Decentralized Patient Healthcare record analysis using Blockchain Technology

BY

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FINAL YEAR DESIGN PROJECT REPORT

This Report Presented in Partial Fulfillment of the Requirements for the **Degree of Bachelor of Science in Computer Science and Engineering**

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APPROVAL

This Project titled **"Decentralized Patient Healthcare Record Analysis Using Blockchain Technology"**, submitted by Md. Majedur Rahman, ID No: **212-15-14708** to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on **14 May, 2025**.

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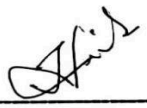

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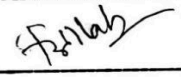

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I hereby declare that this project has been done by me under the supervision of **Ms. Sharmin Akter**, Assistant Professor, Department of Computer Science and Engineering, Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for the award of any degree or diploma.

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ABSTRACT

The next-generation distributed healthcare platform is presented in this work on patient identity and record management, focusing on privacy, transparency, security, and operational efficiency. At its root, the platform combines blockchain (Hyperledger Fabric) with decentralized data storage technologies like IPFS (InterPlanetary File System) and Pinata. Together, they achieve just that commercial-grade preservation, immutability, and patient-controlled security of sensitive health data all of which are the weakest links in today's traditional data silos of healthcare. In a conventional healthcare system, data is owned and controlled by hospitals or third parties, leading to unauthorized access, security breaches, and a lack of data sharing. Centralized systems also constrain patient self-determination such that it becomes difficult for a patient to access, manage, or exchange his or her health record. These problems can be solved by the mentioned platform, which focuses on patient control. Via such a model, users can safely store, retrieve, and share their health data and selectively allow healthcare providers to access them, transforming them into the legitimate owners of their data. The data-sharing policy is enforced automatically using smart contracts. With QR codes and powerful multi-factor authentication (MFA) options, such as Google Sign-In, Apple ID, Face ID, and fingerprint, patients can grant or rescind access to doctors, pathologists, and research labs. Smart contracts guarantee access will be given by verified patient consent, thereby enhancing trust, eliminating manual control, and drastically minimizing the danger of patient data misuse. The platform's clinical utility is significant. It promotes interoperability among hospitals, clinics, and diagnostic centers, thereby avoiding repetition of tests and medical errors related to information fragmentation. For patients, timely access to complete medical records means faster diagnosis and treatment, better care, and outcomes. Furthermore, the platform facilitates medical research and pharmaceutical discovery, making data sharing in categorized and anonymized form possible and then only with the patient's explicit consent for privacy-respecting innovation. Cutting-edge AI-driven analytics integrated into the system provide intelligent insights into the early detection of disease, personalized treatment plans, and efficient healthcare delivery. These instruments enable clinicians and researchers to tap into big data for proactive, predictive, and precision medicine. The platform is developed to be scalable with a high-performance and reliable architecture and is implemented as Docker containers managed by a Kubernetes orchestrator and Network File System (NFS). It also features a modern UI, which is sleek and intuitive, including dark/light mode and real-time notifications, along with smooth animations to provide an optimal experience. Environmentally, it promotes e-health by minimizing the use of paper records and attenuating the demand for overcommitted data centers, thus defraying the earth's carbon manifestations. Conclusively, this decentralized healthcare approach gives patients freedom for control, further secures private data, enables cooperation, aids research, and is in line with the worldwide movement towards digital, secure, and patient-focused healthcare systems.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

Blockchain-powered decentralized patient healthcare record analysis is a cutting-edge healthcare technology made to safely handle patient identities and medical records while guaranteeing efficiency, privacy, and transparency. It provides patients total control over their health information by utilizing decentralized storage (IPFS & Pinata) and blockchain technology (HyperLedger Fabric) to ensure data confidentiality, integrity, and accessibility. The system can secure the patients' data share with all the physicians, pathologists and research labs by using QR codes and multi factor authentication (Google, Apple ID, biometrics security). Smart contracts automatize approvals so that data is not shared before patient consent is obtained. Better treatment outcomes and increased patient trust result from the platform's reduction of medical errors, unnecessary testing, and administrative inefficiencies through improved interoperability across healthcare providers.
To the contrary blockchain based decentralized patient healthcare record analysis is needed to manage beyond a single patient to pharmaceutical and medical research. In addition to enforcing the stiff patient permission and privacy guidelines, the platform permits pharmaceutical companies and research institutes to ask for categorized data. That means that it ensures that vital, anonymized medical data gets to ground breaking research without compromising an individual's privacy. Further improvements of medical decision-making are achieved by integrated AI-driven analytics for predictive insights to illness prevention, treatment improvement and customized healthcare.

