**QUAID-I-AZAM UNIVERSITY ISLAMABAD**

**DEPARTMENT OF COMPUTER SCIENCE**



**IOT BASED MOTHER AND FETUS HEALTH MONITORING**

**SOFTWARE PROJECT TECHNICAL DOCUMENTATION**

|  |  |
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# **Chapter No 1 Software Project Management Plan**

# 1 Introduction

## 1.1 Project Overview

* **Purpose**: To develop an **IoT-based real-time Mother and Fetus Health Care Monitoring System** that enables pregnant women to track vital health parameters at scheduled intervals, facilitating early detection of potential pregnancy-related risks.
* **Objectives**:
  + Design and implement a wearable device capable of measuring
    1. Blood pressure,
    2. Pulse Rate
    3. Body temperature,
    4. Blood sugar levels,
    5. Fetal movement.
  + Store the measured data on an online database for risk analysis.
  + Design a mobile application that will:
    1. Check patient data to detect pregnancy risks related to the above parameters & generate alerts for both patient and doctor if there is any risk.
    2. Connect Doctors with their patients. The doctor can mark the risk as accurate or non-accurate after a detailed medical checkup and doctors can prescribe personalized diet plans and medicine if applicable.
* **Scope:**
  + Development of hardware (smart wristband) and software (mobile application) components.
  + Implementation of data collection at scheduled intervals, transmission, and analysis functionalities.
  + User interface design for both patients and healthcare professionals.
  + This app will not suggest any medicine to the patient because it is illegal to do so without a license.

## 1.2 Project Deliverables

Project deliverable includes:

1. **Technical Documentation:**
   1. Software Project Management Plan
   2. Software Requirement Specification
   3. Software Design Description
   4. Software Test Documentation
2. **Mobile Application**
3. **Wearable Wrist Band:**
   1. Arduino Uno Micro-controller
   2. Arduino ESP8266 Micro-controller
   3. Sensor
      1. Blood Pressure and Pulse Monitor
      2. Body Temperature Sensor
      3. Blood Glucose Sensor
      4. Heart Rate Sensor
      5. Fetal Movement Buttons

## 2 Project Organization

### 2.1 Software Process Model

For the development of IoT Based Mother and Fetus Health Care Monitoring System, An **Agile Software Development Model** is chosen.



Figure 1: Agile Software Development Model

Agile methodologies are iterative and incremental, which means they are known for dividing the project into smaller parts and adjusting to changing requirements. It prioritizes flexibility, collaboration, and customer satisfaction.

### 2.2 Roles and Responsibilities

1. **Student (Khurram Shahzad):**
   1. System Analyst
   2. Software Architect
   3. Database Designer
   4. UI / UX Designer
   5. Front-end Developer
   6. Software Developer
   7. Quality Assurance Engineer
2. **Project Supervisor (Prof. Dr. Muazzam Ali Khan Khattak)**
   1. Mentor, Reviewer, Technical Guidance.

### 2.3 Tools and Techniques

|  |  |
| --- | --- |
| **Tools / Technique** | **Purpose** |
| Project Libre | For creating Project Timeline & Gantt Charts & tracking milestones. |
| Microsoft Word | For creating technical project documentation. |
| Draw.io | For designing UML diagrams. |
| Android Studio | As an IDE for Mobile Application Development for Mother and Doctor. |
| Vs Code | A lightweight code editor for NodeJS, ExpressJS programming. |
| Firebase | For storing data by syncing real time health data from sensor to the cloud. |
| NodeJS & Express.JS | NodeJS & Express JS for Backend Development. |
| Dart | Backend Programming Language for Mobile Application development. |
| Flutter | For cross platform Mobile Application’s Front end. |
| Git GitHub | For version control and collaboration. |
| Postman | For API Testing. |
| Figma | For creating UI design. |
| Arduino IDE | As an IDE for writing the code to program Arduino/ESP32 micro-controllers to read sensor data and transmit it. |
| C++ | Language supported by Arduino Micro-controller. |

## 3 Project Management Plan

The Project Management Plan describes how time and resources are managed throughout the project life cycle.

### 3.1 Tasks

These are the task that will be carried out through the software development life cycle.

## 3.1.1 Requirement Analysis Phase

### 3.1.1.1 Requirements Identification

|  |  |  |
| --- | --- | --- |
| **Task Description** | The initial step of this project is the identification of requirements which are functional and non-functional. | |
| **Deliverables** | Requirements are collected and reviewed | |
| **Resource Needed** | **People** | Khurram Shahzad,  Prof. Dr. Muazzam Ali Khan Khattak |
| **Software** | Microsoft Word |
| **Hardware** | Laptop |
| **Dependencies and Constraints** | None | |
| **Risks** | None | |

### 3.1.1.2 Defining Use Cases

|  |  |  |
| --- | --- | --- |
| **Task Description** | After finalizing all **Software** requirements, Use Case Description and Diagrams will be created. | |
| **Deliverables** | Use Case Description, Use Case Diagram | |
| **Resource Needed** | **People** | Khurram Shahzad,  Prof. Dr. Muazzam Ali Khan Khattak |
| **Software** | Microsoft Word, Draw.io |
| **Hardware** | Laptop |
| **Dependencies and Constraints** | All functional requirements should be clear. | |
| **Risks** | Requirements may change frequently. | |

### 3.1.1.3 Develop Domain Model

|  |  |  |
| --- | --- | --- |
| **Task Description** | After finalizing the Use Case description and diagrams, Domain Model will be created. | |
| **Deliverables** | Domain Model | |
| **Resource Needed** | **People** | Khurram Shahzad,  Prof. Dr. Muazzam Ali Khan Khattak |
| **Software** | Microsoft Word, Draw.io |
| **Hardware** | Laptop |
| **Dependencies and Constraints** | We must know all the Use Case before developing domain model. | |
| **Risks** | Addition of new use cases may affect the domain model. | |

