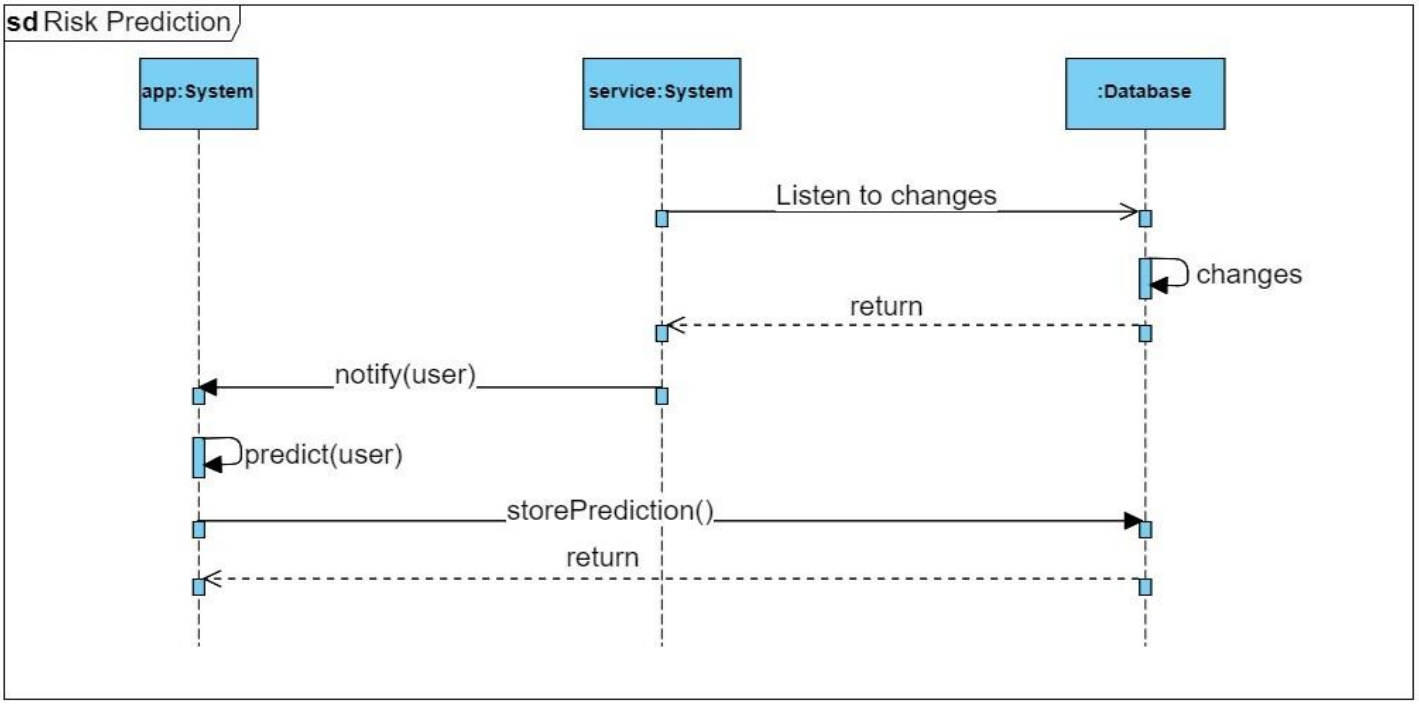
➢ Sequence diagram

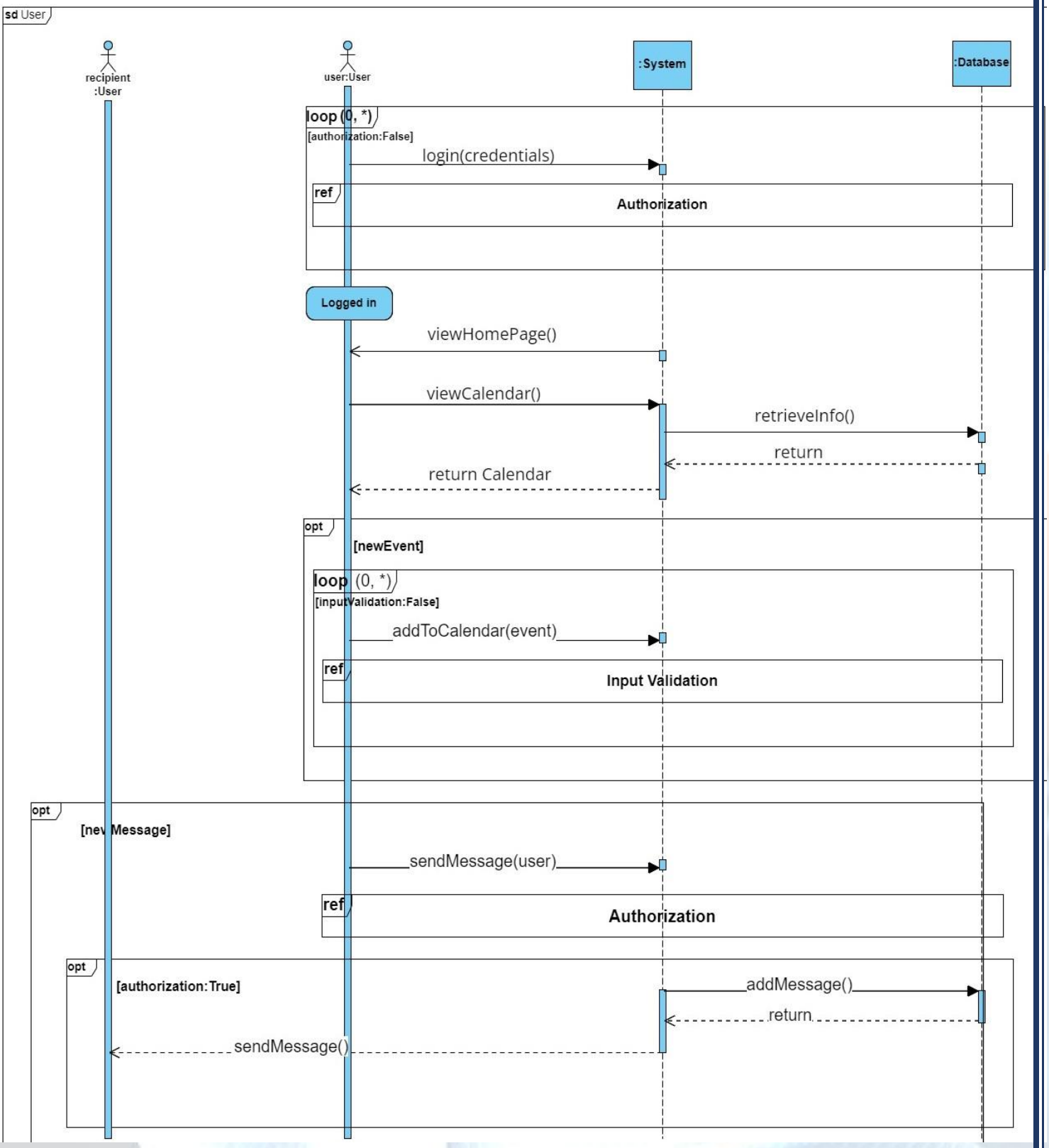


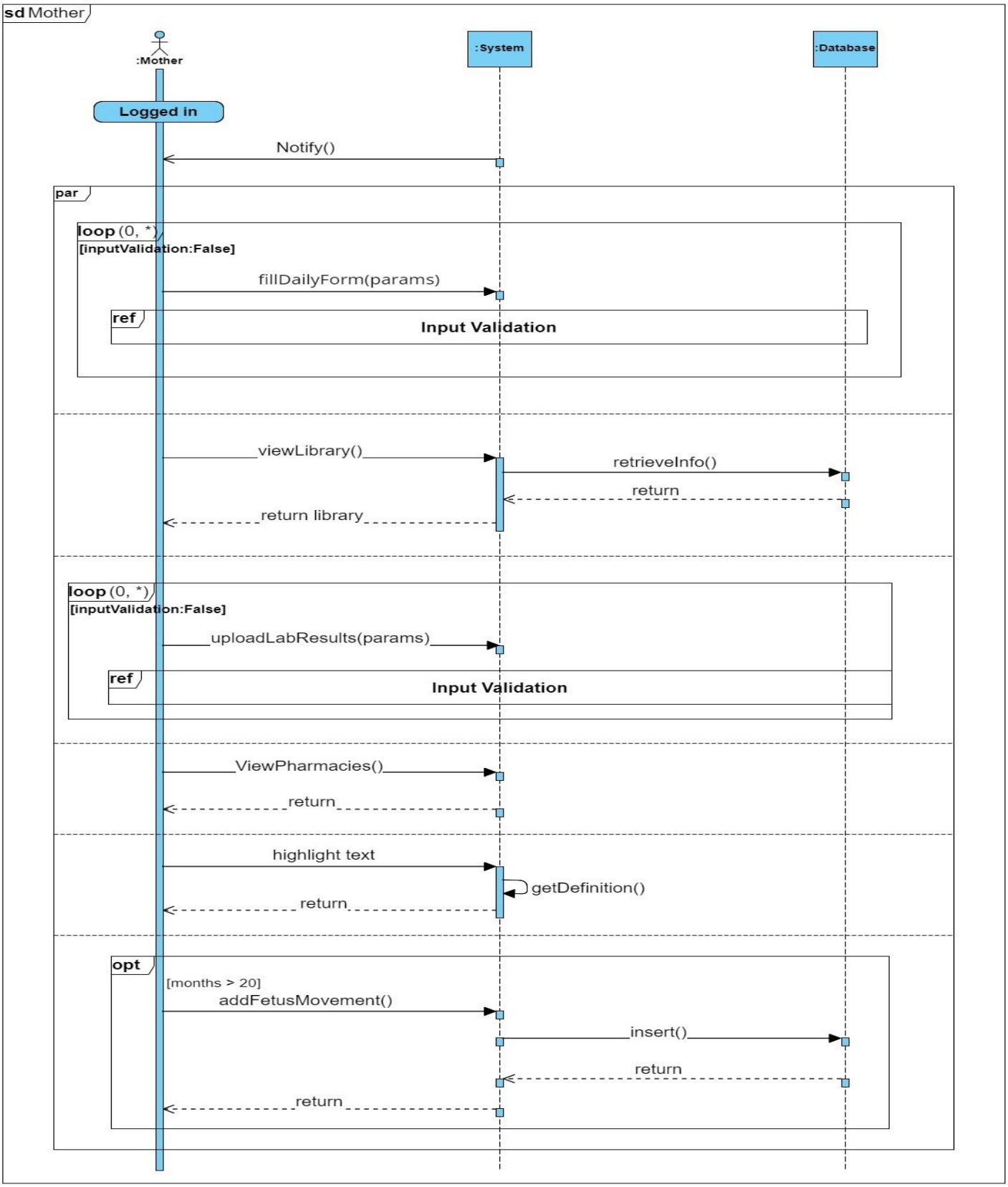

sd Authorization
:User
:System
:Database
retrieveInfo(user)
return info
authorization()
alt
[authorization:True]
return True
[authorization:False]
return False

