American International University-Bangladesh (AIUB)

Department of Computer Science

Faculty of Science & Technology (FST)

Bangladesh Digital Health Registry (BDHR)

A Software Engineering Project Submitted
By

Semester: Spring_24_25		Section: N	Group Number: 4	
SN	Student Name	Student ID	Contribution (CO3+CO4)	Individual Marks
1	SAIED AL MASUD			
2	MD. MAKAIL ISLAM RAHIM			
3	SADMAN SAKIB			
4	MD. NISHAD			
5	RAIYAN RAFIQ SARKER			

The project will be evaluated for the following Course Outcomes

	Total Marks	
CO3: *Select* appropriate software engineering models, project management roles, and their associated skills for the complex software engineering project and evaluate the sustainability of developed software, taking into consideration the societal and environmental aspects	Total Marks	
Appropriate Process Model Selection and Argumentation with Evidence	[5 Marks]	
Evidence of Argumentation Regarding Process Model Selection	[5Marks]	
Analysis of the impact of societal, health, safety, legal, and cultural issues	[5Marks]	
Submission, Defense, Completeness, Spelling, grammar, and Organization of the Project report	[5Marks]	
CO4: *Develop* a project management plan to manage software engineering projects following the principles of engineering management and economic decision process	Total Marks	
Develop the project plan, its components of the proposed software products	[5Marks]	
Identify all the activities/tasks related to project management and categorize them within the WBS structure. Perform detailed effort estimation correspond with the WBS and schedule the activities with resources	[5Marks]	
Identify all the potential risks in your project and prioritize them to overcome these risk factors.	[5Marks]	

CO5: Perform as an effective team member or leader in diverse team settings and solve multi-disciplinary problems in the computer science and engineering domain	Total Marks	
Taking project responsibility: perform assigned tasks on time independently	[5Marks]	
Contribution to project group meetings, sharing fruitful ideas	[5Marks]	
Positive attitude towards group work, collaboration, compromise, helping others to understand their project work responsibility	[5Marks]	
Showing respect and value towards other team member's opinion	[5Marks]	

Description of Student's Contribution in the Project work

Student Name: SAIED AL MASUD
Student ID: 22-48943-3
Contribution in Percentage (%): 20%
Contribution in the Project:
▪ Project Proposal
▪ Functional Requirement- 12
▪ Use Case Diagram
▪ Test Case- 5
▪ WBS
▪ Risk Analysis- 3

Saied Al Masud
_____
Signature of the Student

Student Name: MD. MAKAIL ISLAM RAHIM
Student ID: 22-48946-3
Contribution in Percentage (%): 20%
Contribution in the Project:
▪ Project Proposal
▪ Functional Requirement-12
▪ Class Diagram
▪ Test Case- 5
▪ Effort Estimation
▪ Risk Analysis- 3

Makail
_____
Signature of the Student

Student Name: SADMAN SAKIB
Student ID: 22-48978-3
Contribution in Percentage (%): 20%

Contribution in the Project:
- Project Proposal
- Functional Requirement-12
- Sequence Diagram
- UI design & Wareframing
- Test Case- 5
- EVA Analysis
- Risk Analysis- 3

_Sadman_

_____
Signature of the Student
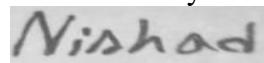
Student Name: MD. NISHAD
Student ID: 22-49390-3
Contribution in Percentage (%): 20%
Contribution in the Project:
- Project Proposal
- Functional Requirement-12
- Class Diagram
- Test Case- 5
- Timeline Chart
- Risk Analysis- 3

Nishad

_____
Signature of the Student

Student Name: RAIYAN RAFIQ SARKER
Student ID: 22-49418-3
Contribution in Percentage (%): 20%
Contribution in the Project:
- Project Proposal
- Functional Requirement-12
- Activity Diagram
- Test Case- 5
- Timeline Chart
- Risk Analysis- 3

Raiyan

_____
Signature of the Student

Rubric for Project Assessment (CO3)

Criteria	Marks distribution (Max 3X5= 15)				Acquired Marks
	Inadequate (1-2)	Satisfactory (3)	Good (4)	Excellent (5)	
Selection of Software Engineering Models	Does not articulate a position or argument of choosing appropriate model. Does not present any evidence to support the arguments for the choice of the model	Articulates a position or argument for choosing models that is unfocused or ambiguous. Presents incomplete/vague evidence to support argument for model choice	Articulates a position or argument of choosing models that is limited in scope. Does not present enough evidence to support the argument for the choice of the model	Clearly articulates a position or argument for the choosing software engineering models. Presents sufficient amount of evidence to support argument for the model selection	
Role identification and Responsibility Allocation	The project has poor project management plans for identifying roles and assigning the responsibilities	Identify few roles in the project management where some of the roles are left alone with any project responsibilities	Identify most of the roles in the project management and assign their responsibilities	Well planned project with proper role identification and responsibility allocation in the project management activities	
Impact identification					
Formatting and Submission	Project report is not complete and Several errors in spelling and grammar. Present a Confusing	Some errors in spelling and grammar. Some problems	Few errors in spelling and grammar. Presents most of the details in	Project report is complete and No errors in spelling and grammar. Consistently	

organization of concepts, supporting arguments, and real-life example. Sentences rambling, and details are repeated.	of organizing the answer in a logical order of defining, elaborating, and providing real-life examples.	a logical flow of organization in definition, details, and example.	presents a logical and effective organization of definition, details, and real-life example of the topic.

Acquired marks:	
CO Pass / Fail:	

Rubric for Project Assessment (CO4)

Marking Criteria	Marks Distribution (Maximum 3X5=15)				Acquired Marks
	Inadequate (1-2)	**Satisfactory (3)**	**Good (4)**	**Excellent (5)**	
Project Planning	No background information regarding the project is given; project goals and benefits are missing.	Insufficient background information is given; project goals and benefits are poorly stated	Sufficient background information is given; the purpose and goals of the project are explained.	Thorough and relevant background information is given; project goals are clear and easy to identify.	
Effort Estimation and Scheduling	Student vaguely discuss the impact of societal, health, safety, legal and cultural issues in their project	Student provided with partial relevance to the impact of societal, health, safety, legal and cultural issues in their project	Student fairly provided the analysis to the impact of societal, health, safety, legal and cultural issues in their project	Student comprehensively provided the analysis to the impact of societal, health, safety, legal and cultural issues in their project	
Risk Management	Ambiguous representative example.	Partially identify / indicate towards real-life example.	Real-life example is fairly connected towards the definition.	Comprehensively defend with real life example.	
				Acquired Marks:	
				CO Pass / Fail:	

CO5 [PO-i-2]: Perform as an effective team member or leader in diverse team settings and solve multi-disciplinary problems in computer science and engineering domain.				
Assessment Attribute/Criteria	**Missing/ Incorrect (0)**	**Inadequate (1)**	**Satisfactory (2)**	**Excellent (3)**
Taking responsibility	Does not perform assigned tasks; often misses meetings and, when present, does not have anything constructive to say; relies on others to do the work;	Partially performs all assigned tasks; attends meetings irregularly and occasionally participates and hence not reliable;	Performs all assigned tasks; attends meetings regularly and usually participates effectively. generally reliable;	Performs all tasks very effectively; attends all meetings and participates enthusiastically; very reliable.
Contributions	Never provides useful ideas when participating in a group discussion	Rarely provides useful ideas when participating in a group discussion	Sometimes provides useful ideas when participating in a group discussion	Routinely provides useful ideas when participating in a group discussion
Collaboration and Ability to Compromise	Not cooperative, unable to compromise and disrupts the team process.	Sometimes cooperative, and rarely displays a positive attitude.	Usually cooperative, able to compromise and generally display positive attitude.	Always cooperative. Willingness to compromise. Always display positive attitude.
Valuing other team members (Working with others)	Often argues with teammates; doesn't let anyone else talk; occasional personal attacks and "put-downs"; wants to have things done his way and does not listen to alternate approaches.	Seldom listens to others' points of view; occasionally behaves in an oppressive manner; tries to force their own ideologies on other.	Generally, listens to others' points of view; always uses appropriate and respectful language; tries to make a definite effort to understand others' ideas.	Always listens to others and their ideas; helps them develop their ideas while giving them full credit; always helps the team reach a fair decision.

Contents

1. PROJECT PROPOSAL

1.1 Background to the Problem

Keeping track of patients' medical histories poses a significant challenge within the healthcare system in Bangladesh. Most of the patients still depends on paper documents like prescriptions, test results, and treatment records. These papers can easily get lost, damaged, or misplaced, which can create complications for both patients and doctors. It is challenging to maintain accurate medical histories. Hence, patients often experience delays in receiving appropriate treatment, while doctors find it tough to make precise diagnoses due to incomplete information.

A major issue is the lack of a centralized system for storing and accessing patient records. In a lot of hospitals and clinics, patient information is kept manually which increases the risk of errors and mismanagement. When patients visit different healthcare providers they must carry their medical documents each time. This not only adds inconvenience but also raises the likelihood of miscommunication between doctors, potentially resulting in unnecessary tests which can lead to incorrect treatments.

Where healthcare facilities are limited, the situation is more critical there, and many people do not have a proper record of their past treatments. According to reports, a large number of people in Bangladesh do not follow their prescribed treatments properly, often because they lose their prescriptions or forget their medical history. This can lead to serious health risks, including complications from untreated diseases.

A study on the "Opportunities and Challenges of E-Health System in Bangladesh" emphasizes the potential of digital health tools, like Electronic Health Records (EHR), to improve healthcare access especially in rural areas. While these systems can enhance care efficiency, it also points out challenges such as poor infrastructure, and security issues. These findings highlight the urgent need for a centralized medical history system to improve communication between patients and healthcare providers, ultimately leading to better healthcare outcomes across the country.

1.2 Solution to the Problem

The primary objective of this project is to-

1. Eliminate fragmentation of medical records by providing a centralized system for storing all patient health records.
2. Ensure easy access to medical history by allowing patients to access their medical records anytime and from anywhere.
3. Improve communication between healthcare providers by facilitating seamless sharing of medical data across healthcare institutions.
4. Reduce medical errors due to incomplete records by enabling doctors to access complete and up-to-date patient information.

5. Promote patient safety and treatment efficacy by ensuring accurate and accessible medical history for better patient outcomes

To address the challenges in managing patient medical records, this project proposes a **Bangladesh Digital Health Registry (BDHR)**, a centralized and secure digital health system. The proposed solution includes the following key components:

1. Unique Health Profile for Lifetime
   - Each citizen will have a permanent digital health profile storing their complete medical history.
2. Centralized Database Under DGHS
   - Accessible across all healthcare institutions under the Directorate General of Health Services (DGHS)
   - Healthcare providers can update and retrieve records in real-time, ensuring continuity of care.
3. Patient Health Card
   - A physical card with a NFC chip for quick and secure record access.
   - Reduces reliance on paper-based documents, preventing loss of critical medical history.
4. Data Security Measures
   - Encryption and secure access protocols to protect sensitive patient data.
   - OTP-based authentication to ensure only authorized personnel can access records.
5. User-Friendly Interface
   - A web and mobile app for patients to view, download, and print medical history in Bangla and English.
   - Ensures accessibility for all users, including those with limited digital literacy.

Basic functionalities of Bangladesh Digital Health Registry (BDHR):

All Medical Records in One Place: Patients and doctors can easily find and update medical records, making treatment faster and more accurate.

Patient Health Card: A small card with a NFC chip that lets doctors quickly see a patient's medical history. No need to carry paper documents.

Automatic Reminders: Patients get alerts for medicine refills and doctor appointments, helping them stay on track with treatments.

Strong Data Security: Personal health information stays safe with encryption and OTP-based access, so only authorized people can see it.

Easy-to-Use Website & App: Patients can check, download, and print their records anytime. Patients' can use this app in both Bangla and English for better accessibility including those with low digital literacy.

This project will bring massive changes to healthcare and society in Bangladesh. With a central database, patients will not lose important medical records, and doctors can quickly access their history for better treatment. The Patient Health Card will make checkups faster and easier, especially in emergencies. Automatic reminders will help people take medicines on time and not miss doctor visits, improving their health. Strong security measures will protect personal data, so only authorized people can see it. The Bangla and English app will ensure that even those with little digital knowledge can use it easily. This project will make healthcare more organized, safe, and accessible for everyone, improving public health and reducing medical mistakes across the country.

Target Users and Their Benefits:

The Bangladesh Digital Health Registry (BDHR) is designed for a wide range of users, including patients, doctors, hospitals, and government health organizations.

- Patients: BDHR lets patients easily access their medical records anytime, reducing the risk of lost documents. Automatic reminders help them stay on top of medications and appointments, improving their health.
- Doctors & Healthcare Providers: Doctors can quickly access complete medical histories to provide accurate treatment, reducing errors and unnecessary tests.
- Hospitals & Clinics: A centralized database helps hospitals manage records efficiently, saving time and reducing paperwork.

2. SOFTWARE DEVDELOPMENT LIFE CYCLE

For the development of the Bangladesh Digital Health Registry (BDHR), the Agile Scrum model will be most suitable method. This methodology is particularly well-suited for projects where requirements may evolve over time and continuous collaboration with stakeholders is essential.

2.1 Why select this model?

Scrum is a well-structured, team-based Agile methodology that focuses on delivering working features in short, manageable sprints- ideal for large, evolving systems like BDHR.

2.1.1. Sprint-Based Delivery:
- o The project can be developed in 2-4 week sprints, each focusing on specific modules.
- o This supports phased development and ensures each version is testable, functional, and reviewable.

2.1.2. Backlog and Prioritization:
- o Features can be listed in a Product Backlog and prioritized based on user needs and healthcare urgency.
- o This allows flexibility if any new regulation or urgent requirement arises during development.

2.1.3. Daily Standups and Reviews:
- o Daily meetings (Scrum standups) ensure team communication, quick problem-solving, and progress tracking.
- o Sprint Reviews and Retrospectives help continuously improve performance and outcomes.

2.1.4. Continuous Feedback:
- o Patients, doctors, and DGHS can regularly provide input after each sprint - enabling user-centric design and faster alignment with real-world needs.

2.2 Roles in the Scrum Framework

2.2.1. Scrum Master
- o Ensures the project follows Scrum rules and values.
- o Facilitates team collaboration and removes obstacles.
- o Communicates with the team, customer, and management.

2.2.2. Product Owner
- o Owns the product vision and manages the Product Backlog.
- o Prioritizes tasks and makes final decisions on backlog items.
- o Selected by Scrum Master, customer, and management.

2.2.3. Scrum Team
- o A self-organizing team responsible for delivering each Sprint.
- o Estimates effort, creates the Sprint Backlog, and removes impediments.
- o Reviews and improves the backlog continuously.

2.2.4. Customer
- o Participates in backlog-related tasks and provides feedback.
- o Helps ensure the system meets real healthcare needs.

2.2.5. Management
- o Sets goals, requirements, and project standards.
- o Supports the team with resources and policy alignment.
- o Involved in key decision-making.

2.3 How Value is Positively Impacted by Agile and Scrum

2.3.1. Customer-Centric Focus
- o The Scrum framework ensures that the development of BDHR remains focused on the real needs of users, including patients, doctors, and hospital administrators.

o Regular feedback from stakeholders allows the system to evolve effectively-whether for updating health records, accessing medical history, or managing user roles.

2.3.2. Early Delivery of Key Features
o Scrum's incremental delivery enables the early launch of critical modules such as patient registration, hospital dashboard, and emergency access.
o These features can be tested and used by health institutions early on, helping refine the platform based on practical feedback.

2.3.3. Transparency Throughout Development
o Through Sprint Reviews, Daily Scrum meetings, and planning sessions, all team members and stakeholders gain a clear understanding of BDHR's progress and challenges.
o This transparency supports better coordination and informed decision-making across technical and health administration teams.