### 3.1.1.4 ERD Design

|  |  |  |
| --- | --- | --- |
| **Task Description** | This task includes creating of entity relationship diagram. | |
| **Deliverables** | ERD Diagram. | |
| **Resource Needed** | **People** | Khurram Shahzad,  Prof. Dr. Muazzam Ali Khan Khattak |
| **Software** | Microsoft Word, Draw.io |
| **Hardware** | Laptop |
| **Dependencies and Constraints** | We must know the Domain Model Design in order to know the flow of data and what data we will need in this step. | |
| **Risks** | An update in the domain model will also require change in ERD Diagram. | |

### 3.1.1.5 Software Requirements Specification Completion

|  |  |  |
| --- | --- | --- |
| **Task Description** | This task includes making **Software** Requirement Specification document. | |
| **Deliverables** | Complete SRS Document. | |
| **Resource Needed** | **People** | Khurram Shahzad,  Prof. Dr. Muazzam Ali Khan Khattak |
| **Software** | Microsoft Word |
| **Hardware** | Laptop |
| **Dependencies and Constraints** | None | |
| **Risks** | None | |

## 3.1.2 Design Phase

### 3.1.2.1 Develop Design

|  |  |  |
| --- | --- | --- |
| **Task Description** | Development of Architectural Design | |
| **Deliverables** | Architectural Diagram | |
| **Resource Needed** | **People** | Khurram Shahzad,  Prof. Dr. Muazzam Ali Khan Khattak |
| **Software** | Microsoft Word |
| **Hardware** | Laptop |
| **Dependencies and Constraints** | Requirement Analysis must be completed. | |
| **Risks** | None | |

### 3.1.2.2 Developing Interfaces

|  |  |  |
| --- | --- | --- |
| **Task Description** | This task includes how each screen will look like and which feature would come on which screen. | |
| **Deliverables** | Figma Design | |
| **Resource Needed** | **People** | Khurram Shahzad,  Prof. Dr. Muazzam Ali Khan Khattak |
| **Software** | Microsoft Word, Figma |
| **Hardware** | Laptop |
| **Dependencies and Constraints** | Requirement Analysis must be completed. | |
| **Risks** | None | |

### 3.1.2.3 Class Diagram Designing

|  |  |  |
| --- | --- | --- |
| **Task Description** | This task includes creation of Class Diagram. It shows the flow of data and how they are related to each other. | |
| **Deliverables** | Class Diagram. | |
| **Resource Needed** | **People** | Khurram Shahzad,  Prof. Dr. Muazzam Ali Khan Khattak |
| **Software** | Microsoft Word, Draw.io |
| **Hardware** | Laptop |
| **Dependencies and Constraints** | Architectural Design must be completed. | |
| **Risks** | If architectural design and domain model are not well defined, it may cause problems. | |

### 3.1.2.4 Sequence Diagram Design

|  |  |  |
| --- | --- | --- |
| **Task Description** | In this step we will create Sequence Diagrams to show the flow of data between user and system classes. | |
| **Deliverables** | Sequence Diagrams | |
| **Resource Needed** | **People** | Khurram Shahzad,  Prof. Dr. Muazzam Ali Khan Khattak |
| **Software** | Microsoft Word, Figma |
| **Hardware** | Laptop |
| **Dependencies and Constraints** | Architectural Design must be completed. | |
| **Risks** | If architectural design and domain model is not well defined, it may cause problems. | |

### 3.1.2.5 Design Phase Verification

|  |  |  |
| --- | --- | --- |
| **Task Description** | In this step we will verify all the previous steps of this phase. | |
| **Deliverables** | Design Phase is completed and it’s document will be reviewed. | |
| **Resource Needed** | **People** | Khurram Shahzad,  Prof. Dr. Muazzam Ali Khan Khattak |
| **Software** | Microsoft Word, Figma |
| **Hardware** | Laptop |
| **Dependencies and Constraints** | The whole Design Phase must be completed. | |
| **Risks** | If architectural design and domain model is not well defined, it may cause problems. | |

### 3.1.2.6 Software Test Documentation

|  |  |  |
| --- | --- | --- |
| **Task Description** | In this step we will define the test cases. | |
| **Deliverables** | Tests are reviewed. Design Phase is complete. | |
| **Resource Needed** | **People** | Khurram Shahzad,  Prof. Dr. Muazzam Ali Khan Khattak |
| **Software** | Microsoft Word |
| **Hardware** | Laptop |
| **Dependencies and Constraints** | Design Phase should be completed. | |
| **Risks** | None. | |

## 3.1.3 Implementation Phase

### 3.1.3.1 System Implementation

|  |  |  |
| --- | --- | --- |
| **Task Description** | In this step we will connect the sensors to Arduino microcontroller, send data to firebase, create the web server, write code for mobile application. | |
| **Deliverables** | Mobile App, Wrist Band | |
| **Resource Needed** | **People** | Khurram Shahzad,  Electronics Expert,  Prof. Dr. Muazzam Ali Khan Khattak |
| **Software** | Microsoft Word, VsCode, Android Studio, Firebase |
| **Hardware** | Laptop, Arduino ESP8266, Sensors, Wires, |
| **Dependencies and Constraints** | Would need to learn technologies such as Dart, Flutter. | |
| **Risks** | None. | |

## 3.2 Assignments

|  |  |  |
| --- | --- | --- |
| **Task** | **Assignee** | **Role** |
| Requirement Identification | Khurram Shahzad | System Analyst |
| Defining Use Cases | System Analyst |
| Develop Domain Model | System Analyst, Software Architect |
| ERD Design | Database Designer, System Analyst |
| Software Requirement Specification | Technical Writer |
| Develop Design | Software Architect, System Designer |
| Develop Interfaces | UI/UX Designer, Front-End Developer |
| Class Diagram Designing | Software Architect, System Analyst |
| Sequence Diagrams | System Analyst, Software Architect |
| Design Phase Verification | Quality Assurance Engineer, Software Architect |
| Software Test Documentation | QA Engineer, Test Analyst |
| Implementation Phase | Software Developer |

## 3.3 Timetable

A table with numbers and letters

AI-generated content may be incorrect.