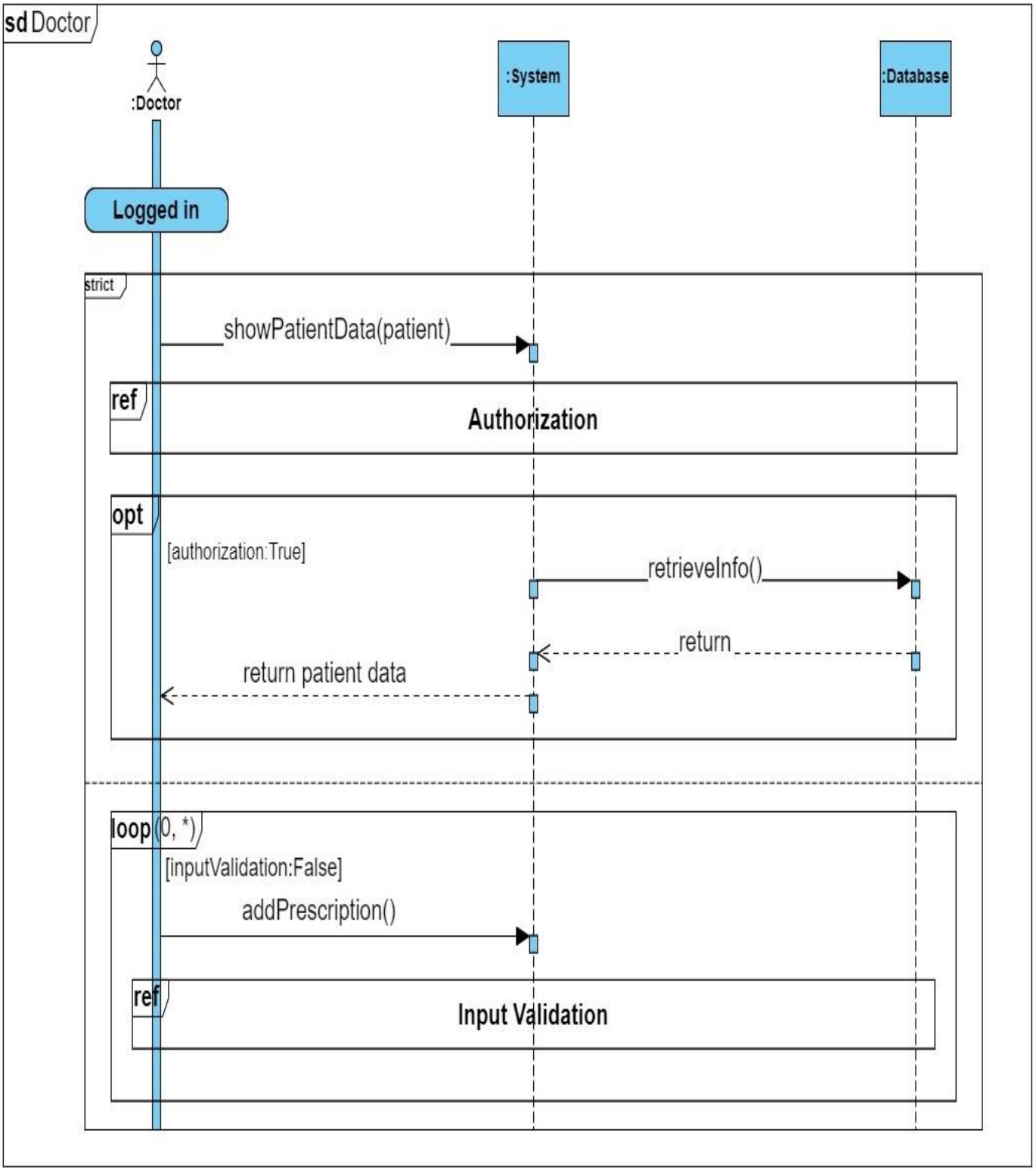

sd Input Validation
:User
:System
:Database
inputValidation(params)
alt
[validation:True]
executeQuery(params)
return
update:True
[validation:False]
return error


sd Sign Up
:Mother
:System
:Database
loop (0, *)
[inputValidation:False]
signUp(params)
ref
Input Validation
Signed up
logIn()
Logged in


sd Risk Prediction
app:System
service:System
:Database
Listen to changes
changes
return
notify(user)
predict(user)
storePrediction()
return