2.3.4. Reduced Risk of Failure
o The iterative development and continuous testing approach minimizes the risk of major issues at the final stage.
o Each Sprint produces a working and tested increment of BDHR, leading to higher system reliability and improved user satisfaction.

2.4   How Scrum Practices Make It Easy to Conduct the Project

2.4.1. Time-Boxed Sprints
The BDHR development process follows short, focused sprints (typically 2 to 4 weeks), enabling the team to concentrate on specific high-priority features such as patient profiles, hospital admin tools, or doctor dashboards. This structured timeline supports timely and efficient delivery.

2.4.2. Daily Scrum Meetings
Quick, daily stand-up meetings help identify blockers, align team efforts, and ensure continuous progress across development, testing, and system integration phases in BDHR.

2.4.3. Sprint Retrospectives for Improvement
After each sprint, the team holds a retrospective to assess strengths and areas for improvement. This promotes a culture of regular reflection and optimization helping BDHR evolve more efficiently.

2.4.4. Continuous Backlog Management

The Product Owner collaborates closely with the team to review and update the Product Backlog. This ensures that BDHR's feature priorities-like secure login, digital prescriptions, or health report viewing-are clearly defined and addressed as per user needs.

2.4.5. Adaptability to Change

Since BDHR is developed in an iterative model, it can easily incorporate changes in government health policies, stakeholder feedback, or technical constraints making the system robust and future-ready.

2.5 Why Not Other Models?

2.5.1. Waterfall Model
  o A traditional linear approach where each phase must be completed before the next begins.
  o It lacks flexibility for incorporating feedback or adapting to changes, which is a key requirement in dynamic healthcare environments like BDHR.
  o Not suitable for iterative development or evolving health data standards.

2.5.2. V-Model (Verification and Validation Model)
  o It emphasizes a strict testing phase for each development stage, ensuring high reliability.
  o However, like Waterfall, it is rigid and does not accommodate frequent requirement changes or iterative feedback.
  o Its sequential nature can delay visibility of deliverables, which is a disadvantage in collaborative health projects.

2.5.3. Extreme Programming (XP)
  o Focuses on engineering practices like pair programming, test-driven development (TDD), and continuous integration.
  o While it ensures high-quality code, it is too developer-centric and lacks a strong structure for project management, stakeholder communication, and planning, which are critical in BDHR.
  o Not ideal for healthcare projects where cross-team collaboration and policy compliance are equally important.

2.5.4. DSDM (Dynamic Systems Development Method)
  o Offers a structured Agile approach with fixed time and cost principles.
  o However, it is documentation-heavy and better suited for commercial enterprise software than public health platforms.

2.5.5. FDD (Feature - Driven Development)
  o Focuses on building and delivering features systematically.

FDD emphasizes upfront design and is less flexible compared to Scrum, making it difficult to adjust features based on health policy changes.

3.   REQUIREMENT ANALYSIS

3.1   Functional Requirement

1. Medical ID Creation

Functional Requirements:
- 1.1. The system should automatically generate a unique Medical ID for every patient at birth.
- 1.2. The Medical ID should be linked to the patient's personal information, including name, date of birth, and national ID (if available).
- 1.3. The system shall allow authorized healthcare providers to update the Medical ID with additional details such as test reports, prescriptions.

Priority Level: High
Precondition: Patient must be registered at birth or manually added later.
Cross-references: 29.1, 28.1, 37.1, 35.1

2. Secure Login

Functional Requirements:
- 2.1. The system shall allow patients to log in using their registered mobile number and OTP verification.
- 2.2. If a patient enters the wrong OTP three times, the system shall temporarily lock the account for security reasons.
- 2.3. Patients shall be able to reset their login credentials using a mobile number or email verification.

Priority Level: High
Precondition: Patient must have a registered mobile number or email.
Cross-references: 9.1, 50.1, 31.1

3. View Medical History

Functional Requirements:
- 3.1. Patients shall be able to view their complete medical history, including past diagnoses, prescriptions, test results, and treatments.
- 3.2. The system shall provide filters to search for specific medical records by date, doctor, or hospital.
- 3.3. The history shall be read-only, ensuring patients cannot modify any medical data.

Priority Level: High
Precondition: Medical records must exist in the database.
Cross-references: 1.1, 30.1, 4.1, 29.1

4. Download Medical Reports

Functional Requirements:

4.1. Patients should be able to download their medical reports, including test reports, and prescriptions, in PDF format.

4.2. The system should allow patients to print medical reports directly from the web or mobile app.

Priority Level: High
Precondition: The required medical report must be available in the system.
Cross-references: 3.1, 1.1, 9.1

5. Update Personal Information

Functional Requirements:

5.1. Patients shall be able to edit personal details, such as contact number, emergency contact, and address.

5.2. The system shall require OTP verification before updating sensitive information.

5.3. The system shall log all changes made to the patient's personal details for security purposes.

Priority Level: Medium
Precondition: Patient must be logged in and have a verified account.
Cross-references: 2.1, 31.1

6. Filter & Search Records

Functional Requirements:

6.1. Patients shall be able to search and filter medical records by date, doctor, hospital, or report type.

6.2. The system shall provide a quick search bar for easy access to recent medical records.

Priority Level: High
Precondition: The patient must have medical records stored in the system.
Cross-references: 3.1, 1.1

7. Access Vaccination History

Functional Requirements:

7.1. Patients shall be able to view past and upcoming vaccinations linked to their Medical ID.

7.2. The system shall send automated reminders for upcoming vaccine doses.

7.3. Patients shall be able to download or print their vaccination history for official use.

Priority Level: High
Precondition: Vaccination records must be uploaded by authorized healthcare providers.
Cross-references: 28.1, 1.1, 4.1

8. Track Ongoing Treatments

Functional Requirements:
8.1. Patients shall be able to view details of ongoing treatments, including prescriptions and follow-up dates.
8.2. Doctors shall be able to update treatment progress and patients shall receive notifications.

Priority Level: High
Precondition: Patient must have an active treatment plan recorded in the system.
Cross-references: 17.1, 11.1, 34.1

9. OTP Verification for Access

Functional Requirements:
9.1. The system shall require OTP verification before a patient can view or download their medical records.
9.2. The OTP shall be sent to the patient's registered mobile number or email.
9.3. The OTP shall expire after a short time (e.g., 5 minutes) for security reasons.
9.4. If the OTP is entered incorrectly three times, the system shall temporarily lock access for security.

Priority Level: High
Precondition: The patient must have a registered mobile number or email.
Cross-references: 2.1, 4.1, 3.1, 5.1

10. Set Privacy Preferences

Functional Requirements:
10.1.   Patients can choose to restrict access to certain types of records (e.g., mental health history).
10.2.   The system shall allow modifying privacy settings at any time through the user dashboard.
10.3.   If a doctor requests access to restricted records, the system shall send a permission request to the patient.

Priority Level: Medium

Precondition: The patient must have medical records stored in the system.
Cross-references: 19.1, 49.1, 21.1

11. Book Appointments

Functional Requirements:

 11.1. Patients shall be able to schedule, reschedule, or cancel appointments with doctors.
 11.2. The system shall display available time slots and provide appointment confirmations.

Priority Level: High
Precondition: The doctor or hospital must be registered in the system.
Cross-references: 20.1, 45.1, 60.1

12. Contact Support

Functional Requirements:

 12.1. Patients shall be able to reach support via chat, email, or helpline for system-related issues.
 12.2. The system shall track issue reports and provide updates on resolutions.

Priority Level: Medium
Precondition: The patient must have a valid system account.
Cross-references: 13.1, 34.1

13. Provide Feedback

Functional Requirements:

 13.1. Patients shall be able to report errors in medical records and suggest improvements.
 13.2. Feedback shall be stored for system enhancements.

Priority Level: Medium
Precondition: The patient must have access to the system.
Cross-references: 12.1, 52.1

14. Doctor Profile Setup

Functional Requirements:

 14.1. The system shall allow doctors to register by providing personal details (name, specialization, license number, hospital/clinic details).
 14.2. The system shall require doctors to upload verification documents (medical license, certification, hospital ID).
 14.3. The system shall verify the submitted credentials through the Hospital Admin or Government Health Authority before granting access.

14.4. Upon successful verification, the system shall generate a unique Doctor ID for the user.

Priority Level: High

Precondition: The doctor must have valid credentials and a registered hospital/clinic affiliation.

Cross-references: 27.1, 15.1, 26.1

15. Doctor Login

Functional Requirements:

15.1. The system shall allow doctors to log in using their registered email/username and password.

15.2. The system shall implement OTP-based two-factor authentication (2FA) for added security.

15.3. If the login fails three times, the system shall temporarily lock the account for one hour.

Priority Level: High

Precondition: The doctor must have an active account with verified credentials.

Cross-references: 14.1, 31.1, 29.1

16. Update Patient Diagnoses

Functional Requirements:

The system shall allow doctors to search for a patient using their ID.

16.1. The system shall allow doctors to add new diagnoses, including condition name, severity, symptoms, and additional notes.

16.2. The system shall allow doctors to update existing diagnoses if required.

16.3. The system shall maintain a history of all diagnosis changes for auditing.

Priority Level: High

Precondition: The doctor must have patient access permissions (via OTP from the patient).

Cross-references: 19.1, 29.1, 30.1

17. Prescribe Medications Digitally

Functional Requirements:

17.1. The system shall allow doctors to search for a patient and view their medical history and allergies before prescribing medication.

17.2. The system shall allow doctors to select medications from an approved drug database.

17.3. The system shall allow doctors to specify dosage, frequency, duration, and instructions for each medication.

Priority Level: High

Precondition: The doctor must have access to the patient's medical records and be authorized to prescribe medications.

Cross-references: 47.1, 16.1, 1.1, 55.1

18. Review & Approve Lab Reports

Functional Requirements:

18.1. The system shall allow doctors to access and review lab reports uploaded by diagnostic centers.

18.2. The system shall allow doctors to approve or request additional tests based on lab results.

18.3. The system shall allow doctors to provide recommendations or comments on the report.

18.4. The system shall notify patients once a report is reviewed and approved.

Priority Level: High

Precondition: The lab test must be completed and uploaded to the system.

Cross-references: 34.1, 30.1

19. Receive Patient Consent Alerts

Functional Requirements:

19.1. The system shall send a real-time notification to doctors when a patient grants or denies access to their records.

19.2. The system shall allow doctors to request access again if initially denied by the patient.

19.3. The system shall log all consent approvals or rejections for security and auditing purposes.

Priority Level: High

Precondition: The patient must have an active health record in the system and be able to grant/revoke access.

Cross-references: 10.1, 49.1, 16.1

20. Schedule & Manage Appointments

Functional Requirements:

20.1. The system shall allow doctors to book, reschedule, or cancel appointments for patients.

20.2. The system shall allow doctors to view upcoming appointments in a calendar format.

20.3. The system shall send appointment reminders to patients and doctors via SMS/email notifications.

20.4. The system shall prevent double booking by checking appointment availability before confirming.

Priority Level: Medium

Precondition: The doctor and patient must be registered in the system.

Cross-references: 11.1, 45.1, 60.1

21. Link Family Medical Records

Functional Requirements:

21.1.   The system shall allow patients to link medical records with immediate family members (e.g., children, spouse, elderly dependents).

21.2.   Guardians shall be able to manage and view medical data of dependents until legal age. Patients may grant or revoke access at any time through privacy settings.

Priority Level: Medium
Precondition: All involved members must be registered in the system
Cross-references: 10.1, 1.1, 49.1

22. Health Insurance Integration-

Functional Requirements:

22.1.   Patients shall be able to upload and manage health insurance information in their profiles.

22.2.   The system shall allow validation of insurance policies through integration with insurance.

22.3.   Healthcare providers shall view insurance details to facilitate billing and eligibility checks.

Priority Level: Medium
Precondition: Patient must enter valid insurance information
Cross-references: 44.1

23. Hospital & Clinic Locator

Functional Requirements:

23.1.   The system shall allow patients to search for nearby hospitals or clinics based on their location.

23.2.   Search results shall include facility details, services offered, and doctor availability. Patients shall be able to book appointments directly from the search results.

Priority Level: Medium
Precondition: Location services must be enabled or zip code entered
Cross-references: 11.1, 40.1

24. Blood Donation Tracker

Functional Requirements:

24.1.   Patients shall be able to record past blood donations and view upcoming eligibility dates.

24.2.   The system shall send reminders when the patient is eligible to donate again. Hospitals may request eligible donors via the system based on blood type and location.

Priority Level: Medium
Precondition: Patient must opt in to blood donation tracking.

Cross-references: 34.1, 5.1, 59.1

25. Multi-Language Support

Functional Requirements:

25.1.   The system shall allow users to select and change their preferred language at any time.

25.2.   All user interfaces and system notifications shall be displayed in the selected language.

Priority Level: High

Precondition: Supported languages must be pre-configured and maintained in the system database.

Cross-references: 2.1, 3.1, 4.1, 5.1, 34.1

26. Referral System

Functional Requirements:

26.1.   The system shall allow doctors to refer patients to other specialists within the network and digitally forward the patient's medical records securely.

26.2.   The referred specialist shall receive a notification and have access to the forwarded patient records and referral notes.

Priority Level: High

Precondition: Both referring and referred doctors must be registered and authorized users of the system.

Cross-references: 15.1, 40.1, 42.1

27. Digital Signature Support

Functional Requirements:

27.1.   The system shall allow doctors to digitally sign prescriptions, diagnoses, and medical reports using secure authentication methods.

27.2.   Each digital signature shall be time-stamped and linked to the doctor's verified Medical ID for authenticity and legal compliance.

Priority Level: High

Precondition: Doctors must have a verified and registered Medical ID within the system

Cross-references: 14.1, 17.1, 16.1, 18.1

28. Vaccination Record Management

Functional Requirements:

28.1.   The system shall maintain a complete digital record of all vaccinations administered to each patient, including vaccine name, date, and healthcare provider details.

28.2.   Authorized healthcare providers shall be able to update, view, and verify a patient's vaccination history securely.

Priority Level: High
Precondition: Patients must have a registered Medical ID in the system.
Cross-references: 7.1, 1.1, 29.1

29. Emergency Access Mode

Functional Requirements:

29.1. The system must let healthcare providers access a patient's basic medical history (allergies, blood type, chronic conditions) in emergencies.

29.2. The system must log and monitor emergency access, requiring the healthcare provider to justify it afterward.

Priority Level: High
Precondition: The patient must have a registered Medical ID with pre-approved emergency data.
Cross-references: 1.1, 3.1, 2.1, 19.1

30. Medical Record Version History

Functional Requirements:

30.1. The system must keep older versions of a patient's medical records when updates are made.

30.2. The system must allow users to view past versions if needed.

Priority Level: High
Precondition: The patient must have at least one medical record uploaded to the system.
Cross-references: 16.1, 18.1, 3.1

31. Activity Logs

Functional Requirements:

31.1. The system must log all user actions, including logins, record updates, downloads, and permission changes.

31.2. Patients and admins must be able to view their own activity logs.

Priority Level: High
Precondition: Users must have an active account.
Cross-references: 2.1, 5.1, 15.1, 50.1

32. Real-Time Appointment Waiting List

Functional Requirements:

32.1. The system must let patients join a waiting list for earlier appointments if slots open due to cancellations.

32.2. The system must automatically notify the next patient when a slot is available.

Priority Level: Medium

Precondition: The patient must already have a booked appointment.
Cross-references: 11.1, 60.1, 45.1

33. Basic Reporting Dashboard

Functional Requirements:

33.1. The system must provide admins with a dashboard showing basic stats (registered users, doctors, uploaded reports, booked appointments).