Figure 2 Timetable

## 3.4 Gantt Chart

A screenshot of a computer

AI-generated content may be incorrect.

Figure 3 Gantt Chart

# **Chapter 2 Software Requirement Specification**

## 2.1 Introduction

This document describes the expected software features, constraints, interfaces and other attributes. In this document we will define cases, sequence diagrams, domain model and database design of the project.

## 2.2 Functional Requirements

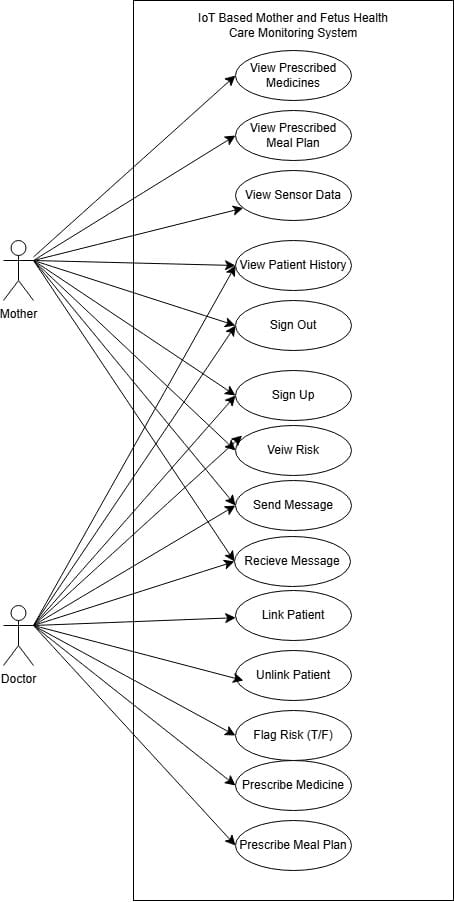
The functional requirements for the IoT Based Mother and Fetus Health Monitoring System wearable device are:

1. The wearable device should be capable of measuring:
   1. Body Temperature.
   2. Heart Rate.
   3. Blood Pressure.
   4. Pulse Rate.
   5. Fetus Movement
   6. Blood Sugar Level.
2. The wearable device should save data on an online database.
3. The device should provide a set of buttons that will help the mother to count kicks, flutter, roll, jabs etc.

The functional requirements of Mobile App are:

1. It should allow the patient and doctor to sign up on the app.
2. It should allow the doctors and patients to sign in to the app.
3. It should allow the patient and doctor to link with each other.
4. It should allow the patient and doctor to unlink once delivery is successful or ends
5. It should allow text messages between a patient and her doctor.
6. It should display the live sensors output to the patient and her doctor.
7. It should send push notifications to patients and doctors if there are any risks.
8. Clicking on the push notifications should show an interface to the patient and doctor displaying the reason why alert was generated and what is the risk?
9. It should allow the doctor to mark the risk as true or false.
10. It should allow the doctor to see the patient’s history if it is her second pregnancy and the patient is using the app for her second pregnancy as well.
11. It should allow the doctor to prescribe medicine and meal plans.
12. It should allow the doctor to update the prescribed meal plan and medicines.
13. It should allow the patient to view prescribed meal plans and medicines.
14. The body temperature should be measured continuously to check fever.
    1. If the mother’s body temperature is between 36.1°C to 37.3°C (97°F to 99.1°F) then it’s normal temperature.
    2. If the mother’s body temperature is greater than 38°C (100.4°F) then it is fever and there is risk of infection, preterm labor or birth defects (especially in early pregnancy).
    3. If the mother’s body temperature is less than 35°C (95°F) then it is Hypothermia and there is risk of slow metabolism, fetal distress or poor circulation.
15. The blood pressure should be checked every 4 hours a day after 20 weeks of pregnancy.
    1. If blood pressure is around 120/80 mmHg, then the blood pressure is normal.
    2. If blood pressure is greater than or equals to 140 / 90 mmHg on 2 occasions in 4 hours apart in pregnancy, and blood pressure was normal before pregnancy then the patient is suffering from Pregnancy Induced Hypertension. This problem is resolved within 12 weeks of postpartum.
    3. If blood pressure is greater than or equals 140 / 90 mmHg after 20 weeks of pregnancy, then this type of hypertension is known as Gestational Hypertension. In this case there is no proteinuria or end organ damage.
    4. If blood pressure is greater than or equals 140 / 90 mmHg but less than 160 / 110 mmHg, then this type of hypertension is known as mild Preeclampsia.
    5. If blood pressure is greater than or equals 160 / 110 mmHg after 20 weeks of pregnancy, then this type of hypertension is known as severe preeclampsia. In this case there are signs of end organ damage.
    6. If blood pressure is greater than or equals 160 / 110 mmHg with generalized tonic seizures after 20 weeks of pregnancy, then this type of hypertension is known as eclampsia.
16. The heart rate should be measured continuously.
    1. If heart rate is between 60 to 100 bpm the heart rate is normal.
    2. If the heart rate is greater than 100 bpm then it is a risk known as Tachycardia.
    3. If the heart rate is less than 60 bpm then it is a risk known as Bradycardia.
17. The blood sugar should be checked
    1. In the first trimester if patient is overweight or has a family history of diabetes to diagnose gestational diabetes. If gestational diabetes is diagnosed, then sugar should be checked daily before breakfast and 1-2 hours after meals.
    2. If gestational diabetes is diagnosed between 24 to 28 weeks of pregnancy, then sugar should be checked daily before breakfast and 1-2 hours after meals.
    3. If blood sugar is 75 -95 mg /dL before meal or less than 140 mg/dL but greater than 120 mg/dL after 1 hour meal or less than 120 mg/dL after 2-hour meal, then it is normal blood sugar in pregnant women.
    4. If blood sugar is greater than 92 mg /dL before meal or greater than 180 mg/dL after 1 hour meal or greater than 153 mg/dL after 2-hour meal, then this risk in pregnant women is known as Gestational Diabetes Mellitus.
18. The mother should be counting the baby kicks in the third trimester.
    1. The mother should choose a time in which the baby moves well.
    2. 10 movements in 1 hour are considered typically normal.
    3. If a mother feels less than 10 movements in the 1st hour, then it does not mean that something is wrong. In this case the machine should help the mother to count the time until it reaches 10 kicks. After 2-3 days, mother will know what the normal time for her baby is to reach movements. This technique is known as Cardiff count technique.
    4. If there is an enormous amount of change in movement patterns or no movement for i.e yesterday it took 1.3hrs to complete 10 movements and today it took 3-4 hrs., then the patients should inform the doctor. It can be a sign of fetal distress.
    5. If mothers are troubled to count kicks than others in case, they are higher BMI (overweight) or in case placenta is in the front side of the moves.
19. Pregnancy falls into a high-risk category if mother has gestational diabetes, high blood pressure or fetal growth retaliation or cholestasis this calls for a stricter kick count. In case this going to hospital necessary for ultrasound.