sd User
recipient :User
user:User
:System
:Database
loop (0, *)
[authorization:False]
login(credentials)
ref
Authorization
Logged in
viewHomePage()
viewCalendar()
retrieveInfo()
return
return Calendar
opt
[newEvent]
loop (0, *)
[inputValidation:False]
addToCalendar(event)
ref
Input Validation
opt
[new Message]
sendMessage(user)
ref
Authorization
opt
[authorization:True]
addMessage()
return
sendMessage()


sd Mother
:Mother
:System
:Database
Logged in
Notify()
par
loop (0, *)
[inputValidation:False]
fillDailyForm(params)
ref
Input Validation
viewLibrary()
retrieveInfo()
return
return library
loop (0, *)
[inputValidation:False]
uploadLabResults(params)
ref
Input Validation
ViewPharmacies()
return
highlight text
getDefinition()
return
opt
[months > 20]
addFetusMovement()
insert()
return
return


sd Doctor
:Doctor
:System
:Database
Logged in
strict
showPatientData(patient)
ref
Authorization
opt
[authorization:True]
retrieveInfo()
return
return patient data
loop (0, *)
[inputValidation:False]
addPrescription()
ref
Input Validation

Description of a sequence diagram

➢ Input Validation sequence diagram

- The Input Validation sequence diagram is referenced many times in other diagrams after a function inside the system object that requires input validation has been called.
- Input validation should be done on three levels, Front-End, Back-End, and Database.
- This sequence diagram illustrates the validation done at Front-End and Back-End.
- The details of the input validation function are ambiguous as of now and more depth will be added later.
- If the input validation function returns true then we execute the insert query and return that the operation was successful to the user.
- If the input validation function returns False then we return an error message back to the user.
- We illustrate different kinds of messages sent based on which condition by using an alt operator.

➢ Authorization sequence diagram

- The Authorization sequence diagram is referenced many times in other diagrams after a function inside the system object that requires authorization has been called.
- First the system will retrieve the relevant information of the user from the database and waits for the database's response.
- After receiving the data from the database, an internal function "authorization" is called.
- This function uses the retrieved user information to check if this specific user has the privileges to make his initial request.
- If the authorization function is done without error, it returns True back to the user, else it will return False.

➢ Doctor sequence diagram

- This timeline starts with a system invariant for the doctor called “Logged in”. This describes the current state of the doctor object before any of the following functions can take place.

- Then we have a par operator that has two operands for two different functions:

❖ Viewing patient data
❖ Adding prescriptions

- The par operator decides that any of the two operands can be performed first and doesn’t enforce a specific order.

- It also allows interleaving of execution paths of the two operands:

❖ ***The first*** operand for viewing patient data starts with the doctor object sending a message to the system object calling the showPatientData function with a certain patient as the argument.

Since doctors are not allowed to view any patient but their patients, there was a need for authorization, this is where we inserted an interaction reference for embedding the Authorization sequence diagram inside the Doctor sequence diagram.

If the doctor is authorized to view this particular patient’s (sent as an argument) data, then the system retrieves the information of that patient from the database and returns it to the doctor
To ensure that only the authorized doctors can view patient’s data, we made sure to put the retrieving messages inside an opt operator with a guard that checks for authorization. If the authorization function returned true then the rest of the messages inside the opt fragment are executed.

❖ ***Second*** If the doctor wants to add prescription, he will simply fill an already existent paper format ready to receive his input.
After filling it, the system will view it for input validation and either add it to the database or return an error.

These two steps are wrapped inside a loop operator so the mother could re-enter her input if it fails however much times.
Since the doctor could get it right on the first try, we have set the minimum of the loop to 0.

➢ Mother sequence diagram

- This timeline starts with a system invariant for the mother called "Logged in". This describes the current state of the mother object before any of the following functions can take place.

- Afterwards the system sends an asynchronous message to the mother by executing the Notify function. This notify function reminds the mother to fill the daily form.

- The rest of the functions initiated by the mother are wrapped inside a par operator to allow concurrency between operands and their internal messages.

There are 6 operands inside the par operator which represent the following functions:

1. Fill daily form.
2. View library.
3. Upload laboratory results.
4. View pharmacies.
5. Highlight text.
6. Add fetus movement.

- ***First*** filling the daily form means adding new input to the database which calls for validation of said input.

So first mother object sends a message to system object calling for the fillDailyForm function and afterwards there is an interaction reference to embed the Input Validation sequence diagram inside the Mother sequence diagram.

These two steps are wrapped inside a loop operator so the mother could re-enter her input if it fails however much times.

Since the mother could get it right on the first try, we have set the minimum of the loop to 0.

- ***Second*** The mother could choose to view the library any time, this is simply done by retrieving the information from the database and returning it to the mother.

- ***Third*** Uploading lab results follows the exact same steps as filling the daily form, it requires user-input, and input validation and a loop fragment to allow repetition.

- ***Fourth*** There are many online pharmacies that allow for uploading prescriptions, having medicine delivered and such, so to ensure the full comfort of the mother, we plan to embed links to these pharmacies inside our application.

Those pharmacies are countable and need not be stored in a database.

So the process of retrieving these pharmacies consists of sending a message to the system requesting to view them to which the system responds with their embedded links.

- ***Fifth*** The last operand is one of the most important features in our application as fetus movement is extremely important to check on.

The fetus movement is only checked after 20 months of pregnancy, so it’s wrapped inside an opt operator.