33.2. The dashboard must update data every day.

Priority Level: Medium
Precondition: The admin must have dashboard access permissions.
Cross-references: 31.1, 37.1

34. Notification Center

Functional Requirements:

34.1. The system must have a central place where patients and doctors can see all alerts, reminders, and messages.

34.2. Notifications must be sorted by type (appointments, prescriptions, vaccinations).

Priority Level: High
Precondition: Users must have an active account.
Cross-references: 18.1, 45.1, 8.1, 24.1

35. Deceased Patient Record Management

Functional Requirements:

35.1. The system must let authorized users mark a patient as deceased, locking their Medical ID.

35.2. The system must securely archive deceased patients' records, allowing access only to authorized users for legal or historical reasons.

Priority Level: Medium
Precondition: The patient's death must be verified by an authorized source.
Cross-references: 1.1, 31.1, 36.1

36. Automated Record Expiration

Functional Requirements:

36.1 The system shall automatically archive outdated test results after 5 years

36.2 Patients and providers shall receive 30-day notices before automatic archiving occurs

Priority Level: Low
Precondition: Records must be older than the retention period with no recent access

Cross-references: 30.1, 34.1, 35.1

37. National Health Data Aggregation

Functional Requirements:

37.1. The system shall aggregate patient medical records from various public and private healthcare facilities across Bangladesh to create a unified health database. 37.2. The system shall provide a centralized view of national health data, accessible to authorized government bodies for policy-making and public health management. 37.3. The system shall allow healthcare providers to contribute patient data to the central database in real-time for up-to-date information.

Priority Level: High
Precondition: All healthcare facilities must be connected to the BDHR system.
Cross-references: 1.1, 33.1, 40.1, 41.1

38. Emergency Access to Patient Records

Functional Requirements:

38.1. The system shall allow healthcare providers to access a patient's critical health information (e.g., allergies, blood type, chronic conditions) in emergencies, without the patient's consent, for life-threatening situations.
38.2. Emergency access must be logged and tracked, including the reason for access and the healthcare provider's identification.
38.3. The system must provide an option for patients to review emergency access logs in their personal accounts.

Priority Level: High
Precondition: The patient's emergency data must be pre-approved and registered in the system.
Cross-references: 1.1, 29.1, 31.1, 19.1

39. Data Anonymization for Research

Functional Requirements:

39.1. The system shall anonymize patient data when shared for medical research or public health studies, ensuring no personal identifiers are included.

39.2. Researchers shall submit requests to access anonymized data, which must be reviewed and approved by authorized personnel

39.3. The system shall allow healthcare providers to opt-out of having their patient data used for research purposes while ensuring that anonymized data remains accessible.

Priority Level: Medium
Precondition: Data must be appropriately anonymized before being shared for research.
Cross-references: 49.1, 43.1, 41.1

40. Real-Time Medical Record Sharing Across Institutions

Functional Requirements:

40.1. The system shall facilitate real-time sharing of medical records between healthcare institutions in Bangladesh, improving patient care across hospitals.
40.2. Doctors from different institutions shall be able to view the medical records of patients in real-time, ensuring seamless care continuity during referrals or transfers.
40.3. The system shall allow the secure transfer of patient records from one hospital to another, ensuring data integrity and privacy.

Priority Level: High
Precondition: The system must support integration with multiple hospital and clinic databases.
Cross-references: 26.1, 3.1, 41.1, 42.1

41. Public Health Monitoring

Functional Requirements:

41.1. The system shall collect data on common health trends, including vaccination rates, disease outbreaks, and health metrics across regions.
41.2. The system shall generate reports that help government agencies monitor public health, identify potential epidemics, and respond in a timely manner.
41.3. The system shall provide real-time dashboards with health data analytics, allowing decision-makers to take immediate action.

Priority Level: High
Precondition: National health statistics must be integrated with the BDHR system.
Cross-references: 37.1, 39.1, 33.1

42. Appointment and Care Coordination Across Multiple Providers

Functional Requirements:

42.1. The system shall allow patients to schedule appointments with multiple healthcare providers for different services (e.g., specialist consultations, lab tests).

42.2. The system shall coordinate between providers and ensure that appointments do not overlap, offering alternatives when necessary.

42.3. The system shall notify the patient and providers about any changes in the schedule, cancellations, or reminders for upcoming appointments.

Priority Level: Medium
Precondition: Multiple providers and appointment scheduling must be integrated into the system.
Cross-references: 11.1, 26.1, 40.1, 45.1

43. Patient Access to Health Data for Public Health Surveys

Functional Requirements:

43.1. The system shall allow patients to voluntarily share their medical records for public health surveys conducted by the government or research bodies.

43.2. Patients must opt-in for participating in public health surveys, with full transparency on the data being used and the purpose of the research.

43.3. The system shall allow patients to withdraw from the survey at any time without affecting their access to the BDHR system.

Priority Level: Medium
Precondition: Patient consent must be obtained before sharing data for surveys.
Cross-references: 39.1, 49.1, 37.1

44. Medical Data Integration with National Insurance Systems

Functional Requirements:

44.1. The system shall integrate with national health insurance platforms, allowing patients to link their medical records with their insurance information.
 44.2. The system shall enable healthcare providers to validate insurance eligibility and process claims directly through the BDHR system.

44.3. The system shall provide real-time updates on the patient's insurance coverage status, including co-pays, deductibles, and claim history.

Priority Level: Medium
Precondition: The patient must have registered insurance details in the system.
Cross-references: 22.1, 26.1

45. Appointment Reminder System

Functional Requirements:

45.1. The system shall send automated reminders to patients 24 hours before their scheduled appointment.
45.2. Patients shall be able to customize reminder preferences, such as via email, SMS, or mobile push notifications.
45.3. The system shall allow patients to confirm, reschedule, or cancel appointments directly from the reminder notification.

Priority Level: High
Precondition: The patient must have an active, confirmed appointment in the system.
Cross-references: 11.1, 20.1, 32.1, 34.1

46. Blood Pressure Tracking and Alerts

Functional Requirements:

46.1. The system shall allow patients to manually enter their blood pressure readings or sync data from compatible devices.
46.2. The system shall alert patients and doctors when a reading exceeds normal ranges.
46.3. The system shall store a history of blood pressure readings and display trends over time.

Priority Level: Medium
Precondition: The patient must be diagnosed with hypertension or have blood pressure data entered.
Cross-references: 51.1, 34.1, 8.1

47. Medication History and Interactions

Functional Requirements:

47.1. The system shall allow patients to view a detailed history of all prescribed medications.
47.2. The system shall check for potential interactions between new medications and those in the patient's current prescription list.
47.3. The system shall alert doctors if a new prescription may cause harmful interactions with other medications.

Priority Level: High
Precondition: The patient must have an active medication history stored in the system.
Cross-references: 17.1, 55.1, 29.1

48. Emergency Contact Notification System

Functional Requirements:

48.1. The system shall allow patients to register emergency contact details in their profile.
48.2. The system shall notify emergency contacts in the event of a critical health situation (e.g., when a patient is admitted to a hospital).

48.3. Patients shall have the ability to update or remove emergency contacts as necessary.

Priority Level: Medium
Precondition: The patient must have registered emergency contact details in the system.
Cross-references: 5.1, 29.1, 34.1

49. Patient Consent for Data Sharing

Functional Requirements:

49.1. The system shall require explicit patient consent before sharing any personal health data with third parties (e.g., research, insurance companies).
49.2. Patients shall be able to view and manage the list of parties who have access to their health data.
49.3. The system shall send notifications to patients when their consent is requested for data sharing.

Priority Level: High
Precondition: The patient must have a registered account with verified contact details.
Cross-references: 10.1, 19.1, 39.1, 43.1

50. User Account Deactivation

Functional Requirements:

50.1. The system shall allow patients and doctors to request account deactivation for any reason.
50.2. Before deactivating an account, the system shall ask for a confirmation from the user to prevent accidental deactivation.
50.3. The system shall permanently delete all personal data after account deactivation, following data retention policies.

Priority Level: Medium
Precondition: The user must have an active account in the system.
Cross-references: 2.1, 31.1

51. Patient Health Risk Dashboard

Functional Requirements:

51.1. The system shall provide patients with a personalized health risk dashboard based on their medical history and lifestyle factors.

51.2. The dashboard shall display potential risks for conditions like heart disease, diabetes, and cancer.

51.3. The system shall provide recommendations for lifestyle changes to mitigate identified risks.

Priority Level: Medium
Precondition: The patient must have a completed health assessment or medical history stored in the system.
Cross-references: 46.1, 3.1, 55.1, 8.1

52. Patient Feedback on Care

Functional Requirements:

52.1. The system shall allow patients to provide feedback on their healthcare provider's performance after each appointment.

52.2. The system shall send feedback requests to patients via email or app notifications following an appointment.

52.3. The feedback results shall be accessible by the healthcare provider's administrative team to improve service quality.

Priority Level: Medium
Precondition: The patient must have attended an appointment with a registered healthcare provider.
Cross-references: 11.1, 13.1, 34.1

53. Daily Health Tips & News Feed

Functional Requirements:

53.1. The system shall display curated health tips, public health announcements, and verified news.

53.2. Users may personalize the feed based on health interests like fitness and heart health.

Priority Level: Low
Precondition: Patient must be logged in.
Cross-references: 34.1, 51.1, 55.1

54. Virtual Consultation Support

Functional Requirements:

54.1. The system shall allow patients to initiate video consultations with doctors via a secure interface.
54.2. Doctors shall be able to prescribe medications and update records after the session.

Priority Level: High
Precondition: Both parties must have devices with audio,video support and internet access.
Cross-references: 17.1, 11.1, 15.1

55. AI-Powered Symptom Checker

Functional Requirements:

55.1. The system shall allow patients to input symptoms and receive preliminary assessments powered by AI.
55.2. The system shall recommend whether to consult a doctor or take-home remedies based on symptom severity.

Priority Level: Medium
Precondition: Patient must input at least one symptom.
Cross-references: 16.1, 47.1, 51.1, 53.1

56. Lost Card Recovery and Record Access Restoration

Functional Requirements:

56.1. In case a patient loses their Health Card, the system shall provide a secure method to reissue the card after verifying identity using biometric or multi-factor authentication.
56.2. All medical records must remain intact and accessible under the user's Medical ID.

Priority Level: High
Precondition: Patient must request card recovery through the app or hospital.
Cross-references: 2.1, 29.1, 1.1

57. Offline Patient Health Card Reader

Functional Requirements:

57.1. The system shall support offline access to basic patient medical history using NFC-enabled health cards at hospitals or clinics with limited internet.
57.2. Only authorized healthcare devices can read and write to the NFC chip using secure encryption.

Priority Level: High
Precondition: Patient must possess a registered BDHR Health Card.
Cross-references: 29.1, 1.1

58. Health Goal Setting & Progress Tracking

Functional Requirements:

58.1. Patients can set personalized health goals like weight loss and blood sugar targets.
58.2. The system shall track progress and send motivational reminders.

Priority Level: Medium
Precondition: Patient must define measurable health goals.
Cross-references: 51.1, 46.1, 34.1

59. Community Health Events Calendar

Functional Requirements:

59.1. The system shall display upcoming government or NGO-led health events like free check-ups, vaccination drives, and awareness seminars.

59.2. Patients shall be able to register for these events directly.

Priority Level: Low
Precondition: Event data must be provided by official organizers.
Cross-references: 24.1, 34.1, 53.1

60. Missed Appointment Recovery System

Functional Requirements:

60.1. The system shall track missed appointments and automatically suggest the next available slot to the patient.

60.2. Doctors shall receive notifications of repeat no-shows for follow-up actions.

Priority Level: Medium
Precondition: The patient must have at least one missed appointment in the system.
Cross-references: 11.1, 20.1, 32.1, 34.1

3.2   Non-Functional Requirements

1. Security - Password Encryption

1.1.All passwords must be encrypted using industry-standard algorithms both in transit (via HTTPS) and at rest.

Priority: High

Cross references: 1.2, 1.7

2. Performance - Login Response Time

2.1.The system must verify login credentials and redirect users within 2 seconds under normal load (=<1,000 concurrent users).

Priority: High

Cross-references: 1.3, 1.4

3. Usability - Clear Error Messages

3.1.Error messages must clearly state the reason for failure (e.g., "Incorrect password") without revealing sensitive details (e.g., "User does not exist").

Priority: Medium

Cross-references: 1.4, 1.5

4. Security - Account Lockout

4.1.After 3 failed login attempts, the account must be locked for 1 hour, and a notification must be sent via email.

Priority: High

Cross-references: 1.5

5. Usability - Password Visibility Toggle

5.1.The "eye" icon must toggle password visibility instantly without reloading the page.

Priority: Medium

Cross-references: 1.6

6. Security - Password Reset

6.1.The "Forgot Password" feature must generate a time-limited (1-hour) reset link sent via email, expiring after use.

Priority: High

Cross-references: 1.7

7. Performance - Concurrent Users

7.1.The system must support 10,000 concurrent users without degradation in response time.

Priority: High

Cross-references: 1.1, 1.3

8. Reliability - Uptime

The system must maintain 99.9% uptime, excluding scheduled maintenance windows.
Priority: High
Cross-references: All pages

9. Security - Session Timeout
9.1.User sessions must automatically expire after 15 minutes of inactivity, requiring re-authentication.
Priority: High
Cross-references: All profile pages

10. Usability - Responsive Design
10.1.   All pages must be responsive and function correctly on devices with screen sizes from 320px to 1920px.
Priority: Medium
Cross-references: All pages

11. Compatibility - Browser Support
11.1.   The system must support the latest versions of Chrome, Firefox, Safari, and Edge.
Priority: Medium
Cross-references: All pages

12. Data Validation - Input Sanitization
12.1.   All user inputs (e.g., registration, login) must be sanitized to prevent SQL injection and XSS attacks.
Priority: High
Cross-references: Page 5 (Registration), Login pages

13. Audit - Login Attempts Logging
13.1.   All login attempts (success/failure) must be logged with timestamps, IP addresses, and geolocation data.
Priority: High
Cross-references: 1.2, 1.5

14. Scalability - Horizontal Scaling
14.1.   The system architecture must allow horizontal scaling (e.g., load balancers, auto-scaling groups) to handle increased traffic.
Priority: Medium
Cross-references: Performance requirements