## Use Case Diagram



## Use Case Descriptions

### **UC-1 Sign Up**

|  |  |
| --- | --- |
| **USE CASE ID** | UC-1 |
| **USE CASE NAME** | Sign Up |
| **PRIMARY ACTORS** | * + - 1. Doctor       2. Mother |
| **SECONDARY ACTORS** | * + - 1. Firebase |
| **STAKE HOLDERS**  **AND INTEREST** | **Doctor:** Create an account to monitor patients.  **Mother:** Create an account to track health data. |
| **PRE CONDITION** | 1. The user has installed the Mobile App. 2. The user account does not exist on the system. |
| **POST CONDITION** | 1. A new user account is created and stored in Firebase. 2. The user is redirected to the Sign In screen. |
| **MAIN SUCCESS SCENARIO** | 1. The user opens the mobile application. 2. The system displays the Sign up Screen. 3. The user enters credentials (email, name, password, confirm password role: Doctor or Mother). 4. The system validates the credentials (i.e valid email format, password strength). 5. The system stores the account in Firebase. 6. The system displays a confirmation message and redirects to the Sign In screen. |
| **EXTENSION**  **(ALTERNATIVE FLOW)** | **3a. Invalid email format:** System displays “Invalid email format” and prompts re-entry.  **3b. Password mismatch:** System displays “Passwords do not match” and prompts re-entry.  **3c. Account already exists:** System displays “Account exists” and prompts to sign in or use another email. |
| **SPECIAL REQUIREMENT** | Email should be a valid email.  Minimum password length: 8 characters , including one uppercase, one number, and one special character. |
| **TECHNOLOGY**  **AND DATA VARIATION LIST** | Smart Phone,  Firebase (JSON data format). |
| **FREQUENCY OF USE** | Low. |
| **SPECIAL ISSUES** | None |

### **UC-2 Sign in**

|  |  |
| --- | --- |
| **USE CASE ID** | UC-2 |
| **USE CASE NAME** | Sign in |
| **PRIMARY ACTORS** | * + - 1. Doctor       2. Mother |
| **SECONDARY ACTORS** | * + - 1. Firebase |
| **STAKE HOLDERS AND INTEREST** | **Doctor:** Access the patient’s data.  **Mother:** Monitor health data. |
| **PRE CONDITION** | 1. The user has installed the Mobile App. 2. The user account exists in Firebase. |
| **POST CONDITION** | 1. The user has signed in and redirected it to the home screen. 2. The sign-in fails and the user remains on the login screen. |
| **MAIN SUCCESS SCENARIO** | 1. The user opens the mobile application. 2. The system displays a Sign in Screen. 3. The user enters email and password. 4. The system validates credentials against Firebase. 5. The system authenticates the user and redirects to home screen. |
| **EXTENSION (ALTERNATIVE FLOW)** | **3a. Invalid email/password:** System displays “Incorrect email or password” and prompts re-entry.  **3b. Account does not exist:** System displays “Account not found” and prompts to sign up. |
| **SPECIAL REQUIREMENT** | - |
| **TECHNOLOGY AND DATA VARIATION LIST** | Smart Phone,  Firebase (JSON data format). |
| **FREQUENCY OF USE** | Low. |
| **SPECIAL ISSUES** | None |