Decentralized Patient Healthcare record analysis using Blockchain Technology uses Docker, Kubernetes, and NFS to ensure scalability and high availability to provide quick, safe, and unobstructed user experience. It reduces the overall carbon footprint of the healthcare data management by eliminating the paper based medical record and making the health data storage completely in the cloud. It also has real-time notifications, dark/light mode, fluid UI/UX animations to guarantee an intuitive and user friendly interface. Using the patient's first methodology and system is decentralized to improve security, accessibility, efficiency and indoctrinating the patient friendly healthcare environment.

The analysis with the help of Decentralized Patient Healthcare records, powered by blockchain technology, is shaping the future of digital healthcare: it brings blockchain security, AI powered insights, seamless interoperability and sustainable design. It ensures patients' data are secure and private, and offers more choice over their own medical information, better provider to provider collaboration and important medical research. Efficiency, safety and readiness to all available through Blockchain based, decentralized patient healthcare record analysis is here to revolutionize the healthcare sector through innovation, trust and transparency

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1.2 Motivation

The increasing intricacy of contemporary healthcare systems has resulted in a multitude of challenges, including data mismanagement, identity fraud, and limited access to precise medical information. Conventional healthcare infrastructures frequently depend on disjointed databases and antiquated record-keeping practices, which hinder the ability of patients and providers to effortlessly access and exchange essential health information. Consequently, patients frequently experience a sense of disconnection from their own medical history, which can result in delays in treatment, misdiagnoses, and a diminished trust in the healthcare system. Concurrently, healthcare providers contend with inefficiencies stemming from incomplete patient records, communication deficiencies among medical institutions, and administrative burdens that diminish the quality of care.

My work was born of the desperate need to address those issues by putting patients at the center of their health care. It takes us half as long to access whatever data is needed on your chart, so that the installment cost to the system of paying us is way smaller than the waste of having unfavorable ratio of doctors to patients. Our main technology tools: cutting-edge blockchain, decentralized storage, are used to deliver a safe, simple method to manage your health data in way that does not ever take control away from you and provide for you a very easy to use app you can access and store all your health data in one place before you could do it today, in only a fraction of the time it takes today. This eliminates the need for centralized databases and the potential for breaches that could lead to identity theft, it also fosters trust and transparency between patients and providers.

This project not only guarantees security and access, but promotes patient autonomy by empowering people to make educated decisions about their health. With features like role-based data sharing, QR code authentication and AI-driven analytics, the platform improves patient outcomes and increases operational efficiency for providers. What is more, if those companies and research institutions were allowed to request anonymized patient data, subject to patient consent, it would also make it easier to develop new medicines whilst preserving privacy.

Above all, My project is based on the belief that health ought to be safe, available, and surrounding patient needs. The company aims to disrupt the healthcare industry by giving people control and ownership of their health-related data, and to create a world in which that data is secure, portable and has a positive impact on quality of life.

1.3 Objectives

The main aim of decentralized patient healthcare record analysis using blockchain technology is to create a patient centered healthcare system where medical data and identities can be administered safely, easily and in accessible privacy. The traditional healthcare systems suffer from problems of data fragmentation, security flaws and patients having unhindered access to their personal medical records. Decentralized Patient Healthcare Record Analysis deals with the above issues by using blockchain technology, decentralized storage, and the advanced authentication techniques.

The main goals of blockchain-based decentralized patient healthcare record analysis for patients are:

- **Empowering Individuals:** Patients retain absolute control over their health records and will reject unsolicited mail-outs without the proper consent. This will enable them to securely access, control and share their health data which helps to enhance the coordination of patient care among researchers, pharmacists and healthcare providers.
- **Enhancing Data Security:** The use of both role-based access restrictions as well as blockchain encryption makes only those with the proper authorization able to 'see or modify patient data'.

Patients can protect their medical records from unwanted access by means of QR codes exchange or biometric verification.

- **Enhancing Accessibility:** Users no longer need to worry about lost or unavailable records since through this app they get to have the capacity to look at their medical history from any place at any given time.