4.   SOFTWARE DESIGN

4.1   Use Case Diagram

Case Study: Use Case Diagram

The Bangladesh Digital Health Registry (BDHR) is a centralized digital healthcare platform designed to improve the accessibility, coordination, and efficiency of medical services across the country. By connecting patients, doctors, hospitals, and government health agencies, the system replaces paper-based records with secure, digital profiles. Patients can search for doctors, book or cancel appointments, make payments through multiple methods, and access their medical history and reports while controlling data access through secure logins. Doctors can view authorized patient records, update diagnoses, prescribe medications, and manage appointments, ensuring continuity of care. Hospital administrators handle admissions, upload lab reports, and issue digital health cards, while the government oversees user authentication, health statistics, and system compliance. Built on a secure cloud infrastructure, BDHR enhances transparency, empowers patients, and supports data-driven public health strategies, especially in underserved regions.
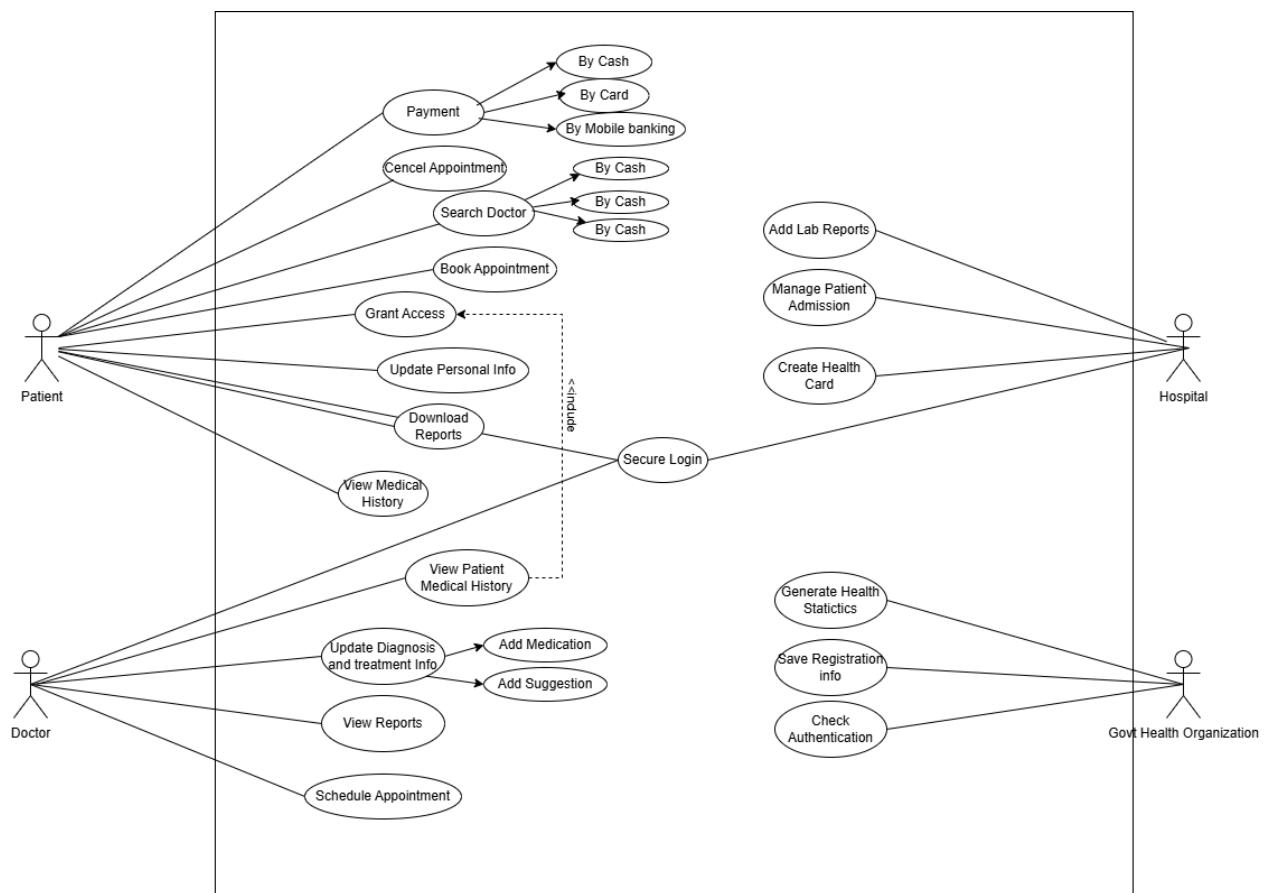

Fig 4.1: Use Case Diagram

4.2   Class Diagram

Case Study: Class Diagram

The Smart Hospital Electronic Medical Record (EMR) System is designed to address the limitations of traditional paper-based medical record management by offering a centralized, secure, and efficient digital alternative. In many hospitals, the manual handling of patient records often leads to data redundancy, loss, unauthorized access, and inefficiencies in service delivery. This system introduces a structured approach to managing patient data, facilitating better collaboration between hospital staff, patients, and pharmacists, while maintaining strong data privacy and security measures.

At the core of the system lies the MedicalRecord class, which connects doctors, patients, prescriptions, lab reports, and downloadable PDFs. The Patient class plays a central role, holding ownership of the medical records and managing access through features like OTPService and PrivacySettings. These services allow patients to control who can view or modify their health data. For example, a patient can use a one-time password for secure authentication and update their privacy settings to allow or restrict data access by a specific doctor or pharmacist.

Doctors interact heavily with the system, as they are responsible for creating and updating medical records, writing prescriptions, and requesting lab tests. Each doctor operates under the supervision of a HospitalAdmin, who oversees and manages the healthcare providers in the system. The LabReport class is used to document diagnostic test results, which are then linked to the patient's medical record for future reference. Similarly, the Prescription class allows doctors to prescribe medication, which pharmacists can later retrieve and use for dispensing medicines. The Pharmacist class has read access to prescriptions but cannot alter them, ensuring data integrity.

Another key feature is the use of NFCScanner technology, which allows patients to retrieve their medical records contactlessly at hospital kiosks or terminals. This enhances convenience and supports faster service at the point of care. Additionally, the ability to export data into Pdf format ensures that patients or doctors can store or print necessary records offline if needed.

Overall, the system ensures that every medical interaction from diagnosis to prescription to follow-up is digitally recorded, accessible, and secure. Patients are empowered to take control of their healthcare data while enabling doctors, pharmacists, and administrators to perform their duties more effectively. By combining role-based access control, digital communication, and privacy-focused design, the Smart Hospital EMR System significantly improves the quality and efficiency of healthcare delivery in modern hospitals.
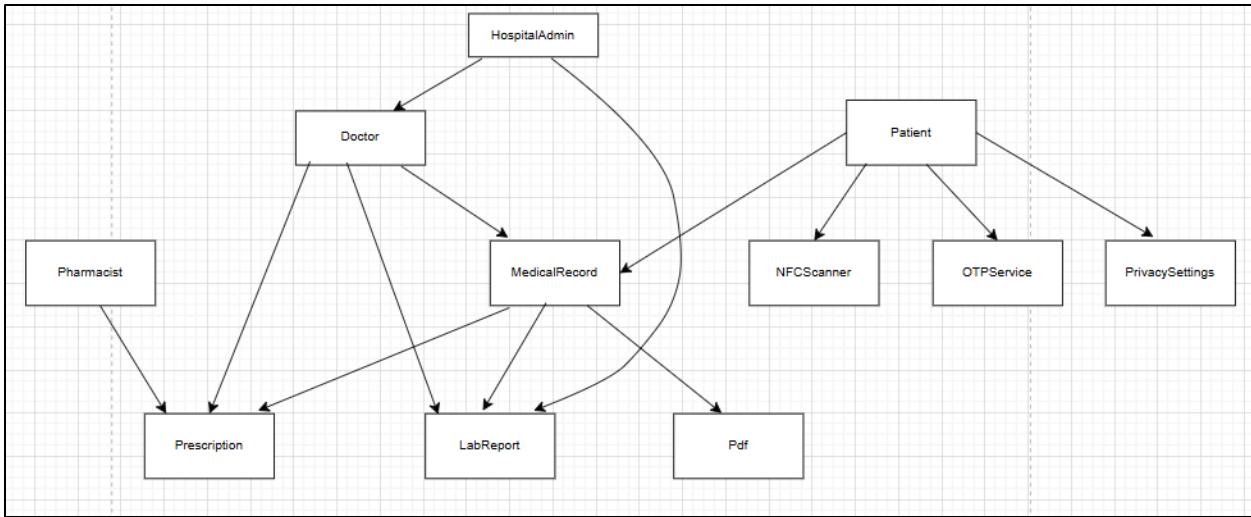
Fig 4.2: Class Diagram

HospitalAdmin
-adminID: String -name: String -hospitalName: String
+verifyDoctor(doctorID: String): void +registerPatient(): void +uploadLabReport(): void +monitorDataQuality(): void

Doctor
-doctorID: String -name: String -specialization: String
+login(otp: String): boolean +viewPatientData(patientID: String): List<MedicalRecord> +updateRecord(): void +issuePrescription(): Prescription +requestLabTest(): LabTest

MedicalRecord
-recordID:String -diagnoses: String[] -prescriptions: List<Prescription> -labReports: List<LabReport>

-doctorID: String
+generatePDF(): PDF

LabReport
-reportID: String -testName: String -result: String -issuedDate: Date

Pdf
-fileName: String -fileSize: int
+generate(): void

Pharmacist
-pharmacistID: String -name: String -pharmacyName: String
+validatePresaription(presariptionID: String): boolean dispenseMedication(): void

Prescription
-prescriptionID: String -medication: String[] -dosage: String -issuedBy: Doctor -issuedTo: Patient

Patient
-patientID: String -name: String -nid: String -contactinfo: String -address: String -emergencyAccess: boolean -privacySettings: PrivacySettings

+register(nid: String): void
+login(otp: String): boolean
+updateDetails(): void
+viewRecords(): List<MedicalRecord>
+grantAccess(doctorID: String): void

NFCScanner
+scan(cardID: String): String

OTPService
+sendOTP(phoneNumber: String): void
+verifyOTP(otp: Stnng): boolean

PrivacySettings
-allowAllDoctors: boolean
-restrictedDoctorIDs: List<String>
+updateSettings(): void

4.3   Activity Diagram

Case Study: Activity Diagram

The Bangladesh Digital Health Registry (BDHR) is a groundbreaking centralized digital health platform designed to address the challenges of fragmented, inaccessible, and paper-based medical records in Bangladesh's healthcare system. By empowering patients, doctors, hospital administrators, pharmacists, and the Directorate General of Health Services (DGHS), the BDHR system fosters collaboration among healthcare providers and enables seamless access to medical information, especially in rural and underserved regions.

Patient Perspective: The BDHR system enables patients to take control of their health information by providing a digital health ID and an NFC-enabled health card linked to their personal health profile. Upon registration using their National ID (NID), patients can log in securely via OTP-based authentication. This allows them to access, view, and download historical medical records, including diagnoses, lab reports, prescriptions, and vaccination details. Patients can update personal information such as contact details and addresses and customize privacy settings for controlling access to their health data. When visiting healthcare facilities, patients can present their NFC card for quick retrieval of medical records by doctors or hospital staff.

Additionally, the system facilitates patient engagement through automated SMS or email notifications for medication schedules and follow-up appointments. In emergencies, patients can pre-authorize emergency data access, ensuring prompt and informed medical interventions.

Doctor Perspective: Doctors use the BDHR system to securely access patient health records after receiving consent from the patient. By scanning the NFC-enabled health card or searching with the health ID, doctors gain access to critical medical information, including past treatments and lab results. This helps them make informed decisions, update diagnoses and treatment plans, issue digital prescriptions, and request further lab tests if needed. Real-time updates ensure that any new medical entries are immediately available for future consultations. Doctors also manage appointments and ongoing treatment records directly within the system, and during emergencies, they can access patient data if emergency permissions were enabled. Accountability is ensured through timestamps and doctor credentials associated with every entry, allowing both doctors and patients to track data usage.

Hospital Administrator Perspective: Hospital administrators play a critical role in maintaining the integrity and operational efficiency of the BDHR system. After securely logging in, administrators verify doctors' credentials to ensure that only authorized professionals gain access to sensitive medical data. Administrators handle patient admissions, register patients into the system, and issue NFC-enabled health cards for streamlined clinic visits. They are responsible for uploading diagnostic reports and lab results to patient profiles, keeping records accurate and complete. Administrators monitor the quality of data entered the system and flag any discrepancies or suspicious entries for review by the DGHS, thereby ensuring data consistency and compliance with health regulations.

Pharmacist Perspective: Pharmacists use the BDHR system to validate prescriptions issued by registered doctors, verifying authenticity through digital signatures. Once verified, they dispense medications to patients and update prescription statuses in the system to maintain transparency and traceability. This process ensures secure and error-free medication distribution while minimizing fraudulent practices.

Directorate General of Health Services (DGHS) Perspective: The DGHS oversees the BDHR system by accessing anonymized patient data to ensure privacy while gathering insights for national health planning. DGHS monitors compliance among institutions, hospitals, doctors, and pharmacists ensuring adherence to policies and regulations. They generate health reports to inform public health strategies, review hospital registrations, and approve verified facilities for integration into the system. The authority also resolves flagged data discrepancies to uphold the integrity of the registry.

System Overview and Impact: The BDHR platform is built using cutting-edge technologies, including cloud-based storage for scalability, encryption for robust security, and responsive web interfaces for user accessibility. The system promotes efficiency, transparency, and accountability

in healthcare delivery, empowering patients to manage their health information while facilitating informed decision-making for healthcare providers. By digitizing medical records and enabling seamless communication among users, the BDHR system enhances healthcare outcomes, reduces administrative burdens, and builds trust in the healthcare system especially for underserved populations in Bangladesh.
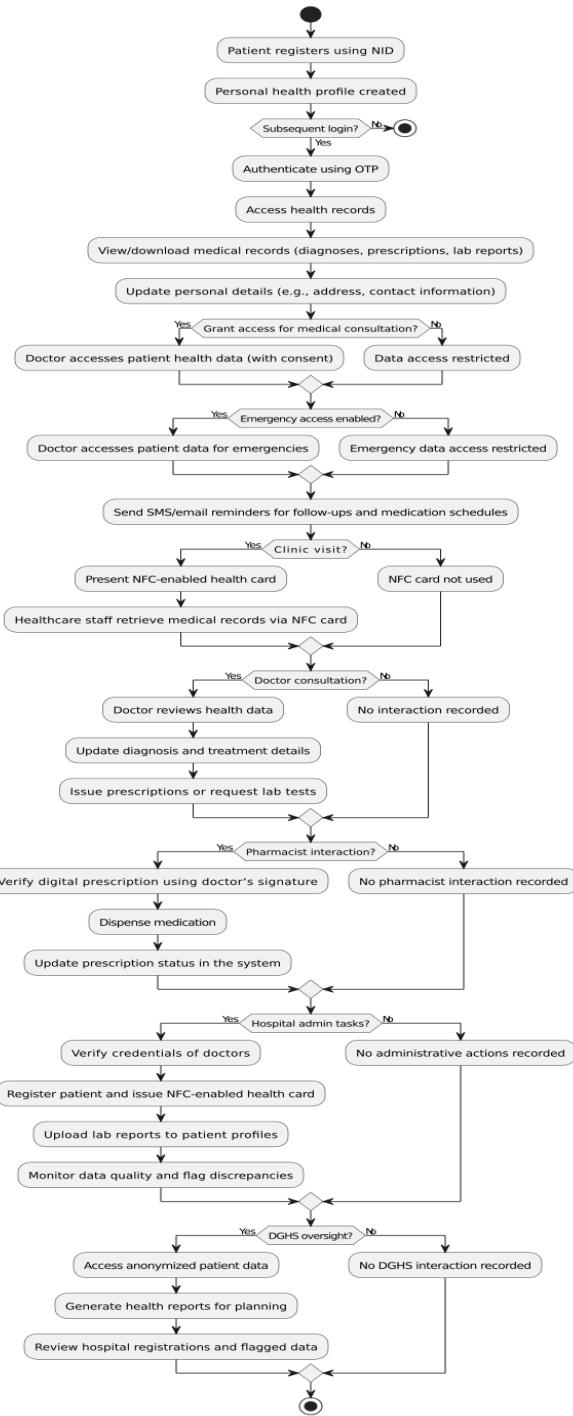

Fig 4.3: Activity Diagram

4.4 Sequence Diagram

Case Study: Sequence Diagram

Case 1: (Patient perspective)
When a patient attempts to access the Bangladesh Digital Health Registry system, the system first prompts for the patient's mobile number and sends an OTP for verification. If the OTP is valid, the system grants access to the patient. The patient then requests to view their medical records, and the system retrieves the records from the database. If records are available, the system provides the patient with their medical history; otherwise, the patient is notified that no records are found. Next, the patient initiates an appointment booking. The system checks for an available doctor in the database and requests access to the doctor's records on behalf of the patient. If access is granted, the booking is confirmed, and the patient is notified of a successful booking. If access is not granted, the patient is informed that the booking was unsuccessful. The patient then updates their personal details, which the system stores in the database and confirms the update to the patient. Finally, the patient requests a prescription. The system forwards the request to the doctor, who uploads the prescription and related reports to the database. Once the upload is successful, the system notifies the patient, and the prescription is made available. If the initial OTP is invalid, the patient's access to the system is denied, and they are prompted to try again.