### **UC-3 Pair Wrist Band**

|  |  |
| --- | --- |
| **USE CASE ID** | UC-3 |
| **USE CASE NAME** | Pair Wrist Band |
| **PRIMARY ACTORS** | 1. Mother |
| **SECONDARY ACTORS** | 1. Wrist Band 2. Firebase |
| **STAKE HOLDERS**  **AND INTEREST** | **Mother:** Pair wrist band to send health data to the app.  **Doctor:** Receive accurate health data from paired device |
| **PRE CONDITION** | 1. The mother has Signed In to the account. 2. The mother has turned the Wrist Band on. 3. Mother has turned on Bluetooth of phone. |
| **POST CONDITION** | 1. Device Pairing Success. 2. Failed pairing with device. |
| **MAIN SUCCESS SCENARIO** | 1. The mother opens the Bluetooth setting on phone. 2. The mother’s phone displays a list of available Bluetooth devices. 3. The mother selects the Wristband from list of available Bluetooth devices to connect it with her phone. 4. The system establishes the connection and display connected. |
| **EXTENSION**  **(ALTERNATIVE FLOW)** | **3a. Failed Device Pairing:** Mother may see failed to connect. In this scenario she may try again.  **4a. No Device Configured:** Mother will be displayed a warning message “No Wrist Band Paired”. |
| **SPECIAL REQUIREMENT** | The Wrist Band should connect to the phone within 30 seconds. |
| **TECHNOLOGY**  **AND DATA VARIATION LIST** | Wrist Band (Bluetooth)  Smart Phone. |
| **FREQUENCY OF USE** | Low, User will remain signed into the app. |
| **SPECIAL ISSUES** | None |

### **UC-4 View Live Sensors Data**

|  |  |
| --- | --- |
| **USE CASE ID** | UC-4 |
| **USE CASE NAME** | View Live Sensor Data |
| **PRIMARY ACTORS** | 1. Doctor 2. Mother |
| **SECONDARY ACTORS** | 1. Wrist Band 2. Firebase |
| **STAKE HOLDERS AND INTEREST** | **Mother:** View Own Health in real time.  **Doctor:** Monitor patient health in real time. |
| **PRE CONDITION** | 1. The mother is wearing the wrist band with all sensors in contact with the skin. 2. Mother has paired the Wrist Band with the App. 3. The doctor is signed in and linked to the mother. |
| **POST CONDITION** | 1. Sensor data (e.g. heart rate, blood pressure) is displayed on the app. |
| **MAIN SUCCESS SCENARIO** | 1. The user (Doctor or Mother) opens the mobile app and navigates to Live Sensor Screen. 2. The system displays the Live Sensor Data screen. 3. The wrist band collects and sends data (e.g., heart rate, blood pressure) to system. 4. The system retrieves and displays real-time sensor data and stores data on the Firebase. |
| **EXTENSION (ALTERNATIVE FLOW)** | **3a. Wrist band disconnected:** System displays “Device disconnected” and prompts to check connection.  **3b. The Mother Removes Wrist Band:** System displays “Please wear the wrist band to get real-time data”. In this case system stops transmitting the data.  **3c. Sensor Malfunction:** System detects invalid data (e.g. heart rate = 0bpm) and display “Sensor Error”.  **4a. Poor internet:** System displays “Data uploading failed” and retries when connection is restored at this point system stores data locally. |
| **SPECIAL REQUIREMENT** | Real-time data syncing with less than 5 -second latency.  Data must be stored on |
| **TECHNOLOGY AND DATA VARIATION LIST** | 1. Band Wrist 2. Smart Phone 3. Firebase. |
| **FREQUENCY OF USE** | High |
| **SPECIAL ISSUES** | All sensors are not continuous sensors.  Available continuous sensor are not accurate. |

### **UC-5 Prescribe Meal Plan**

|  |  |
| --- | --- |
| **USE CASE ID** | UC-5 |
| **USE CASE NAME** | Prescribe Meal Plan |
| **PRIMARY ACTORS** | 1. Doctor |
| **SECONDARY ACTORS** | 1. Firebase |
| **STAKE HOLDERS AND INTEREST** | **Doctor:** Prescribe dietary recommendations for the patient.  **Mother:** Receive meal plan. |
| **PRECONDITION** | 1. The doctor is signed in and linked to the mother. 2. The mother’s profile exists in Firebase. |
| **POST CONDITION** | 1. Patient or Doctor or both are preview live sensor readings |
| **MAIN SUCCESS SCENARIO** | 1. The doctor opens the mobile app. 2. The system displays the linked patients. 3. The doctor selects the patient. 4. The doctor navigates the Meal Plan section. 5. The doctor enters meal details (e.g., food items, frequency). 6. The system saves the meal plan to Firebase. 7. The system sends a notification to the mother. |
| **EXTENSION (ALTERNATIVE FLOW)** | **4a. Invalid input (e.g., empty fields):** System displays “Please complete all fields” and prompts re-entry.  **5a. Input exceeds character limit:** System displays “Input too long” and prompts editing.  **5a. Database error:** System displays “Failed to save” and retries. |
| **SPECIAL REQUIREMENT** | Meal plan saving and notification delivery must complete within 5 seconds under stable network conditions. |
| **TECHNOLOGY AND DATA VARIATION LIST** | Smart Phone  Firebase |
| **FREQUENCY OF USE** | Medium |
| **SPECIAL ISSUES** | None |