Even though, there is an input being inserted to the database, there is no input validation as this input is not user-dependent but mere incrementing of an already existent value.

➢ Sign Up sequence diagram

- The sign up feature is exclusive to the mother only.
- A message is sent to the System object calling for signUp with the mother's information as argument.
- Then there is input validation for her information.
- This process is repeated as long as the input validation function returns false.
- If the input validation function returns true, the sign-up loop is broken out of and the state of the mother becomes "Signed up".
- The system immediately logs the mother in, which changes her state to "Logged in".

➢ User sequence diagram

- The User sequence diagram stands for what both the doctor and the mother objects are able to perform.
- First the user logs in and is checked for authorization, this process is repeated until the user is authorized and his state changes to "Logged in".
- As soon as the user is logged in, the system immediately displays the homepage relevant to that particular user.
- The user then can view their calendar by sending a message to the system which the system responds to with a calendar specific to that particular user after retrieving it from the database.
- If there is a new event, the user can add to their calendar, hence the opt operator.

- If there is a new message intended for a specific doctor/mother, the user sends it to that particular recipient, however, there is a need to check if the user is authorized to chat with that particular recipient or not.
- If the user is authorized, the new message is added to the database and sent to the recipient.
- We use two different roles for the same class objects here which are: user, recipient.
- The recipient role is only needed so the user object will be able to send to another user object.

➢ Online Call sequence diagram

- The Online Call sequence diagram is to show one of the important features of our application and requires both the actors of the Mother and Doctor to interact.

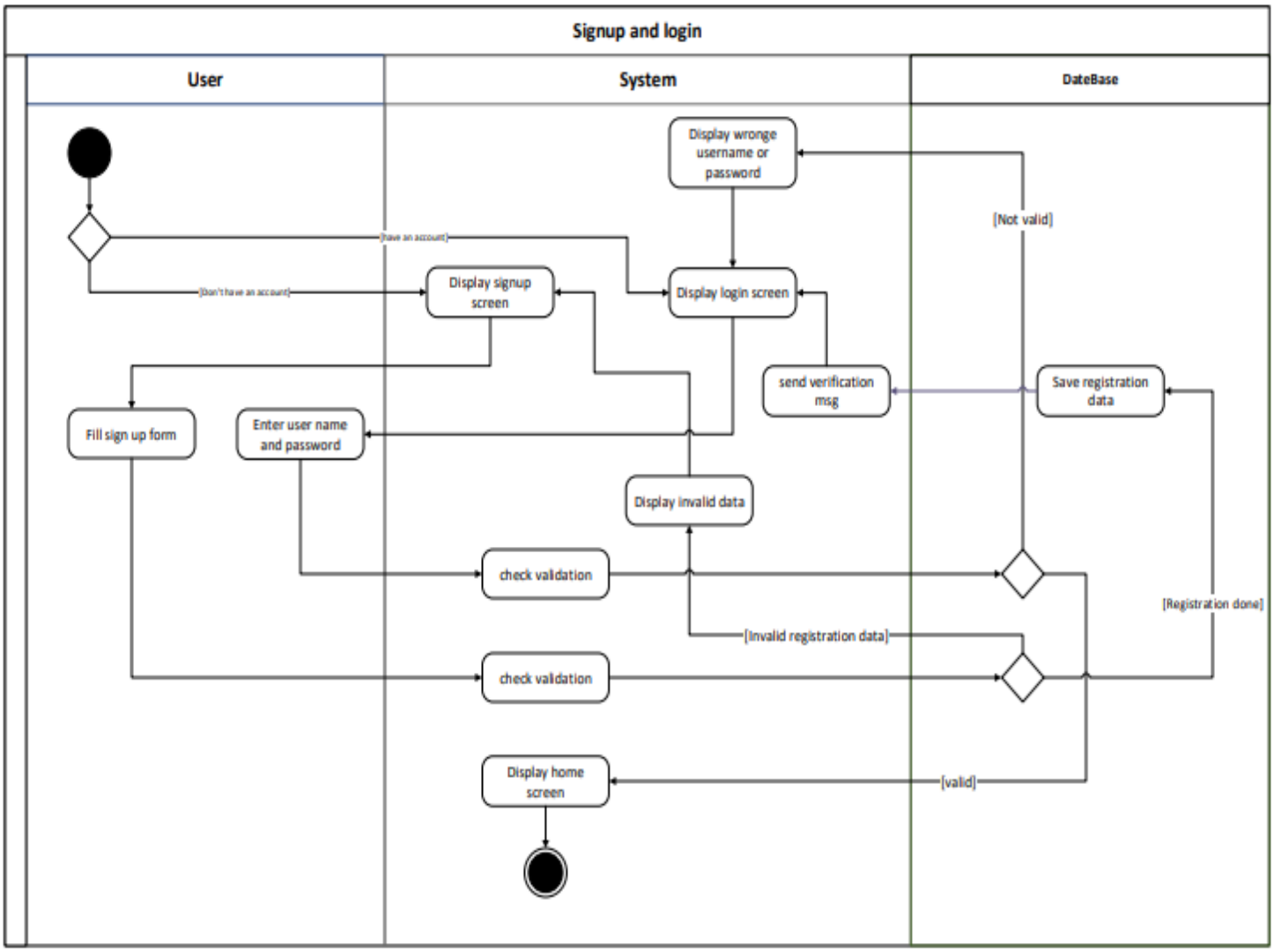
- First we have a strict operator with two operands two ensure that the first operand will be executed before the second.
- The first operand starts with the doctor object in an “Authorized” state.
- The doctor then must upload his timetable for his available online call times which the system will validate.
- Afterwards we move onto the second operand, where the mother sends a message to the system requesting to view the timetable of a specific doctor, after which the system must make sure the mother is authorized to do so.