For Healthcare Professionals:

- **Seamless Collaboration:** The safe data exchange between doctors and pathologists, as well as experts, contributes to faster diagnosis and success of treatment plans.
- **Mitigating Medical Errors:** A well-functioning system keeps the possibility of misdiagnoses, unnecessary testing and medication errors at a minimum because accurate and up to date data are kept.
- **Optimizing Workflow:** Through decentralizing data retrieval and updates using blockchain technology, the administrative load of the patient healthcare record analysis is automated and frees up the time of healthcare practitioners to spend with the patients, instead of performing administrative activities.

Providers of Services:

The solutions that we offer with this blockchain technologies are to increase the efficiency, security and cooperation between Healthcare professionals and then also involves the seamless managements of health data. Systemic defects such as security breaches, lack of administrative efficiency, and data accessibility are ailing traditional healthcare system, resulting in the transformation of how healthcare and healthcare IT address these issues. The decentralized patents health care record analysis with blockchain solution devoid these worries and let the service providers offer much better services via automating processes, enhancing the safety of the data and supporting secure cooperation.

Primary Objectives for Service Providers:

Promote the Secure Administration of Data

1. For doctors, pathologists, pharmaceutical companies, and medical research labs, the platform simplifies the registration and enrollment processes.
2. It reduces reliance on paper-based documentation and lowers the possibility of data loss or inaccuracy by ensuring that healthcare practitioners can safely save, retrieve, and manage patient records.
3. Blockchain encryption strengthens adherence to privacy laws and guards against unwanted access, protecting patient data.

Facilitate Uninterrupted Collaboration

1. Decentralized patient healthcare record analysis on the blockchain enables medical services and research projects of service providers to be displayed prominently among the healthcare ecosystem in a more accessible and visible manner.
2. This means that patients, doctors and specialists can instantly share data which ensures efficient communication, coordination for care.
3. Particularly as it will encourage responsible use of data and for the purposes of medical progression and treatment, doctors and other healthcare workers can ask patients for consent to be able to access their health data.

For the Administrator:

Administrators are responsible for the secure, reliable, compliant management and processing of data in a blockchain for decentralized analysis of patient-level healthcare data. Patient and provider data

security, system integrity, and compliance with regulatory requirements are some of the key responsibilities of maintaining the reliability, trustworthiness of the platform for patients and providers alike.

Principal Objectives for Administrators

1. **Supervise Data Security and Privacy Measures**

   - Administrators ensure that all the patient critical data are free from data breach or unauthorized access which is the reason behind, that we secure the patient sensitive data with stringent security methods such as encryption process, access control, and multifactor authentication.

   - They continually review and audit the system for potential vulnerabilities and to ensure that security holes are discovered and quarantined.

   - Patients' privacy is guaranteed complying with local data privacy regulations (GDPR, HIPAA) and secure and privacy-preserving data access mechanisms are provided, thus not compromising HIPAA/HITECH and GDPR private regulatory requirements, and platform trust is preserved

2. Maintain System Integrity

   - Through ongoing system maintenance, update implementation, and troubleshooting, administrators are in charge of making sure Decentralized Patient Healthcare record analysis utilizing Blockchain Technology runs efficiently, dependably, and error-free.
   - Frequent performance reviews help to maximize system effectiveness, which promotes continuous data flow and improves user experiences.
   - To guarantee high availability and little downtime, they are in charge of infrastructure administration, which includes server performance, uptime monitoring, and database integrity.

3. **Ensure Adherence to Regulatory Standards**
   - Administrators watch over the ethical (in terms of legal law and standards in the industry) and legal use of patient data making sure it complies with the industry standards, laws for data privacy and healthcare regulations.
   - Systematic audits and compliance evaluations are then carried out with the aim of guaranteeing compliance with national and international standards for ensuring the protection of the healthcare data.
   - As a result, they also help user education and training to ensure that stakeholders and healthcare providers know and comply with platform policies and security best practices.

1.4 Expected Outcome

Expected outcomes of embedding this project within the health care system are increased patient empowerment and activation through the ability to control their health data and share, update, and distribute their medical records as needed. The solution enhances data security protocols and protects patient data from breeches and unauthorized entry, hence enhancing trust. In addition, sharing of data and communication will be optimized so that diagnoses and appropriate treatment can be achieved more quickly and accurately; improving the efficiency of health care service delivery. Careful logging will decrease the number of medical errors and communications gaps leading to healthier patients. The move has potential to build trust throughout the healthcare industry, by giving patients as well as providers the benefits of safe and transparent data management. The integration of these systems contributes to increased productivity within healthcare organizations, in which overhead costs are reduced as a consequence of reduced administrative tasks and improved operational

effectiveness. What's more, Patient Bio will ensure compliance with healthcare policies, in compliance with all legal and ethical concerns. Ultimately, the system will support the widespread adoption of digital health applications, and promote a more integrated, efficient, patient-focused healthcare system.