### **UC-6 Prescribe Medicine**

|  |  |
| --- | --- |
| **USE CASE ID** | UC-6 |
| **USE CASE NAME** | Prescribe Medicine |
| **PRIMARY ACTORS** | 1. Doctor |
| **SECONDARY ACTORS** | 1. Firebase |
| **STAKE HOLDERS AND INTEREST** | **Doctor:** Prescribe medications for the patient.  **Mother:** Receive prescription. |
| **PRE CONDITION** | 1. The doctor is signed in and linked to the mother.  2. The mother’s profile exists in Firebase. |
| **POST CONDITION** | 1. A prescription is saved in Firebase and associated with the mother’s profile. 2. The mother receives a notification. |
| **MAIN SUCCESS SCENARIO** | 1. The doctor opens the mobile app. 2. The system displays the list of linked patients. 3. The doctor navigates to the Medicine Prescription section. 4. The doctor enters medicine prescription details (e.g., medicine name, dosage, frequency). 5. The system saves the prescription to Firebase. 6. The system sends a notification to the mother. |
| **EXTENSION (ALTERNATIVE FLOW)** | **4a. Invalid input (e.g., empty fields):** System displays “Please complete all fields” and prompts re-entry.  **5a. Database error:** System displays “Failed to save” and retries. |
| **SPECIAL REQUIREMENT** | None. |
| **TECHNOLOGY AND DATA VARIATION LIST** | Smart Phone  Firebase |
| **FREQUENCY OF USE** | Medium |
| **SPECIAL ISSUES** | None |

### **UC-7 View Prescribed Medicine**

|  |  |
| --- | --- |
| **USE CASE ID** | UC-7 |
| **USE CASE NAME** | View Prescribed Medicine |
| **PRIMARY ACTORS** | 1. Doctor 2. Mother |
| **SECONDARY ACTORS** | 1. Firebase |
| **STAKE HOLDERS AND INTEREST** | **Doctor:** Review prescribed medications.  **Mother:** View prescribed medications. |
| **PRE CONDITION** | 1. The user (Doctor or Mother) is signed in. 2. A prescription exists in Firebase for the mother. |
| **POST CONDITION** | 1. The user views the prescribed medicine details. |
| **MAIN SUCCESS SCENARIO** | 1. The user opens the mobile app. 2. The system displays the patient’s personal profile (Mother) to the mother and doctor. 3. The user navigates to the Medicine Prescription section. 4. The system retrieves and displays medicine prescription details (e.g., medicine name, dosage) from Firebase. |
| **EXTENSION (ALTERNATIVE FLOW)** | **4a. No medicine prescriptions found:** System displays “No prescriptions available.”  **4b. Database error:** System displays “Failed to load data” and retries. |
| **SPECIAL REQUIREMENT** | Data must be displayed within 2 seconds. |
| **TECHNOLOGY AND DATA VARIATION LIST** | Smart Phone.  Firebase |
| **FREQUENCY OF USE** | Medium |
| **SPECIAL ISSUES** | None |

### **UC-8 View Prescribed Meal Plan**

|  |  |
| --- | --- |
| **USE CASE ID** | UC-8 |
| **USE CASE NAME** | View Prescribed Meal Plan |
| **PRIMARY ACTORS** | 1. Doctor 2. Mother |
| **SECONDARY ACTORS** | 1. Firebase |
| **STAKE HOLDERS AND INTEREST** | **Doctor:** Review prescribed meal plans.  **Mother:** View dietary recommendations. |
| **PRECONDITION** | 1. The user (Doctor or Mother) is signed in. 2. A meal plan exists in Firebase for the mother. |
| **POST CONDITION** | 1. The user views the prescribed meal plan details. |
| **MAIN SUCCESS SCENARIO** | 1. The user opens the mobile app. 2. The system displays the patient’s profile (Doctor) or personal profile (Mother). 3. The user navigates to the Meal Plan section. 4. The system retrieves and displays meal plan details (e.g., food items, frequency) from Firebase. |
| **EXTENSION (ALTERNATIVE FLOW)** | **4a. No meal plans found:** System displays “No meal plans available.”  **4b. Database error:** System displays “Failed to load data” and retries. |
| **SPECIAL REQUIREMENT** | Data must be displayed within 2 seconds. |
| **TECHNOLOGY AND DATA VARIATION LIST** |  |
| **FREQUENCY OF USE** | Medium |
| **SPECIAL ISSUES** | None |

### **UC-9 Mark Risk (T /F)**

|  |  |
| --- | --- |
| **USE CASE ID** | UC-9 |
| **USE CASE NAME** | View Prescribed Meal Plan |
| **PRIMARY ACTORS** | 1. Doctor |
| **SECONDARY ACTORS** | 1. Firebase 2. Notification Service |
| **STAKE HOLDERS AND INTEREST** | **Doctor:** Validate system-generated health risks.  **Mother:** Be informed of validated risks. |
| **PRE CONDITION** | 1. The doctor is signed in and linked to the mother. 2. A risk alert (e.g., high blood pressure) exists in Firebase. |
| **POST CONDITION** | 1. The risk is marked as True or False in Firebase. 2. The mother receives a notification if the risk is True |
| **MAIN SUCCESS SCENARIO** | 1. The doctor receives a risk alert notification. 2. The doctor opens the mobile app. 3. The system displays the Risk Details screen. 4. The doctor reviews the risk data (e.g., blood pressure readings). 5. The doctor marks the risk as True or False. 6. The system saves the decision to Firebase. 7. If True, the system sends a notification to the mother. |
| **EXTENSION (ALTERNATIVE FLOW)** | **4a. Insufficient data:** System prompts the doctor to request additional data.  **6a. Database error:** System displays “Failed to save” and retries. |
| **SPECIAL REQUIREMENT** | Notification Delivery in less than 5 seconds. |
| **TECHNOLOGY AND DATA VARIATION LIST** | Smart Phone  Firebase  Notification Service |
| **FREQUENCY OF USE** | Medium |
| **SPECIAL ISSUES** | None |