Case 2: (Doctor Perspective)
When a doctor accesses the Bangladesh Digital Health Registry system, the system prompts for the doctor's credentials and sends an OTP for verification. If the OTP is valid, the system grants access to the doctor. The doctor then searches for a patient to view their medical history, and the system retrieves the patient's records from the database, provided the patient has granted access. If the records are available, the system displays the patient's history to the doctor; otherwise, the doctor is notified that access is denied or no records are found. Next, the doctor prescribes medications for the patient, and the system stores the prescription in the database, notifying the patient of the new prescription. The doctor also schedules an appointment for the patient, and the system checks for available time slots in the database. If a slot is available, the appointment is confirmed, and both the doctor and patient are notified of the successful booking. If no slot is available, the doctor is informed that the booking failed. If the initial OTP is invalid, the doctor's access to the system is denied, and they are prompted to try again.
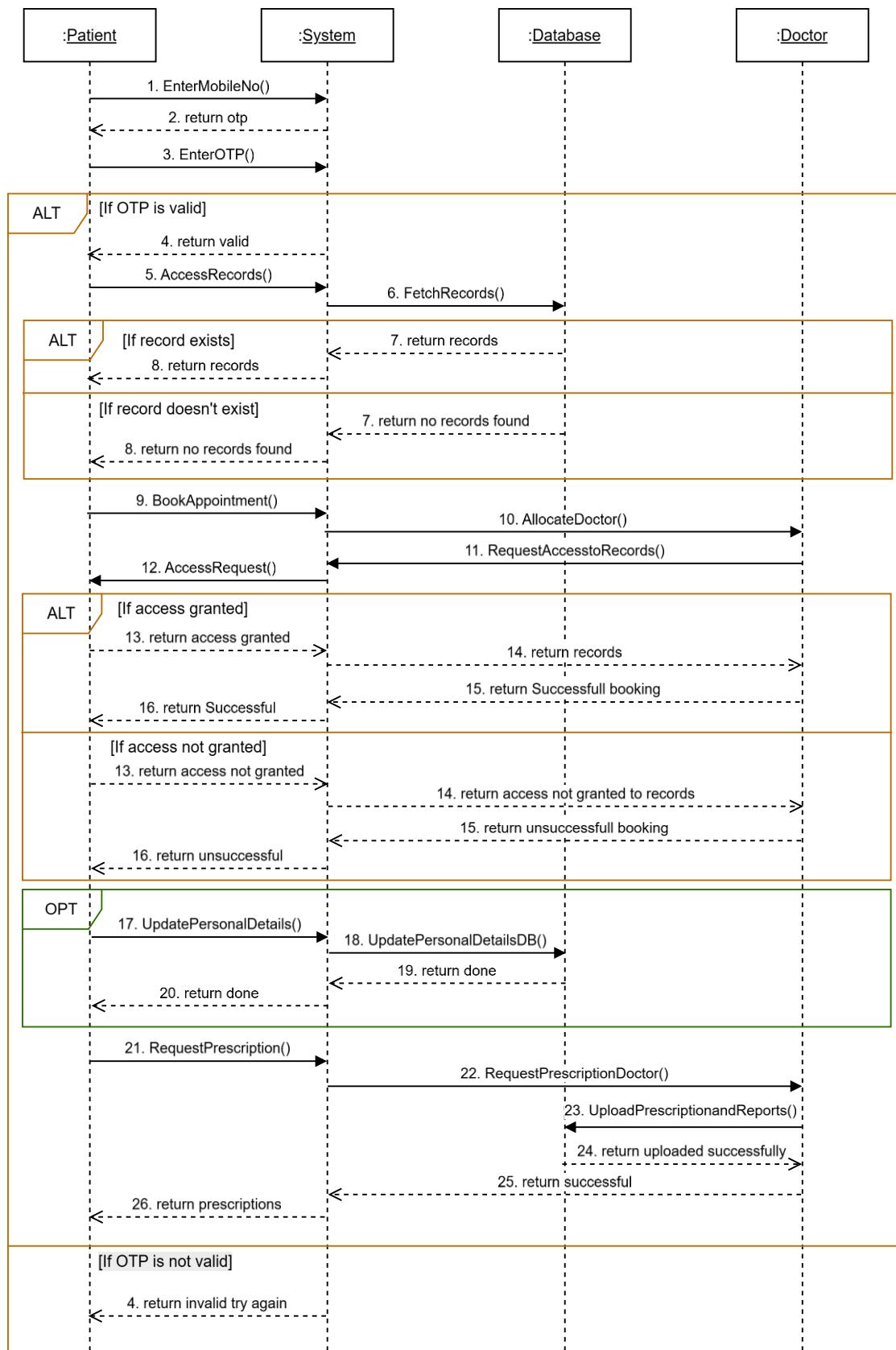
Fig 4.4.1: Sequence Diagram (Patient perspective)
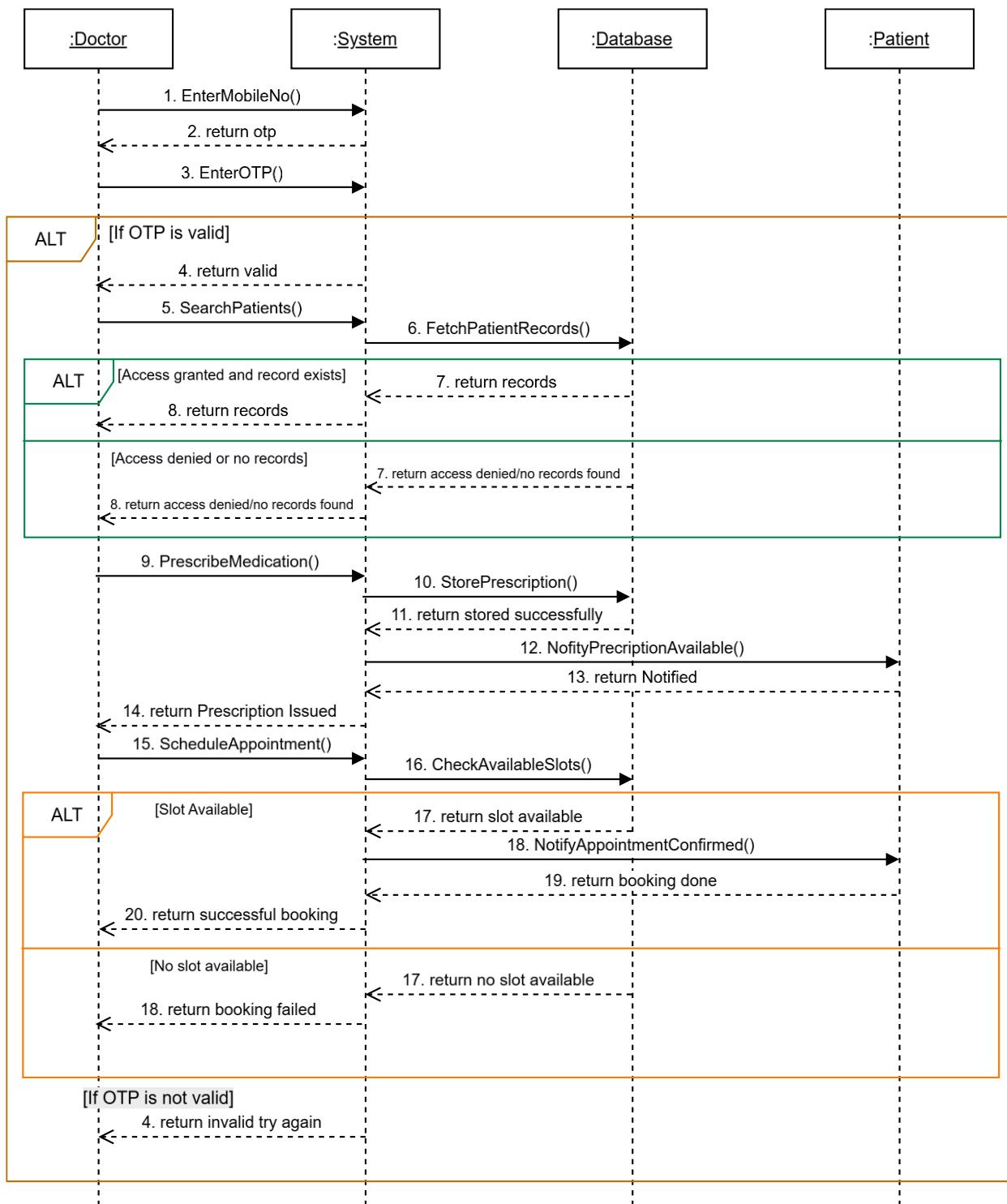
Fig 4.4.1: Sequence Diagram (Doctor perspective)

5.   UI DESIGN
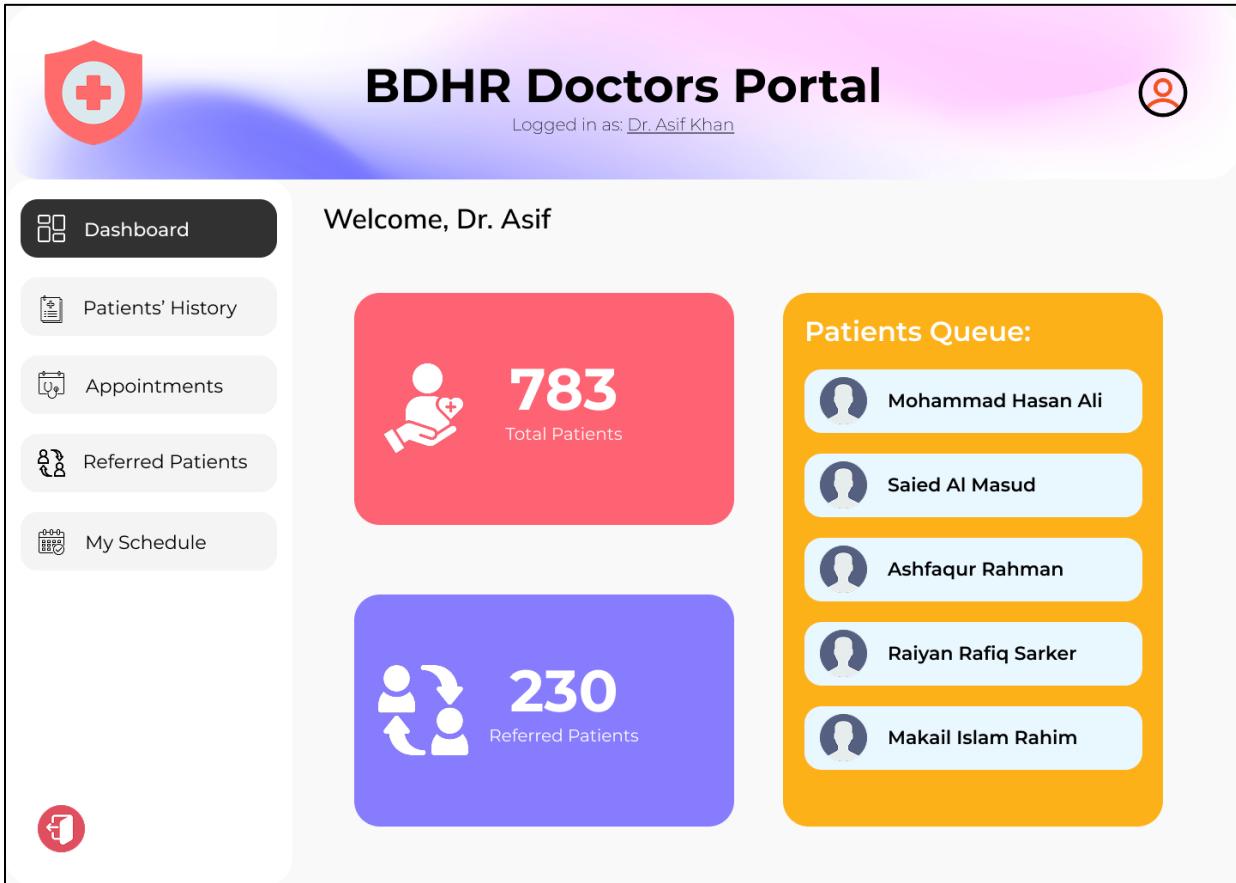
Fig 5.1: This webpage shows a doctor's dashboard on BDHR Doctors portal. The logo of BDHR is visible on the top left corner of the webpage and in the top middle of the webpage the "BDHR Doctors Portal" is visible. Below that it also appears the logged in doctor's name. From the top right corner of the webpage the doctor can access his own profile.

On the dashboard the doctor can see his total patients and referred patients. Also, he can see his patient queue, who are on the way to receive treatment. From the side menu the doctor can access different functionalities such as Patients' History, Appointments, Referred Patients, My Schedule.
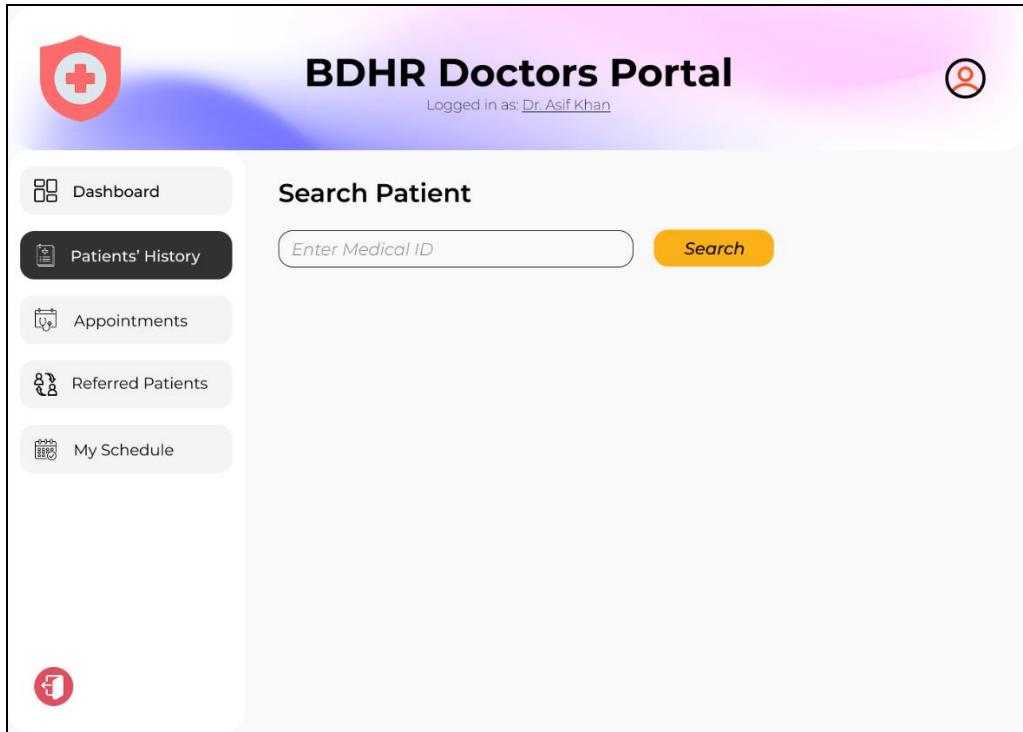
Fig 5.2: The doctor intended to check patients' history. After clicking to Patient's History button from the side panel, A search box appears and prompts for the medical ID.
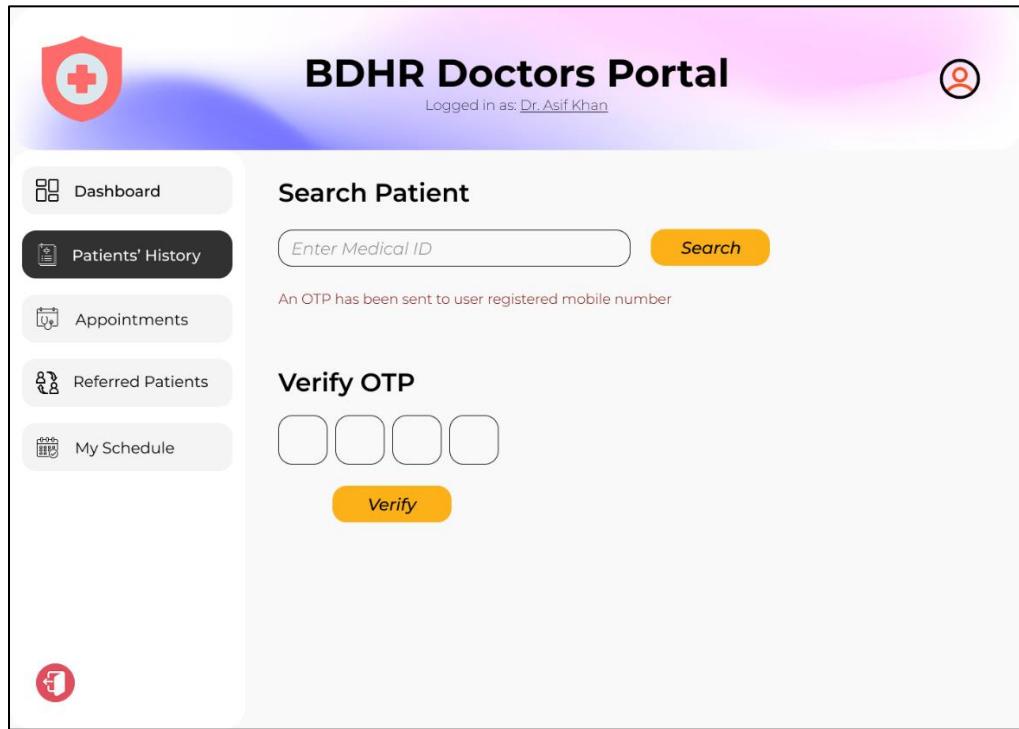
Fig 5.3: After entering a valid medical ID and clicking search button the system asks for the OTP sent to patient's registered mobile number.