Who can share data to others:

	Patient	**Doctors**	**Medical R.L**	**Pathologist**	**Pharmacy Company**	**Admin**
Patient		Yes	Yes	Yes	Yes	Yes
Admin			Yes		Yes	
Doctors	Yes			Yes		
Medical R.L						
Pathologist	Yes	Yes				

1.5 Project management and finance

The key to My project's success is a well-thought-out and meticulously structured organisation of the project and of financial planning so that the platform is able to carry out its mission in an efficient and timely manner and within the budget limits. The first phase of project management comes in the definition of the project scope which encompasses a clear statement of what the project's objectives, deliverable, and outcomes should be. Ii.1.3 Project Vision This is the cornerstone of the entire project, ensuring cohesion with the team and clarifying the project expectations for all stakeholders. A multidisciplinary team combining blockchain specialist, healthcare system expert, data security expert, and user experience designer will build and synergy into the creation of such a vision. Work will be divided based on expertise and project necessities, and realistic deadlines will be set for each milestone in order to keep the project moving. Effective communication and cooperation will be emphasised so that all members will be up to date and aligned.

The team will proactively identify key issues, such as technology risks, regulatory requirements, and security threat; and develop the strategy to address them. Regular monitoring of the projects progression through tracking tools and status reports will help ensure the project stays on track. Project managers will also implement quality checks to make sure the end-product meets user expectations and maintain compliance. Through careful monitoring of the activities, this project will strive to maintain the schedule and the costs while providing high-quality results.

Financially There obviously needs to be a very structured and strategic approach to ensure the project is sustainable and is scalable. First, you must prepare a thorough budget that spells out all costs and expenses, including those for research and development, marketing, legal fees, regulatory compliance, infrastructure requirements, and operating expenses. All categories will be thoroughly assessed and ranked to ensure that funds are allocated effectively. Investigation of alternative funding sources will be part of financial planning as well. That may include: fundraising from VCs, receiving grants from healthcare-related entities or establishing partnerships with tech firms or seeking sponsorships/collaborations with health sector leaders.

Cost containment will be a critical component of fiscal responsibility and require careful monitoring of all spending to ensure the project's financial health. In case of essential, quality features safeguards will be set by constraints in order to avoid the potential excessive spending, this guaranteeing the quality and essential nature. To generate revenue in a sustainable manner, my project will design the revenue model which includes subscription services for healthcare provide that delivers value-added services

including analytics, secure data management, and patient-specific solutions. Patients can also access premium features such as advanced EMR tracking and telemedicine. Also, future partnerships with insurance providers, drug manufacturers and healthcare companies will add to the bottom-line and also strengthen the credibility and penetration of the platform. Longterm, I will need to do a lot of forecasting and analysis of the financial side. This includes assessing the project's financial health with KPIs and adjusting strategies as appropriate. With the use of these forecasting methods My project will be able to adapt itself on the market fluctuations effectively, as to lead to resilience and remain competitive in the health-care sector which is in a state of flux. With the combination of strong project management and strategic financial planning, This project will build a stable, cost-effective, patient-focused healthcare environment that will not only be self-sufficient but will also thrive for the long-term.

Blockchain Development Cost Breakdown

1. NFS Cost

- Monthly Cost: $12
- Annual Cost: $12 × 12 = $144
- Converted to BDT: $144 × 125 = 18,000 BDT

2. Nodes Cost

- Monthly Cost per Node: $31.5
- Total for 4 Nodes: $31.5 × 4 = $126
- Annual Cost: $126 × 12 = $1,512
- Converted to BDT: $1,512 × 125 = 189,000 BDT

3. Pinata Cost

- Fixed Annual Cost: $0 (Free Version)

4. Domain Cost

- Fixed Annual Cost: $8
- Converted to BDT: $8 × 125 = 1,000 BDT

Total Estimated Annual Cost

= 18,000 BDT (NFS) + 189,000 BDT (Nodes) + 0 BDT (Pinata) + 1,000 BDT (Domain)
= 208,000 BDT

1.6 Goals

My project's aims align closely with its core mandate – to transform healthcare by providing a secure personal health platform that puts patients in control of their data. This section describes the specific goals that guide the design, behavior, and impact of this project on patients, providers, and the health perspective at large.