### **UC-10 Link Patient**

|  |  |
| --- | --- |
| **USE CASE ID** | UC-10 |
| **USE CASE NAME** | View Prescribed Meal Plan |
| **PRIMARY ACTORS** | 1. Doctor 2. Mother |
| **SECONDARY ACTORS** | 1. Firebase |
| **STAKE HOLDERS AND INTEREST** | **Doctor:** Connect with patient for monitoring.  **Mother:** Share health data with doctor. |
| **PRE CONDITION** | 1. Both Doctor and Mother are signed in. 2. The mother’s profile exists in Firebase. |
| **POST CONDITION** | 1. The doctor and mother are linked in Firebase. 2. Link request fails or is declined. |
| **MAIN SUCCESS SCENARIO** | 1. The mother opens the mobile app. 2. The system displays the Link Patient screen. 3. The mother enters the doctor’s unique ID. 4. The system validates the ID and sends a link request to the doctor via Firebase. 5. The doctor receives a notification and opens the app. 6. The system displays the link request with the mother’s profile details. 7. The doctor accepts the request. 8. The system saves the link in Firebase and notifies both parties. |
| **EXTENSION (ALTERNATIVE FLOW)** | **3a. Invalid ID:** System displays “Invalid ID” and prompts re-entry.  **4a. No matching user:** System displays “User not found” and prompts to check ID.  **7a. Request declined:** System notifies the mother of rejection and returns to the Link screen.  **8a. Database error:** System displays “Failed to link” and retries after 7 seconds. |
| **SPECIAL REQUIREMENT** | The link process must be completed within 10 seconds. |
| **TECHNOLOGY AND DATA VARIATION LIST** | Smart Phone.  Firebase  Notification Service |
| **FREQUENCY OF USE** | Low. |
| **SPECIAL ISSUES** | None |

### **UC-11 Unlink Patient**

|  |  |
| --- | --- |
| **USE CASE ID** | UC-11 |
| **USE CASE NAME** | Unlink Patient |
| **PRIMARY ACTORS** | 1. Doctor 2. Mother |
| **SECONDARY ACTORS** | 1. Firebase |
| **STAKE HOLDERS AND INTEREST** | **Doctor:** End monitoring after delivery.  **Mother:** Stop sharing health data. |
| **PRE CONDITION** | 1. Both Doctor and Mother are signed in. 2. The doctor and mother are linked in Firebase. |
| **POST CONDITION** | 1. The link is removed from Firebase. 2. Unlink request fails. |
| **MAIN SUCCESS SCENARIO** | 1. The user (Doctor or Mother) opens the mobile app. 2. The system displays the Linked Profiles screen. 3. The user selects the linked party to unlink. 4. The system prompts confirmation. 5. The user confirms. 6. The system removes the link from Firebase. |
| **EXTENSION (ALTERNATIVE FLOW)** | **5a. User cancels:** System returns to the Linked Profiles screen.  **6a. Database error:** System displays “Failed to unlink” and retries. |
| **SPECIAL REQUIREMENT** | Unlink process must be completed within 5 seconds. |
| **TECHNOLOGY AND DATA VARIATION LIST** | Smart Phone  Firebase. |
| **FREQUENCY OF USE** | Low. |
| **SPECIAL ISSUES** | None |

### **UC-12 View Risk**

|  |  |
| --- | --- |
| **USE CASE ID** | UC-12 |
| **USE CASE NAME** | View Risk |
| **PRIMARY ACTORS** | 1. Doctor 2. Mother |
| **SECONDARY ACTORS** | 1. Firebase 2. Notification Service |
| **STAKE HOLDERS AND INTEREST** | **Doctor:** Review health risks.  **Mother:** Understand health alerts. |
| **PRE CONDITION** | 1. The doctor or mother is signed in. 2. A risk alert exists in the Firebase. 3. The doctor and mother are linked. |
| **POST CONDITION** | 1. The user views risk details and associated data. |
| **MAIN SUCCESS SCENARIO** | 1. The user receives a risk alert notification. 2. The user opens the mobile app. 3. The system displays the Risk Details screen. 4. The system retrieves and displays risk details (e.g., high blood pressure, reason) from Firebase. |
| **EXTENSION (ALTERNATIVE FLOW)** | **4a. No risks found:** System displays “No active risks.”  **4b. Database error:** System displays “Failed to load data” and retries. |
| **SPECIAL REQUIREMENT** | Display time: < 2 Seconds. |
| **TECHNOLOGY AND DATA VARIATION LIST** | Smart Phone,  Firebase  Notification Service |
| **FREQUENCY OF USE** | Medium. |
| **SPECIAL ISSUES** | Risk visualization format (e.g., graphs, text) TBD. |

### **UC-13 Send / Receive Message**

|  |  |
| --- | --- |
| **USE CASE ID** | UC-13 |
| **USE CASE NAME** | Send / Receive Messages |
| **PRIMARY ACTORS** | 1. Doctor 2. Mother |
| **SECONDARY ACTORS** | 1. Firebase, 2. Notification Service |
| **STAKE HOLDERS AND INTEREST** | **Doctor:** Answers the patient’s queries.  **Mother:** Communicate with doctor. |
| **PRE CONDITION** | 1. Both the mother and doctor are signed in and linked. 2. The messaging feature is enabled in the app. |
| **POST CONDITION** | 1. The message is sent, received, and stored in the firebase. 2. The recipient receives a notification. |
| **MAIN SUCCESS SCENARIO** | 1. The user (mother or doctor) logs into the system. 2. The user navigates to the "Messages" section. 3. The user selects the intended recipient from a contact list. 4. The user composes a message. 5. The user sends the message. 6. The system delivers the message to the recipient. 7. The recipient receives a notification. 8. The recipient views the message. 9. The conversation is stored in the message history. |
| **EXTENSION (ALTERNATIVE FLOW)** | **3a.** Recipient not found → System displays an error message and prompts to try again.  **6a.** Internet unavailable → System shows an error and retries sending when the connection is restored. |
| **SPECIAL REQUIREMENT** | Push notifications for new messages. |
| **TECHNOLOGY AND DATA VARIATION LIST** | Smart Phone. |
| **FREQUENCY OF USE** | Low. |
| **SPECIAL ISSUES** | None |