BDHR Doctors Portal
Logged in as: Dr. Asif Khan

- Dashboard
- Patients' History
- Appointments
- Referred Patients
- My Schedule

Patient Information

Name: Sadman Sakib **Gender:** Male
Medical ID: 00XXXX00 **Age:** 23

Medical History

Prescription Diagnoses Lab Reports Vaccination

Date	Name	Severity	Notes
17.04.24	CBC	None	None
17.04.24	ESR	None	None
27.05.24	X-Ray	Fracture	None
23.07.24	PNS B/V	None	None
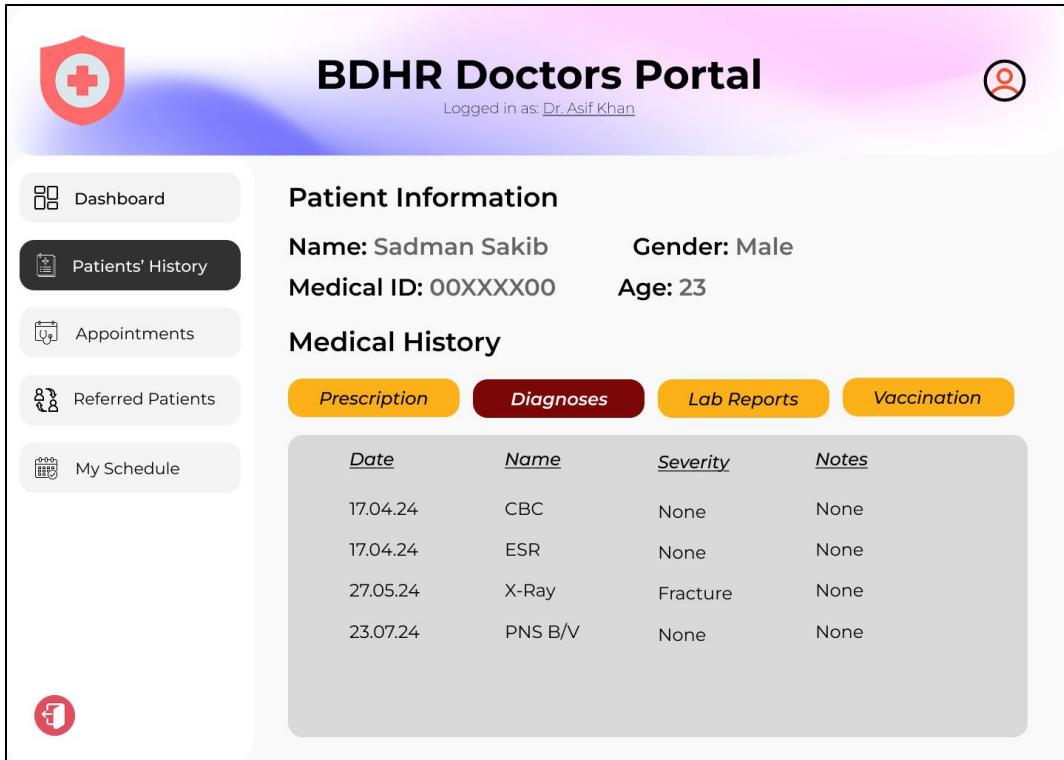
Fig 5.4: After entering the valid OTP and clicking verify button the system showing the patient information and patient's medical history. Here the different buttons can navigate to different types of medical history.

6. PROJECT TEST PLANNING

1.

Project Name: Bangladesh Digital Health Registry	Test Designed by: SAIED AL MASUD
Test Case ID: FR_04	Test Designed date: 07/05/2025
Test Priority (Low, Medium, High): High	Test Executed by: Name
Module Name: Medical Report Access	Test Execution date: date
Test Title: Verify patient can download available medical reports in PDF format	
Description: Test if a logged-in patient can download and print their medical reports (test results and prescriptions) in PDF format	
Precondition: Patient must be logged in with valid credentials and the required medical report must be available in the system	
Dependencies: if any	

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
1. **Navigate to the "My Medical Reports" section** 2. **Click on a specific report to view details** 3. **Click on "Download PDF" button** 4. **Click on "Print" button.**	User logged in as Patient ID: P12345 Select report Click download button next to the report Click print icon on report details page	User is successfully navigated to the "My Medical Reports" page Report details are displayed correctly PDF file is downloaded and can be opened without error Print dialog opens, allowing user to select printer and print report	As expected	Pass

Post Condition: The medical report is successfully downloaded in PDF format, and optionally printed. No data is altered in the system.

2.

Project Name: Bangladesh Digital Health Registry	**Test Designed by: SAIED AL MASUD**
Test Case ID: FR_05	Test Designed date: 07/05/2025
Test Priority (Low, Medium, High): High	Test Executed by: Name
Module Name: Update personal information	Test Execution date: date
Test Title: Verify patient can update personal contact number	
Description: Test if a logged-in, verified patient can successfully update their contact number with OTP verification.	
Precondition: Patient must be logged in and have a verified account.	
Dependencies: if any	

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
1. **Navigate to "Profile" or "Personal Information" section.** 2. **Click "Edit" on the contact number field.** 3. **Enter a new valid contact number and click "Save Changes"** 4. **Enter the received OTP** 1. **Check the number**	New Number: 01712345678 OTP: 1234567	Personal information page is displayed. Contact number field becomes editable. New number is accepted and system prompts for OTP verification. OTP is verified successfully. Contact number is updated, success message is displayed	As expected	Pass

Post Condition: Contact number is updated in the system and the change is logged securely. OTP verification ensures data integrity.

3.

Project Name: Bangladesh Digital Health Registry	Test Designed by: SAIED AL MASUD
Test Case ID: FR_16	Test Designed date: 07/05/2025
Test Priority (Low, Medium, High): High	Test Executed by: Name
Module Name: Update Patient Diagnoses	Test Execution date: date
Test Title: Verify doctor can add and update patient diagnoses after patient OTP verification	
Description: Test if a doctor with patient access permissions (via OTP) can successfully add a new diagnosis, update an existing diagnosis, and verify diagnosis change history is logged.	
Precondition: The doctor must have patient access permissions via OTP verification	
Dependencies: Patient must provide OTP; diagnosis data must be available	

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
1. **Navigate to "Patient Search" and enter valid patient ID** 2. **Enter OTP received by patient and confirm access** 3. **Go to "Diagnoses" section and click "Add Diagnosis"** 4. **Enter new diagnosis details: name, severity, symptoms, notes** 5. **Click "Edit" on existing**	Patient ID: PT12345 OTP: 654321 Condition: Hypertension, Severity: Moderate, Symptoms: Headache, Notes: Initial stage	Patient profile is found. Access granted to patient's medical records. Diagnosis input form appears. Diagnosis is submitted and saved. Existing diagnosis is updated successfully. Log displays all changes with timestamps and user info	As expected	Pass

diagnosis and update **6. Open diagnosis history log**				

Post Condition: **New and updated diagnoses are saved to the patient record, and all changes are captured in the audit log for traceability.**

4.

Project Name: Bangladesh Digital Health Registry	Test Designed by: SAIED AL MASUD
Test Case ID: FR_22	Test Designed date: 07/05/2025
Test Priority (Low, Medium, High): High	Test Executed by: Name
Module Name: Health Insurance Integration	Test Execution date: date
Test Title: Verify patient can upload and validate health insurance information	
Description: Test whether a patient can upload valid insurance information, the system can validate the data via integration, and providers can access this for billing and eligibility checks.	
Precondition: Patient must enter valid insurance information	
Dependencies: Active insurance provider API connection	

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
1. Navigate to "Insurance Information" in profile **2. Click "Add Insurance" and enter policy details** **3. Click "Validate"**	Insurance Provider: Delta Life insurance LTD Policy No: D12345678	Insurance management page is shown Form accepts data and shows "Validate" button Policy is successfully validated with confirmation	As expected	Pass

4. **Save insurance information** 5. **Login as healthcare provider and view patient profile**	Patient ID: PT12345	Insurance info is saved and confirmation is shown Insurance information is visible under patient billing section		

Post Condition: **Insurance details are validated and saved under the patient's profile, accessible to healthcare providers for billing and eligibility verification.**

5.

Project Name: Bangladesh Digital Health Registry	Test Designed by: SAIED AL MASUD
Test Case ID: FR_23	Test Designed date: 07/05/2025
Test Priority (Low, Medium, High): High	Test Executed by: Name
Module Name: Hospital & Clinic Locator	Test Execution date: date
Test Title: Verify patient can search for nearby hospitals/clinics.	
Description; Test that patients can search for nearby medical facilities using location services or zip code, view facility and doctor details.	
Precondition: Location services must be enabled or valid zip code must be entered	
Dependencies: GPS/location access	

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
1. **Navigate to "Find Hospital/Clinic" section** 2. **. Allow location access or manually enter zip code** 3. **View list of results with**	Zip Code: 1216	Patient dashboard is displayed Search interface is displayed System fetches nearby hospitals/clinics based on location	As expected	Pass

facility and doctor info 4. **View search results**		List displays facility names, addresses, services, and doctor availability.		

Post Condition: **The patient is able to view accurate, detailed information about nearby hospitals or clinics based on their current location or entered zip code.**

6.

Project Name: Bangladesh Digital Health Registry (BDHR)	Test Designed by: SADMAN SAKIB
Test Case ID: FR_09	Test Designed date: 07-05-2025
Test Priority (Low, Medium, High): High	Test Executed by:
Module Name: Authentication	Test Execution date:
Test Title: OTP Verification for Accessing Patient's Medical Records	
Description: The system will require an OTP before a doctor can view or download patients' medical records	
Precondition: The doctor is logged in with valid credentials and is on the Dashboard page. The patient must have a registered mobile number or email.	
Dependencies: Functional login system, registered patient contact details, SMS/email service for OTP delivery.	

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
1. **Navigate to patient's medical records section** 2. **Request access to view patient's medical records**	Patient ID: PAT7869 Patient Mobile: 01713571667 Patient Email: contact.sadman@gmail.com Valid OTP: [Generated dynamically, e.g., 4830] Incorrect OTP: 9999	1. Doctor navigates to patient's records section from Dashboard 3. System prompts for OTP verification.	As expected	Pass

2. **Receive OTP on the patient's mobile number** 3. **Enter the OTP and submit.** 5. **Lock out test with incorrect OTP (3 times)**		4. OTP is sent to patient's registered mobile or email. 6. Entering valid OTP grants access to patient's records. 7. System will ask to reattempt OTP 8. System will ask to reattempt OTP 9. System will lock account temporarily and display an error message.		

Post Condition: If valid OTP is entered, the doctor gains access to the patient's medical records. If incorrect OTP is entered three times, the system locks access temporarily, and a log is created in the database for the access attempt.

7.

Project Name: Bangladesh Digital Health Registry (BDHR)	Test Designed by: SADMAN SAKIB
Test Case ID: FR_30	Test Designed date: 08-05-2025
Test Priority (Low, Medium, High): High	Test Executed by:
Module Name: Medical Records	Test Execution date:
Test Title: Viewing Older Versions of Patient's Medical Records	

Description: The system will store older versions of a patient's medical records when updates are made and allow a doctor to view past versions.				
Precondition: A patient exists with an initial diagnosis (e.g., "Hypertension, 2024-01-15"). A doctor is logged in with valid credentials and OTP, with permissions to update records.				
Dependencies: Functional login system, Functional record update system, version history database.				
Test Steps	**Test Data**	**Expected Results**	**Actual Results**	**Status (Pass/Fail)**
1. **Navigate to patient's medical records section** 2. **Navigate to the version history section.** 3. **Select and view the original version.** 4. **Update the diagnosis**	Patient ID: PAT7869 Patient Mobile: 01713571667 Patient Email: contact.sadman@gmail.com Updated Diagnosis: "Hypertension, controlled	1. System displays the patient's current record. 2. System shows a list of versions (e.g., original: "Hypertension, 2024-01-15", updated: "Hypertension, controlled" 3. System displays the original diagnosis ("Hypertension, 2024-01-15") with all details intact.	As expected	Pass
Post Condition: The updated record is saved, and the original version remains accessible in the version history.				

8.

Project Name: Bangladesh Digital Health Registry (BDHR)	Test Designed by: SADMAN SAKIB
Test Case ID: FR_31	Test Designed date: 08-05-2025
Test Priority (Low, Medium, High): High	Test Executed by:
Module Name: Security and Auditing	Test Execution date:

Test Title: Logging and Viewing User Activity Logs	
Description: The system will log all user actions (e.g., logins, record updates) and allow to view their activity logs.	

Precondition: A user is registered and has performed prior actions (e.g., login, record update). The user is logged in with valid credentials.

Dependencies: Functional login system, logging database, user permissions.

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
1. **Navigate to the activity logs section from the Dashboard.** 2. **View recent actions in the logs.**	Patient ID: PAT7892 Perform any activity	1. Previous activities are visible with timestamps and details. (e.g., Login, 2025-05-13 16:00:00)	As expected	Pass

Post Condition: Users can view their activity logs, ensuring transparency of system interactions

9.

Project Name: Bangladesh Digital Health Registry (BDHR)	Test Designed by: SADMAN SAKIB
Test Case ID: FR_34	Test Designed date: 08-05-2025
Test Priority (Low, Medium, High): High	Test Executed by:
Module Name: Notifications	Test Execution date:
Test Title: Viewing and Sorting Notifications	
Description: The system will provide a notification center where users can view and sort notifications by type (appointments, prescriptions, vaccinations).	

Precondition: User is registered and has received notifications. User is logged in with valid credentials.

Dependencies: Functional notification system, database with notification data.