The goals of my project include the following:

- **Empowering Patients:** Patient education and having them in control of their healthcare information by being able to obtain and to have an electronic copy of their health information and to be able to share it with their caregivers. This allows the approach to be patient-centered, placing the need and privacy of the patient first.
- **Easy Integration:** Patient Bio aims to provide a smooth, easy-to-use application that fits directly into existing healthcare systems. The goal is to ensure that patients' health data is available to health professionals but also kept secure and private, making it easier to make better, faster decisions.
- **Legal Aspects:** One main aim is to ensure the security and privacy of patient data in order to prevent unauthorized access. The pride of the health system will be the devotion to Patients FIRST, and protecting their most sensitive health data using state-of-the-art technology, while making sure data is shared only with those authorized to access it without "selling out" and making the trust funds of patients' health data pay salaries.
- **Healthcare Collaboration 2.0:** My project is trying to improve communication and coordination among healthcare professionals. The platform aims to reduce errors, enhance the quality of care, and optimize continuity of care across care settings, by providing healthcare professionals with accurate and up-to-date patient information.
- **Technology:** This program is committed to being the front-runner in technology in healthcare. The objective is to keep enhancing the platform with additional tools and capabilities that provide a better experience for our users and better outcomes for their health and healthcare.
- **Efficiency and Access:** I would like to aid in making healthcare more efficient and convenient between a patient and their care provider through advancing the ability to access one another's health records. The objective is to minimize bureaucratic overhead, cut paperwork, and streamline and improve healthcare. These objectives are the essence of this initiative to grow this platform and keep on par with fast-changing patient and provider needs.

Centering around these objectives, my ecosystem aims at forming a safe, efficient and patient-centric healthcare ecosystem conducive to a joyful and enhanced healthcare mood. A win-win-win for customers, service providers and the greater society.

1.7 Project Schedule

We have no time, so I'd better timetable this work! Time is short and I will have to draw up a time plan so that the task gets done on time. It also conveys the sense of how urgently the work needs to get done.

1.7.1 Release Plan and Milestone

The release plan and milestones are given below:

Activities	Duration in week Total week
Research	W1, W2
Specifications	W2, W3, W4
Planning	W3, W4 2
Design	W4, W5 2
Development	W4, W5, W6, W7
Testing Assessment	W7, W8 W9
Documentation	W10, W11, W12
Software release	W12

Table 1.1: Release Plan

CHAPTER 2
BACKGROUND

2.1 Related work

Health Information and Communication Technology (ICT) has changed the way health data are managed, accessed, and exchanged. Prominent solutions like MyChart move the needle forward on data access and usability with patient portals that allow for easy access to personal health records, appointment scheduling, and direct communication with healthcare providers [15]. Likewise, the company Health Gorilla has been highlighted in the news for promoting health information sharing through amalgamation of records and providing individuals with data ownership, which in turn further promotes interoperation and trust in the digital health-care system [12].

However, despite their successes, there remain ongoing limitations of these systems, such as data fragmentation (data exists in silos), issues integrating systems, and a lack of uniformity to the user experience between devices and environments [2], [6]. These are reasons that point to the need for an even more cohesive and resilient backbone. This project seeks to bridge those gaps in knowledge by studying what leading platforms are doing right and what they could do better to lay the groundwork for a patient-owned, decentralized healthcare data management system.

Under the hood of this solution works blockchain, which provides immutability, transparency, and security of medical records. The synergy of blockchain with healthcare has proven to be effective in improving data privacy and protection from tampering or unauthorized access [1], [8]. By using Hyperledger Fabric for permissioned blockchain transactions, it means that only identified users who have the correct permissions to access sensitive health data are allowed access.

Furthermore, the use of cloud-native technology including Docker, Kubernetes and IPFS brings scalability and fault tolerance—imperative amounts of information in healthcare to be well-handled [2]. This method lends itself to quick deployment and retrieval, as well as increased uptime and use performance for users in numerous capacities, such as patients, physicians, pathologists, research labs, and pharmaceutical companies.

Although artificial intelligence (AI) is being used more frequently for predictive diagnostics and personalized treatment [3], [10], this particular initiative purposely omits AI integration, concentrating on secure, open, and user-controlled data systems. However, this fits into a larger ecosystem of digital health innovation including telemedicine, wearables and mobile health apps which all can work together to improve the quality of care and user engagement [5,7,11].