- If the authorization function returns True, the system retrieves the timetable and returns it to the mother.
- If the mother was able to view the timetable, she can then book a time slot by sending a message to the system which will send an update message to the database then return True back to the mother to confirm the booking.

➢ Risk Prediction sequence diagram

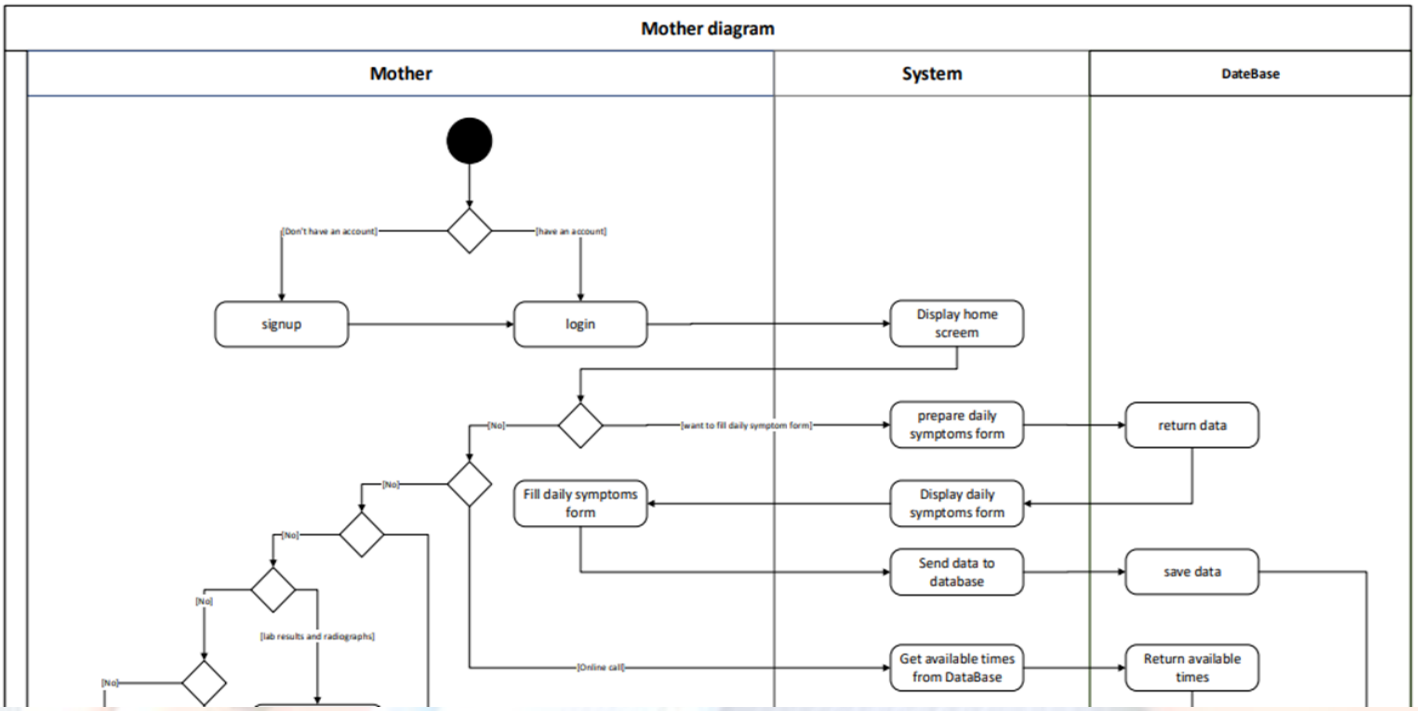
- Our entities in this sequence diagram are the system with two different roles: app and service, and the database.
- This sequence diagram shows the essential objective of our application which is maternal health risk prediction.
- The service will listen to any changes in the database of the mother and once the database changes, the service will notify our application of this change carrying the specific mother object that was changed.
- Our app then reruns our prediction algorithms and stores it in the database so the mother and her doctor can view it or be notified for any risks.