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)

1. **Navigate to the notification center from the Dashboard.** 2. **Check the default view of notifications.** 3. **Sort notifications by type (select "Prescriptions").** 4. **Sort notifications by type (select "Vaccinations").**	Notifications: Prescription: " prescription, 2025-05-13" Vaccination: "flu shot, 2025-05-15"	1. System displays the notification center with all notifications. 2. Notifications are displayed in default order (e.g., by date, latest first). 3. Only the prescription notification ("prescription, 2025-05-13") is shown. 4. Only the vaccination notification ("Vaccination flu shot, 2025-05-15") is shown.	As expected	Pass

Post Condition: The notification center displays and sorts notifications correctly by type.

10.

Project Name: Bangladesh Digital Health Registry (BDHR)	Test Designed by: SADMAN SAKIB
Test Case ID: FR_32	Test Designed date: 08-05-2025
Test Priority (Low, Medium, High): Medium	Test Executed by:
Module Name: Appointments	Test Execution date:
Test Title: Joining and Receiving Notification from Appointment Waiting List	
Description: The system will allow a patient to join a waiting list for earlier appointments if slots open due to cancellations and notify the next patient.	
Precondition: A patient is logged in with valid credentials and OTP. An appointment slot is booked and later cancelled, creating an opening.	
Dependencies: Functional appointment system, real-time notification service.	

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
1. **Navigate to the appointment section from the Dashboard.** 2. **Join the waiting list for an earlier slot.** 3. **Simulate a cancellation of a booked slot (e.g., by admin).** 4. **Accept the notification to book the slot.**	Cancelled Slot: 2025-05-14 10:00 AM	1. System displays the appointment section. 2. System confirms the patient is added to the waiting list. 3. System notifies the patient of an available slot. 4. System books the slot for the patient and updates the appointment status.	As expected	Pass

Post Condition: The patient is successfully booked into the cancelled slot, and the waiting list is updated.

11.

Project Name: Bangladesh Digital Health Registry	Test Designed by: Raiyan Rafiq Sarker
Test Case ID: BDHR_38	Test Designed date: 07/05/25
Test Priority (Low, Medium, High): High	Test Executed by: Name
Module Name: Emergency Access Module	Test Execution date: Date
Test Title: Emergency Access to Patient's Critical Health Information Without Consent	
Description: Verify that healthcare providers can access critical patient health information during life-threatening emergencies without patient consent and that all access is logged and visible to the patient.	
Precondition: Patient has pre-approved and registered emergency health data in the system.	
Dependencies: Emergency access rights assigned to healthcare provider role.	

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)

1. Simulate emergency scenario 2. Login as authorized healthcare provider 3. Attempt to access patient data without consent 4. Enter reason for emergency access 5. System logs emergency access 6. Patient logs into personal account 7. Navigate to emergency access log	The emergency flag is set (e.g., "Cardiac Arrest") for an unconscious patient with a Patient ID 123456. The action is performed by the provider using Username: dr_emergency1 and Password: The relevant details captured include Provider ID, Patient ID, Timestamp, and Reason. Additionally, the patient's login Username is patient123.	Patient sees access entry with details.	As expected	Pass

Post Condition: Emergency access is recorded in audit logs. Patient visibility of emergency access logs is confirmed.

12.

Project Name: Bangladesh Digital Health Registry	Test Designed by: Raiyan Rafiq Sarker
Test Case ID: BDHR_39	Test Designed date: 08/05/25
Test Priority (Low, Medium, High): Medium	Test Executed by: Name
Module Name: Data Anonymization	Test Execution date: date

Test Title: Verify anonymization of patient data before sharing for research	
Description: Test that the system anonymizes patient data before sharing it for medical research	
Precondition: Data must be appropriately anonymized before being shared for research	
Dependences: if any	

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
1. Submit a request to access anonymized data through the research portal 2. Wait for the request to be reviewed and approved by authorized personnel 3. Ensure the shared data does not contain personal identifiers 4. Confirm that opted-out provider data is excluded while anonymized data is still accessible	Research request submitted by researcher Healthcare provider has opted out of research data sharing	Only anonymized patient data is shared after approval	As expected	Pass

Post Condition: Anonymized data is shared with researcher following approval, and opt-out preferences of providers are respected.

13.

Project Name: Bangladesh Digital Health Registry	Test Designed by: Raiyan Rafiq Sarker
Test Case ID: BDHR_40	Test Designed date: 08/05/25
Test Priority (Low, Medium, High): High	Test Executed by: Name

Module Name: Real-Time Medical Record Sharing	Test Execution date: date
Test Title: Verify real-time sharing of medical records across institutions	
Description: Test the system's ability to share medical records in real-time between healthcare institutions	

Precondition: The system must support integration with multiple hospital and clinic databases

Dependencies: if any

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
1. Refer a patient from one hospital to another using the system 2. Attempt to access the patient's medical records from the receiving institution 3. Verify the shared records appear in real-time 4. Confirm that the data transfer maintains integrity and privacy	Doctor from referring hospital initiates transfer Doctor from receiving hospital attempts to access patient record	The receiving doctor can view the patient's medical records in real-time	As expected	Pass

Post Condition: Patient records are securely and accurately shared across hospitals, supporting seamless care.

14.

Project Name: Bangladesh Digital Health Registry	Test Designed by: Raiyan Rafiq Sarker
Test Case ID: BDHR_41	Test Designed date: 08/05/25

Test Priority (Low, Medium, High): High	Test Executed by: Name
Module Name: Public Health Monitoring	Test Execution date: date
Test Title: Verify public health data collection and monitoring functionality	
Description: Test the system's ability to collect and display health trends and metrics for public health monitoring	
Precondition: National health statistics must be integrated with the BDHR system	
Dependences: if any	

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
1. Submit health data from regional clinics to the system 2. Verifying the data is aggregated into public health reports 3. Check for automatic detection and flagging of potential outbreaks 4. Access real-time dashboards displaying collected metrics and analytics	Vaccination rates and disease reports submitted from multiple regions	The system generates real-time analytics and reports to support public health monitoring	As expected	Pass

Post Condition: Government agencies can access timely health reports and dashboards to guide public health decisions.

15.

Project Name: Bangladesh Digital Health Registry	Test Designed by: Raiyan Rafiq Sarker

Test Case ID: BDHR_42	Test Designed date: 08/05/25
Test Priority (Low, Medium, High): Medium	Test Executed by: Name
Module Name: Appointment and Care Coordination	Test Execution date: date
Test Title: Verify appointment scheduling and coordination across multiple providers	
Description: Test the system's ability to manage and coordinate appointments with multiple healthcare providers	

Precondition: Multiple providers and appointment scheduling must be integrated into the system
Dependencies: if any

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
1. Schedule appointments for a patient with multiple providers 2. Check that the system prevents overlapping appointments and offers alternatives 3. Modify one of the scheduled appointments 4. Confirm that notifications are sent to the patient and providers about the update	Appointments created for specialist consultation and lab test from different providers	The system successfully coordinates appointments and sends necessary notifications	As expected	Pass

Post Condition: Patient and providers are updated with a conflict-free, coordinated appointment schedule.

16.

Project Name: Bangladesh Digital Health Registry (BDHR)	Test Designed by: Md. Nishad
Test Case ID: FR_45	Test Designed date: 07/05/2025
Test Priority (Low, Medium, High): High	Test Executed by: Name
Module Name: Appointment Reminder System	Test Execution date: date
Test Title: Verify automated appointment reminders and patient actions	
Description: Test the system's ability to send automated reminders, allow preference customization, and let patients confirm, reschedule, or cancel appointments from the reminder.	
Precondition: The patient must have an active, confirmed appointment in the system.	
Dependencies: Working SMS, email, and push notification services.	

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
5. **Schedule a confirmed appointment for a patient more than 24 hours ahead** 6. **Wait for system to trigger automated reminders 24 hours before the appointment** 7. **Verify the reminder allows preference customization (email/SMS/push)** 8. **Check the reminder message for action options (confirm/reschedule/cancel)** 9. **Click Confirm from the reminder notification** 10. **Click Reschedule and select a new time**	Patient: Asif Appointment : 10 AM tomorrow Select preferences: SMS + Email New time: 2 PM tomorrow	The system sends an automated reminder 24 hours before the appointment through the selected channels (email/SMS/push). The reminder allows the patient to **confirm, reschedule, or cancel** the appointment directly, and the system updates the appointment status accordingly.	As expected	Pass

11. **Click Cancel from the reminder notification**				
Post Condition: The system successfully logs the patient's action (confirm/reschedule/cancel) in the database, and the appointment record is updated accordingly.				

17.

Project Name: Bangladesh Digital Health Registry (BDHR)		Test Designed by: Md. Nishad		
Test Case ID: FR_46		Test Designed date: 07/05/2025		
Test Priority (Low, Medium, High): Medium		Test Executed by: Name		
Module Name: Blood Pressure Tracking and Alerts		Test Execution date: date		
Test Title: Verify blood pressure tracking, alerts, and trend display				
Description: Test the system's ability to allow blood pressure data entry or sync, trigger alerts when readings exceed normal ranges, and store/display historical trends.				
Precondition: The patient must be diagnosed with hypertension or have blood pressure data entered in the system.				
Dependencies: Integration with compatible BP devices (if applicable).				
Test Steps	**Test Data**	**Expected Results**	**Actual Results**	**Status (Pass/Fail)**
1. **Log in as a patient diagnosed with hypertension**	Patient: Asif Systolic: 120 mmHg,	The system allows manual entry and device sync of	As expected	Pass

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
2. **Manually enter a normal blood pressure reading** 3. **Manually enter a high blood pressure reading** 4. **Sync blood pressure data from a compatible device** 5. **Check if system sends alert for high reading to patient and doctor** 6. **View blood pressure history and trend chart in patient profile**	Diastolic: 80 mmHg Systolic: 180 mmHg, Diastolic: 110 mmHg Device: Omron BP Monitor High reading as above	blood pressure readings, sends alerts to patients and doctors when readings exceed normal ranges, and stores all readings with historical trends displayed in the patient profile.		

Post Condition: All blood pressure readings are saved in the database, alerts are logged, and the historical trend graph is updated for the patient.

18.

Project Name: Bangladesh Digital Health Registry (BDHR)	Test Designed by: Md. Nishad
Test Case ID: FR_50	Test Designed date: 07/05/2025
Test Priority (Low, Medium, High): Medium	Test Executed by: Name
Module Name: User Account Deactivation	Test Execution date: date
Test Title: Verify user account deactivation process and data deletion	
Description: Test the system's ability to allow account deactivation requests, confirm the action, and permanently delete personal data in line with data retention policies.	
Precondition: The user must have an active account in the system.	
Dependencies: None	

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)

1. **Log in as a patient or doctor with an active account** 2. **Navigate to the account settings or deactivation section** 3. **Select the option to deactivate the account** 4. **Confirm the deactivation when prompted by the system** 5. **Check if the system permanently deletes all personal data after deactivation** 6. **Attempt to log in again with the deactivated account credentials**	User: Asif Confirm: Yes Username/password	The system allows users to request account deactivation, asks for confirmation to prevent accidental deactivation, permanently deletes all personal data according to retention policies, and ensures that deactivated accounts cannot be accessed again.	As expected	Pass

Post Condition: The user account and all associated personal data are permanently removed from the system, and the user can no longer log in.

19.

Project Name: Bangladesh Digital Health Registry (BDHR)	Test Designed by: Md. Nishad
Test Case ID: FR_51	Test Designed date: 07/05/2025
Test Priority (Low, Medium, High): Medium	Test Executed by: Name
Module Name: Patient Health Risk Dashboard	Test Execution date: date
Test Title: Verify patient health risk dashboard and recommendations	

Description: Test the system's ability to display a personalized health risk dashboard, highlight potential health risks, and provide lifestyle recommendations.	
Precondition: None	
Dependencies: Working SMS, email, and push notification services.	

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
1. **Log in as a patient with a completed health assessment** 2. **Navigate to the health risk dashboard** 3. **Review the displayed health risks for conditions like heart disease, diabetes, and cancer** 4. Review the system-provided recommendations for lifestyle changes to reduce identified risks	Patient: Asif	The system provides a personalized health risk dashboard based on the patient's medical history and lifestyle factors, displays potential risks (such as heart disease, diabetes, and cancer), and offers clear, actionable lifestyle recommendations to mitigate those risks.	As expected	Pass

Post Condition: The patient views their health risks and receives personalized recommendations, which are saved in the system for future updates.

20.

Project Name: Bangladesh Digital Health Registry (BDHR)	Test Designed by: Md. Nishad
Test Case ID: FR_52	Test Designed date: 07/05/2025
Test Priority (Low, Medium, High): Medium	Test Executed by: Name
Module Name: Patient Feedback on Care	Test Execution date: date
Test Title: Verify patient feedback process after healthcare appointments	

Description: Test the system's ability to send feedback requests to patients after appointments, collect feedback, and make the results accessible to the healthcare provider's administrative team.	

Precondition: The patient must have attended an appointment with a registered healthcare provider.

Dependencies: Active email and app notification services.

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
1. **Log in as a patient who has completed an appointment** 2. **Check for feedback request sent via email or app notification after the appointment** 3. **Open the feedback form and submit feedback on the healthcare provider's performance** 4. **Log in as a healthcare admin and review submitted feedback for the provider**	Patient: Asif Email/App Inbox Rating: 4/5, Comment: "Good service" Admin Account	The system sends a feedback request to the patient after the appointment, allows the patient to submit feedback on the provider's performance, and makes the feedback accessible to the healthcare provider's administrative team to support service quality improvement.	As expected	Pass

Post Condition: The feedback is saved in the system and available for the provider's admin team to review.

21.

Project Name: Bangladesh Digital Health Registry (BDHR)	Test Designed by: Makail
Test Case ID: FR_53	Test Designed date: 13 May, 2025
Test Priority (Low, Medium, High): Low	Test Executed by: Name

Module Name: Health Feed			Test Execution date: date		
Test Title: Verify health tips and news feed are displayed after login					
Description: Test that health tips, announcements, and news feed appear for logged-in users.					
Precondition: User must be logged in					
Dependencies: Internet connection must be active.					
Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)	
1. Navigate to "Health Feed" section 2. View displayed content		The system displays health tips, public announcements, and news updates.	As expected	Pass	
Post Condition: Health feed is visible and refreshed regularly based on interest preferences.					

22.

Project Name: Bangladesh Digital Health Registry (BDHR)			Test Designed by: Makail		
Test Case ID: FR_54			Test Designed date: 13 May, 2025		
Test Priority (Low, Medium, High): High			Test Executed by: Name		
Module Name: Virtual Consultation			Test Execution date: date		
Test Title: Verify video consultation and doctor record updates					
Description: Ensure users can initiate video consultations and doctors can update records after the session.					
Precondition: User must be logged in, Both parties must have audio/video-enabled devices and internet.					
Dependencies: Doctor and patient must be available during scheduled consultation.					
Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)	

1. **Navigate to Appointments Video** 2. **Start consultation** 3. **Doctor prescribes medication**	User:01812, doctor:937, video session, prescription: DR-393	Patient and doctor complete a secure consultation, and medical records are updated.	As expected	Pass

Post Condition: Session is logged, and prescription is stored under patient records.

23.

Project Name: Bangladesh Digital Health Registry (BDHR)	Test Designed by: Makail
Test Case ID: FR_55	Test Designed date: 13 May, 2025
Test Priority (Low, Medium, High): Medium	Test Executed by: Name
Module Name: Symptom Checker	Test Execution date: date
Test Title: Verify AI symptom checker and recommendation	
Description: Test the system's ability to provide suggestions based on patient-input symptoms.	
Precondition: User must be logged in, Patient must input at least one symptom.	
Dependencies: AI system must be enabled on the backend.	