### **UC-14 Count Fetal Movements**

|  |  |
| --- | --- |
| **USE CASE ID** | UC-14 |
| **USE CASE NAME** | Count Fetal Movements |
| **PRIMARY ACTORS** | 1. Mother |
| **SECONDARY ACTORS** | 1. Wrist Band 2. Notification Service 3. Firebase |
| **STAKE HOLDERS AND INTEREST** | **Mother:** Track Fetal movement to monitor baby health.  **Doctor:** Receive alerts for abnormal patterns. |
|  |  |
| **PRECONDITION** | 1. The Mother has signed in and has paired with the wrist band. 2. The mother is in third trimester. 3. The wrist band has functional fetal movement buttons. |
| **POST CONDITION** | 1. Fetal Movement Data is recorded in the database. 2. A risk movement is generated if movement patterns are abnormal. |
| **MAIN SUCCESS SCENARIO** | 1. The mother opens the mobile app. 2. The system displays the Fetal Movement Tracking screen 3. The mother presses the wrist buttons to log movements (e.g., kicks). 4. The system records each press and tracks time to reach 10 movements. 5. The system saves data on a Firebase. 6. If <10 movements in 2 hours, the system generates a risk alert and notifies doctor and mother. |
| **EXTENSION (ALTERNATIVE FLOW)** | **3a.** **Wrist band disconnected:** System displays “Device disconnected” and prompts to reconnect.  **6a. Database error:** System displays “Failed to save” and retries.  **6b.** **High-risk pregnancy:** System applies stricter thresholds (e.g., |
| **SPECIAL REQUIREMENT** | Real-time tracking with <1- second response to button presses. |
| **TECHNOLOGY AND DATA VARIATION LIST** | Smart Phone,  Wrist Band (Bluetooth),  Firebase (JSON data format),  Notification Service. |
| **FREQUENCY OF USE** | Medium (daily in third trimester) |
| **SPECIAL ISSUES** | None |

### **UC-15 Reset Password**

|  |  |
| --- | --- |
| **USE CASE ID** | UC-15 |
| **USE CASE NAME** | Reset Password |
| **PRIMARY ACTORS** | * + - 1. Doctor       2. Mother |
| **SECONDARY ACTORS** | * + - 1. Firebase |
| **STAKE HOLDERS**  **AND INTEREST** | **Doctor:** Reset the password if forgotten.  **Mother:** Reset the password if forgotten. |
| **PRECONDITION** | 1. The user account exists on the system. 2. The user has access to registered email address or phone number. |
| **POST CONDITION** | 1. The user’s password is updated successfully, and they can log in with the new password |
| **MAIN SUCCESS SCENARIO** | 1. The user (Mother or Doctor) navigates to the login page of the system’s web portal or mobile app. 2. The user selects the “Forgot Password” link. 3. The system prompts the user to enter their registered email address or phone number. 4. The user enters the required information and submits the request. 5. The system validates the email/phone number against the user database. 6. The system sends a password reset link or one-time code to the user’s registered email/phone. 7. The user receives the link/code and clicks the link or enters the code in the provided interface. 8. The system verifies the link/code and prompts the user to enter a new password. 9. The user enters and confirms the new password, adhering to security requirements (e.g., minimum length, special characters). 10. The system updates the password in the database and notifies the user of a successful reset. 11. The user can now log in with the new password. |
| **EXTENSION**  **(ALTERNATIVE FLOW)** | **5a. Invalid email format:** System displays “Invalid email format” and prompts re-entry.  **3b. One Time Password Wrong or Expired:** System displays “Expired One Time Password” and try again.  **3c. Account does not exists:** System displays “Account does not exists”. |
| **SPECIAL REQUIREMENT** | Email should be a valid email.  Minimum password length: 8 characters , including one uppercase, one number, and one special character. |
| **TECHNOLOGY**  **AND DATA VARIATION LIST** | Smart Phone, Firebase (JSON data format). |
| **FREQUENCY OF USE** | Low. |
| **SPECIAL ISSUES** | None |

### **UC-16 Logout**

|  |  |
| --- | --- |
| **USE CASE ID** | UC-16 |
| **USE CASE NAME** | Logout |
| **PRIMARY ACTORS** | * + - 1. Doctor       2. Mother |
| **SECONDARY ACTORS** | * + - 1. Firebase |
| **STAKE HOLDERS**  **AND INTEREST** | **Doctor:** Logout From the App.  **Mother:** Logout from the App. |
| **PRE CONDITION** | 1. The user is loogged in. |
| **POST CONDITION** | 1. The user is Logged out from the system. |
| **MAIN SUCCESS SCENARIO** | 1. The user selects the “Logout” option from the user interface (e.g., menu or profile settings). 2. The system terminates the user’s active session. 3. The system clears any session-related data (e.g., cookies, tokens) from the user’s device. 4. The system redirects the user to the login page or a confirmation message indicating successful logout. |
| **EXTENSION**  **(ALTERNATIVE FLOW)** | - |
| **SPECIAL REQUIREMENT** | - |
| **TECHNOLOGY**  **AND DATA VARIATION LIST** | Smart Phone,  Firebase (JSON data format). |
| **FREQUENCY OF USE** | Low. |
| **SPECIAL ISSUES** | None |

### **System Sequence Diagrams**

System Sequence Diagrams illustrate the interactions between external actors and the system, showing the flow of events and data over time

### SSD – UC 1 Sign up