➢ Activity diagram

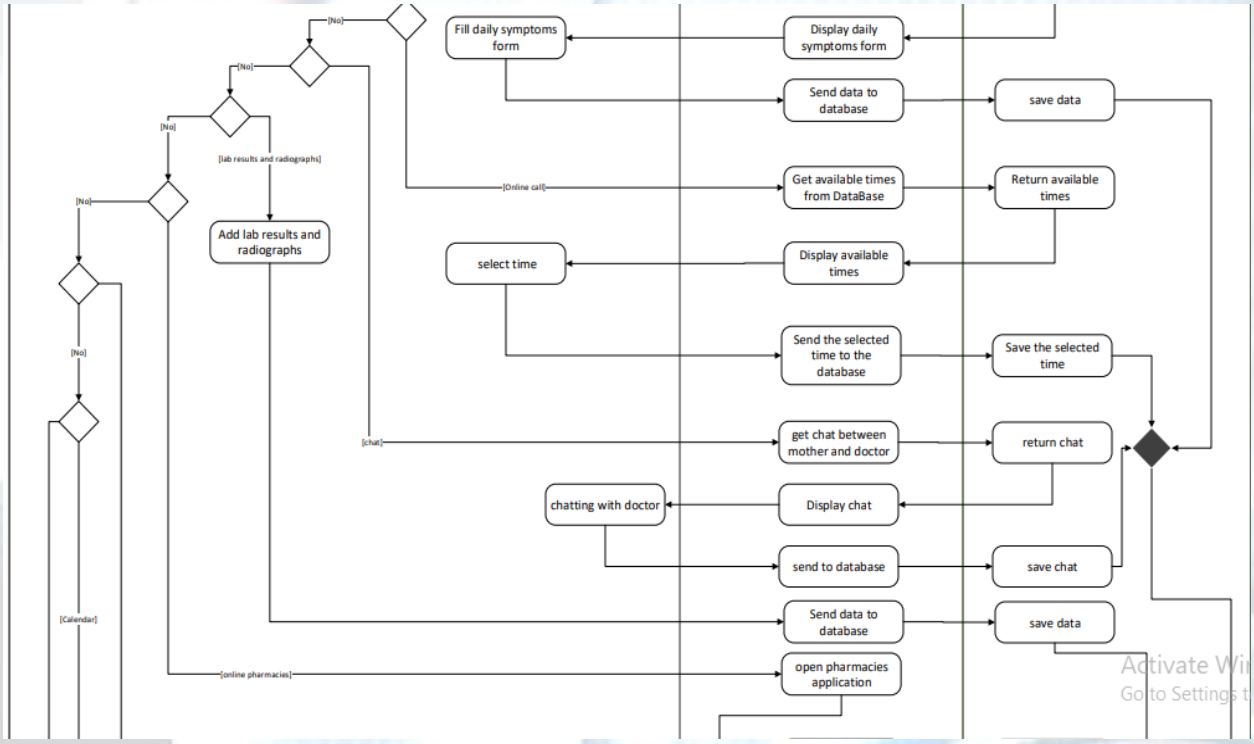


Activity diagram describes the signup and login processes. It describes the flow from when the user opens the application to logging in successfully. If the user has an account, the system displays the login screen, where the user enters the user name and password, and the system validates the data. If the user enters valid data, the system displays the home screen; if the data is not valid, the system displays wrong username or password and displays the login screen again.