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
1. **Go to Symptom Checker** 2. **Enter symptom**	Username: urs99 symptom: Headache,nausea	The system suggests use home remedies.	As expected	Pass

Post Condition: Symptom and recommendation are logged under temporary health logs.

24.

Project Name: Bangladesh Digital Health Registry (BDHR)	Test Designed by: Makail
Test Case ID: FR_57	Test Designed date: 13 May, 2025
Test Priority (Low, Medium, High): High	Test Executed by: Name
Module Name: Card Management	Test Execution date: date
Test Title: Verify health card reissue and access retention	
Description: Verify the system allows card reissue and keeps patient records accessible.	
Precondition: User must be logged in, Patient must request card recovery via app or hospital.	
Dependencies: User must pass identity verification.	

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
1. **Navigate to "Health Card Services"** 2. **Click "Report Lost Card"** 3. **Verify identity** 4. **Submit card reissue request**	ID:24224, OTP:32134	System processes reissue request; medical records remain accessible under Medical ID.	As expected	Pass

Post Condition: Old card is deactivated, new request is logged, records remain intact.

25.

Project Name: Bangladesh Digital Health Registry (BDHR)	Test Designed by: Makail
Test Case ID: FR_58	Test Designed date: 13 May, 2025
Test Priority (Low, Medium, High): High	Test Executed by: Name
Module Name: Card Reader Access	Test Execution date: date
Test Title: Verify offline access to patient data using health card	

Description: Ensure that NFC-enabled card works without internet to display patient's basic medical data.	

Precondition: Patient must possess a registered BDHR Health Card.

Dependencies: NFC-compatible device with authorized software.

Test Steps	Test Data	Expected Results	Actual Results	Status (Pass/Fail)
1. **Insert card into NFC reader** 2. **View basic patient data**	ID:24224, Blood type:A+	The reader securely displays basic medical info even without internet connection.	As expected	Pass

| Post Condition: Data is viewable offline, but no write access is allowed until internet is restored. |
|---|

7. WORK BREAKDOWN STRUCTURE (WBS)

Fig 7: Work Breakdown Structure (WBS)

8. TIMELINE CHART

| Assign Task	Date Assigned	Due Date	Duration
Project Planning			
Define project scope	2/28/2025	3/2/2025	2
Create a project timeline	4/28/2025	5/1/2025	3
Identify stakeholders	3/4/2025	3/6/2025	2
Risk management	3/6/2025	3/8/2025	2
Budget estimation	3/7/2025	3/8/2025	1
Establish quality standards	3/8/2025	3/11/2025	3
Diagram Drawing + Functional Requirements			
Entity-relationship diagrams (ERD)	3/11/2025	3/16/2025	5
Use case diagrams	3/13/2025	3/16/2025	3
Class diagrams	3/14/2025	3/17/2025	2
Define system functionality	3/16/2025	3/18/2025	2
User requirements gathering	3/18/2025	3/20/2025	2
Performance requirements	3/20/2025	3/22/2025	2
Security requirements	3/22/2025	3/24/2025	2
Integration requirements	3/24/2025	3/27/2025	3
Data requirements	3/27/2025	3/30/2025	3
Hardware requirements	3/30/2025	4/2/2025	2
Platform requirements	4/2/2025	4/3/2025	1
Software Design			
Architecture design	4/3/2025	4/5/2025	2
Database design	4/5/2025	4/8/2025	3
Module design	4/8/2025	4/11/2025	3
API design	4/11/2025	4/13/2025	2
Design patterns	4/13/2025	4/15/2025	2
User Interface & Experience			
Wireframing	4/15/2025	4/18/2025	3
Prototyping	4/18/2025	4/20/2025	2
Collecting feedback	4/20/2025	4/21/2025	1
Designing key UI components	4/21/2025	4/23/2025	2
Visual design and styling	4/23/2025	4/26/2025	3
Responsive design	4/26/2025	4/28/2025	1
Refining interactions based on feedback	4/28/2025	4/29/2025	1
Usability Testing	4/29/2025	5/1/2025	2
Construction(Development)			
Backend functionality	5/1/2025	5/4/2025	3
Implementing business logic	5/4/2025	5/6/2025	2
Integrating API with the frontend	5/6/2025	5/8/2025	2
Database connections and CRUD operations	5/8/2025	5/10/2025	3
Code reviews and final feature adjustments	5/10/2025	5/13/2025	3
Project test planning			
Test strategy development	5/13/2025	5/15/2025	2
Test plan creation	5/15/2025	5/17/2025	2
Test case creation	5/17/2025	5/19/2025	2
Test environment setup	5/19/2025	5/22/2025	3
Unit testing	5/22/2025	5/25/2025	3
Integration testing	5/25/2025	5/28/2025	3
System testing	5/28/2025	5/31/2025	3
Performance testing	5/31/2025	6/2/2025	2
Security testing	6/2/2025	6/4/2025	2
Deployment & Release			
Deployment preparation	6/4/2025	6/6/2025	2
Final user acceptance testing(UAT)	6/6/2025	6/9/2005	3
Release to production	6/9/2025	6/12/2025	3
Post-release monitoring and support	6/12/2025	6/14/2025	2

Fig 8: Timeline Chart

9. EFFORT ESTIMATION [COCOMO]

Software type: Semi-Detached

Source Line of Code, SLOC = 175800

Coefficient$_{<Effort\ Factor>}$ = 3

Project Complexity, P= 1.12

SLOC dependent coefficient, T= 0.35

$$Effort = PM = Coefficient_{<Effort\ Factor>} \times \left(\frac{SLOC}{1000}\right)^P$$

$$= 3 \times \left(\frac{175800}{1000}\right)^{1.12}$$

$$= 980.7140 \text{ person-month}$$

$$Development\ Time = DM = 2.50 \times (PM)^T$$

$$= 2.50 \times (980.7140)^{0.35}$$

$$= DM = 27.8599 \text{ month}$$

$$Required\ Number\ of\ People = ST = \frac{PM}{DM}$$

$$= \frac{980.7140}{27.8599}$$

$$= 35.2016 \approx 35 \text{ persons}$$

10. EARN VALUE ANALYSIS [EVA]

- Our project Bangladesh Digital Health Registry has 82 planned work tasks that are estimated to require 780 person-days to complete.
- At the time that the team has been asked to do the earned value analysis, 10 tasks have been completed out of 13 tasks.
- However, the project schedule indicates that 13 tasks should have been completed.

Task	Planned Effort	Actual Effort
1	11.0	12.0
2	13.5	11.5
3	12.5	14.0
4	8.5	9.0
5	14.0	14.5
6	12.5	13.5
7	9.0	10.5
8	8.0	10.0
9	6.5	8.0
10	10.0	13.5
11	8.5	-
12	16.5	-
13	13	-

Budgeted Cost of Work Performed, BCWP = 105.5

Budgeted Cost of Work Scheduled, BCWS = 143.5

Actual Cost of Work Performed, ACWP = 116.5

Budget at Completion, BAC = 780

Schedule Performance Index, $SPI = \dfrac{BCWP}{BCWS}$

$$= \frac{105.5}{143.5}$$

$$= 0.7352$$

$$= 73.52\%$$

Schedule Variance, $SV = BCWP - BCWS$

$$= 105.5 - 143.5$$

$$= -38 \text{ person-days}$$

Percent Scheduled for completion $= \dfrac{BCWS}{BAC}$

$$= \dfrac{143.5}{780}$$

$$= 0.1840$$

$$= 18.40\%$$

Percent Complete $= \dfrac{BCWP}{BAC}$

$$= \dfrac{105.5}{780}$$

$$= 0.1353$$

$$= 13.53\%$$

Cost Performance Index, $CPI = \dfrac{BCWP}{ACWP}$

$$= \dfrac{105.5}{116.5}$$

$$= 0.9056$$

$$= 90.56\%$$

Cost Variance, $CV = BCWP - ACWP$

$$= 105.5 - 116.5$$

$$= -11 \text{ person-days}$$

11. RISK TABLE

Risk	Category	Probability	Impact	Mitigation
Larger number of users than planned	Product Size	30%	Marginal	Design system with scalability in mind; use cloud-based infrastructure.
Delivery deadline will be tightened	Business	40%	Critical	Develop buffer in timeline; adopt agile practices to allow incremental delivery.
Customer will change requirements	Product Size	80%	Critical	Use a change management process; maintain flexible architecture.
Lack of training on tools	Development Environment	80%	Marginal	Provide initial and ongoing tool training; assign technical mentors.
Inadequate test coverage leading to post-launch bugs	Process Definition	60%	Critical	Enforce Test-Driven Development automate regression testing.
Data security breaches or leaks	Technology to be Built	50%	Critical	Use encryption, OTP auth, and regular penetration testing
Patients distrust digital records	Customer Characteristics	50%	Critical	Clear rules about how your data is used, and you choose whether to share it or not.
Government policy changes affect data sharing protocols	Business	30%	Critical	Align BDHR framework with national health IT policy; build adaptable APIs.
OTP/authentication delays during login or data access	Technology to be Built	45%	Critical	Use redundant SMS/email gateways; allow backup verification methods.
System downtime during maintenance or updates	Development Environment	30%	Marginal	Schedule updates during off-peak hours; implement failover architecture.

Delays in card delivery due to logistics failures	Business	35%	Marginal	Partner with reliable courier services and allow in-hospital pickup option.
Mobile app is incompatible with older Android/iOS versions	Product Size	45%	Critical	Support lightweight versions for legacy devices; conduct compatibility testing.
Integration failure with national insurance platforms	Technology to be Built	40%	Critical	Test integration in sandbox environments; collaborate closely with insurance APIs.
Duplicate patient records due to inconsistent data entry	Process Definition	35%	Marginal	Use strong identity verification (NID/BRC) and implement duplicate detection logic.

Category:

- Product size [PS]
- Business impact [BU]
- Customer characteristics [CU]
- Process definition [PR]
- Development environment [DE]
- Technology to be built [TE]
- Staff size and experience [ST]

Impact values:

- Catastrophic – 1
- Critical – 2
- Marginal -3
- Negligible – 4

12.   RISK ANALYSIS

High risk (Probability ≥70%)

1. Customer will change requirements

How to manage this risk (RMMM):

Establish a formal change management process with stakeholder sign-offs for every new or altered requirement. Architect the system with modular and loosely-coupled components to allow flexibility and easier integration of future changes. Conduct frequent requirement review meetings with the client to align expectations early and continuously. Employ Agile methodologies to enable incremental deliveries that can absorb shifts in scope with minimal disruption. Ensure all changes are properly documented and version-controlled, with traceability across design, development, and test artifacts.

2. Lack of training on tools (Development Environment, 80%)

How to manage this risk (RMMM):

Conduct comprehensive onboarding sessions and provide initial hands-on workshops on the development and deployment tools. Assign experienced technical mentors or "tool champions" to guide team members. Maintain updated documentation and tutorials for all critical tools in a shared knowledge base. Schedule refresher trainings and tool-specific Q&A forums. Monitor team productivity and tool usage metrics to identify areas where more training may be needed.

Medium risk (30% < Probability < 70%)

1. Inadequate test coverage leading to post-launch bugs

How to manage this risk (RMMM):

Adopt Test-Driven Development (TDD) as a standard practice across the development team. Implement automated unit, integration, and regression tests in the CI/CD pipeline. Enforce a minimum code coverage threshold (e.g., 85%) through build validation. Conduct peer reviews and regular test audits to ensure quality and completeness. Create traceability between requirements and test cases to prevent missed functionalities and edge cases.

2. Data security breaches or leaks

How to manage this risk (RMMM):

Enforce end-to-end encryption for data in transit and at rest. Implement multi-factor authentication (e.g., OTP via email/SMS). Conduct regular penetration testing and vulnerability scans. Ensure strict access control policies (RBAC) are in place and audited. Use secure coding practices,

regularly patch dependencies, and provide cybersecurity training to the development team. Establish an incident response plan to handle breaches swiftly and legally.

3. Patients distrust digital records

How to manage this risk (RMMM):

Build transparent data governance policies, clearly outlining how patient data is used, stored, and shared. Allow users to opt in/out of data sharing and access audit trails of who accessed their data. Promote data ownership, emphasizing that patients control their records. Launch awareness campaigns to educate users about benefits and protections. Incorporate user feedback loops and involve patient advocacy groups in testing and design validation.

4. OTP/authentication delays during login or data access

How to manage this risk (RMMM):

Use multiple OTP delivery channels (SMS, email, push notification) with fallback logic. Partner with redundant SMS/email gateway providers to ensure failover. Allow offline backup codes or biometric authentication as alternatives. Monitor OTP delivery metrics and response time, with alerts on spikes or failures. Implement retry mechanisms and timeout handling in the frontend.

5. Mobile app is incompatible with older Android/iOS versions

How to manage this risk (RMMM):

Develop and maintain a lightweight version of the app optimized for older devices. Use progressive enhancement techniques and device compatibility libraries. Conduct device fragmentation testing using emulators and real devices. Monitor crash reports and version analytics to identify incompatible platforms. Provide clear minimum requirements in app stores and offer web-based alternatives where possible.

6. Integration failure with national insurance platforms

How to manage this risk (RMMM):

Collaborate early with national insurance platform stakeholders to understand API requirements and constraints. Create integration test environments (sandbox APIs) to validate edge cases. Develop retry, timeout, and error-handling mechanisms for communication failures. Maintain detailed logs of integration attempts. Assign a dedicated integration team to handle third-party dependencies and ensure ongoing support agreements are in place.

7. Delays in card delivery due to logistics failures

How to manage this risk (RMMM):

Partner with reliable national courier services with tracking and delivery guarantees. Offer an in-hospital pickup option for faster access. Implement a tracking portal so users can check delivery status. Include delivery buffer time in project milestones and enable batch shipping to reduce cost and delays. Maintain a fallback stock of cards at hospitals for urgent issuance.

8. Duplicate patient records due to inconsistent data entry

How to manage this risk (RMMM):

Use strong identity verification methods such as linking patient records with NID/BRC numbers. Implement duplicate detection logic using fuzzy matching on name, birthdate, and ID. Enforce data validation rules and field constraints during registration. Regularly run deduplication scripts and reconcile anomalies. Train data entry personnel on standard operating procedures to ensure uniform input.

9. Government policy changes affect data sharing protocols

How to manage this risk (RMMM):

Align the BDHR framework with national health IT and data protection policies. Build the system using modular APIs that can be adapted or disabled based on policy changes. Stay engaged with policy-making bodies and industry forums. Assign a compliance officer to track legal developments. Document and implement contingency plans for major regulatory shifts.

Low risk (Probability ≤ 30%):

1. Larger number of users than planned

How to manage this risk (RMMM):

Design the system to be scalable from day one, using cloud-native architecture (e.g., AWS/Azure auto-scaling, container orchestration with Kubernetes). Monitor user load and server utilization metrics to proactively scale resources. Use load balancers and CDNs to distribute traffic efficiently. Conduct stress testing before launch to understand performance limits. Maintain a contingency budget for scaling infrastructure as user numbers grow.

2. Delivery deadline will be tightened

How to manage this risk (RMMM):

Build timeline buffers and use Agile sprint cycles to allow incremental delivery of critical features. Prioritize core functionality using MoSCoW method (Must-have, Should-have, Could-have, Won't-have). Prepare resource ramp-up options (e.g., adding temp developers). Communicate realistic deadlines with stakeholders early, backed by data. Reallocate scope dynamically based on burn-down rates.

3. System downtime during maintenance or updates

How to manage this risk (RMMM):

Schedule maintenance during off-peak hours, and clearly notify users in advance. Implement blue-green deployments and rolling updates to avoid downtime. Use redundant failover infrastructure and real-time health monitoring tools to minimize service disruption. Log and track uptime metrics as KPIs. Maintain rollback scripts and automated backups in case of failed updates.