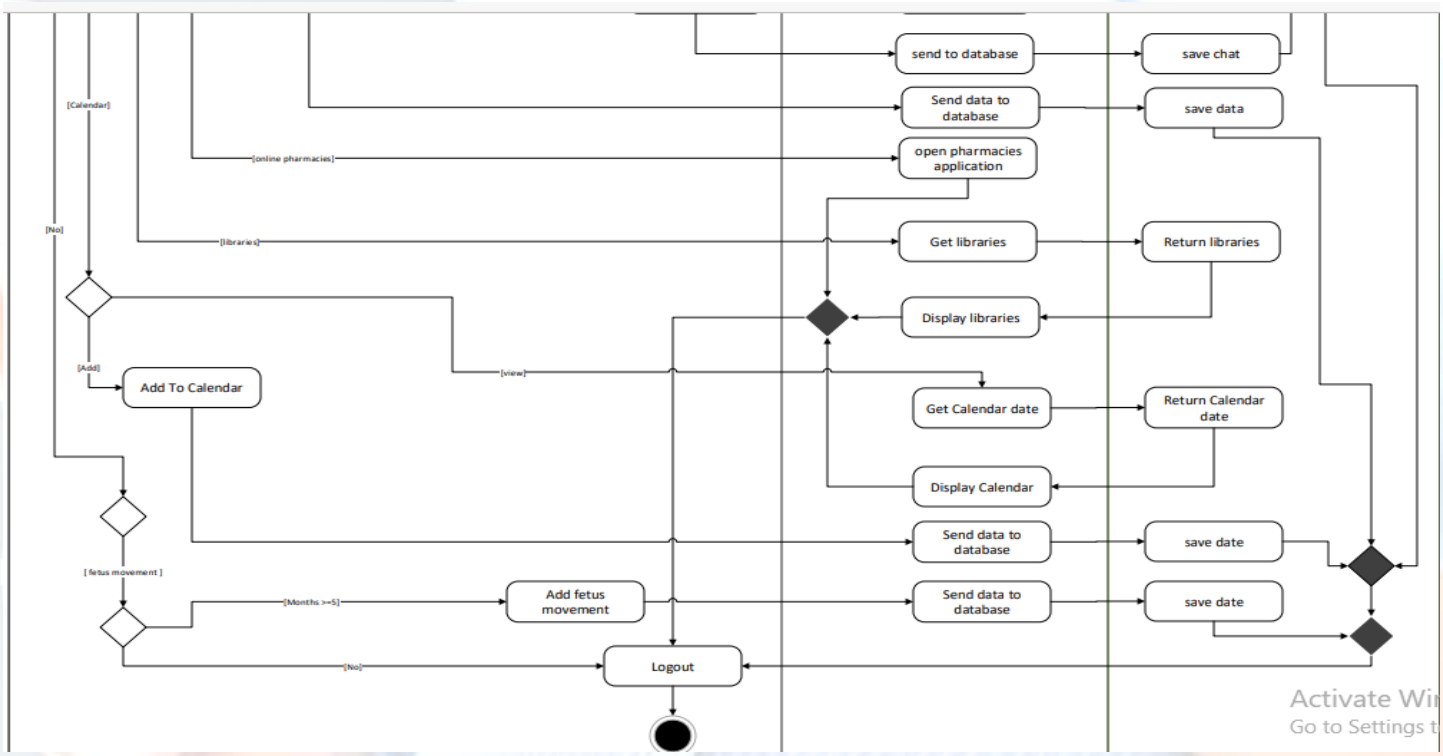
Mother diagram part 1



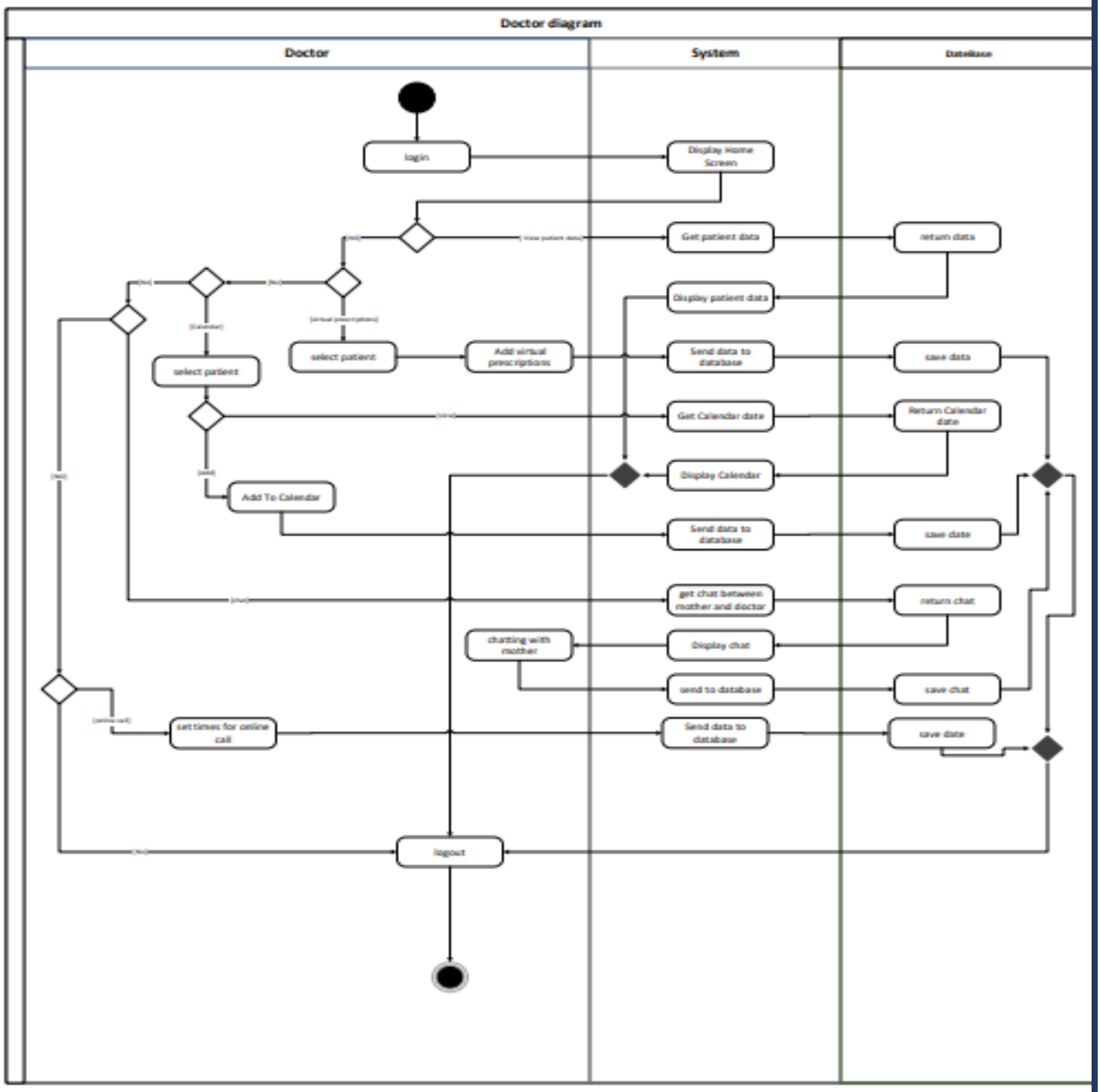
Mother diagram part 2



Mother diagram part 3



The mother activity diagram describes the activities of mothers in the application. It describes the flow of activities that a mother can perform in the application, such as filling out a daily symptoms form, uploading lab results and radiographs, chatting and making online calls with a doctor, add data to Calendar, Add fetus movement and view libraries and so on.



The doctor activity diagram describes the activities of doctors in the application. It describes the flow of activities that a doctor can perform in the application, such as adding virtual prescriptions, adding data to the patient calendar, chatting and making online calls with a mother, viewing patient data, and so on.