The ethical and security aspects are paramount when we design this system. Regulatory compliance and trust are facilitated by role-based access control, biometric authentication, and patient-consent-driven data sharing [9], [13]. Additionally, other works related to big data in public health, and healthcare delivery innovation provide validation of the architectural decisions taken in this project [12],[14].

In summary, this literature-informed investigation is not only pointing to where the restrictions in current health ICT systems still are, but is also a strategic roadmap. Utilizing blockchain, decentralized storage, and a patient-focused user experience, the envisioned solution seeks to drive better healthcare data management while allowing individuals to control their own medical records.

2.2 Scope

The scope of my project is fundamental in establishing the foundation for its development, deployment, and long-term impact on healthcare management. This section outlines the platform's core functionalities, defines its target audience, and specifies its geographical reach, providing a comprehensive understanding of its intended impact on healthcare systems and patients.

Functionalities: Metron includes numerous capabilities that focus the ease of management and patient data enrichment. The service will allow patients to have their health record at their fingertips, sharing it securely with healthcare professionals, tracking their medical history, and booking appointments. What's more, healthcare workers can take more from this with features such as easy access to the most updated patient records, better decision making based on a patient's overall health status and the ability to speed up coordination of care with other providers. The device will also include various protective security functions, so that important content will not easily be leaked, and that may be easily accessed by legitimate users.

The primary target: The primary target audience for this project includes individual patients, healthcare providers (such as doctors, nurses, and hospitals), and healthcare institutions. By catering to the needs of patients who seek control over their medical data, healthcare providers looking for streamlined data access, and institutions aiming for better coordination, my project aspires to become an indispensable tool for the healthcare community. The platform aims to address the growing demand for secure, efficient, and patient-centered data management solutions.

Geographical coverage: First, this ecosystem will be established in a particular geographical scope, for example [specify starting geographical area, e.g., selected cities or regions]. This focused method will permit focused development and integration into local health systems. In the long run, we hope that this will be a scalable project that can grow reach other regions and countries as it's implemented. This stepwise strategy should allow the platform to accommodate different healthcare regulations and infrastructure requirements in ensuring broad usability in a variety of settings.

By specifying the boundaries of my project (based on functionality, target audience and geographic location), the platform is poised to fulfill pressing health care demands while factoring in scalability. This model will guide the implementation of a product that delivers so much value to its users and lays the groundwork for long-term growth within the domain of healthcare.

2.3 Challenges:

As my project progresses with an aim to revolutionize the management of healthcare data, there are several challenges that need to be addressed to achieve success with this platform. These are all technology, regulatory, and operational issues that each need to be dealt with carefully and strategically.

- **Data Privacy and Security:** Securing and protecting patient data will be a key concern. Healthcare information is very sensitive, and any breach can result in severe legal consequences and image damage. This effort would need to be architected with end-to-end encryption, under the guidance of established data security laws (like GDPR and HIPAA), while also making it clear where sensitive patient data are stored, accessed, and shared.
- **Integrating with Existing Healthcare Systems:** Yet another hurdle is to make this project convenient to the established so-called healthcare systems. Many providers, however, still rely on outdated or proprietary record-keeping systems that prevent seamless and efficient transfer of data to and from new systems. Solving the problem of interoperability

requires both technological innovation and partnerships within healthcare organizations to enable frictionless data exchange.

- **Adoption and Trust by Users:** Patients and healthcare professionals need to adopt the platform to make the project a success. It can be challenging to convince people to trust and use a digital tool for the care of their most personal health information, particularly when it comes to people with low technical proficiency. Similarly, clinicians must be prepared to change their workflows to successfully incorporate a new system. Trust will play a key role in driving user adoption, let's say if the platform is transparent in communication, user-friendly, and has proven its reliability in the marketplace.

To successfully address these challenges will require strategic planning, continued innovation, and partnerships with industry, among others. Overcoming these challenges, this project will be able to achieve the goal to build a secure, effective, and patient-oriented medical ecosystem.

CHAPTER 3

REQUIREMENT SPECIFICATION

3.1 Business Process Modelling (BPM)

The project's business model leverages blockchain technology for the creation of a decentralized system that will enable secure, seamless, and transparent healthcare data management. Formal representation of the business model is expressed as follows:

3.1.1 Principal Collaborators

- **Medical Facilities** – Hospitals, Clinics, Diagnostic Centers for collaboration towards treatment of patients.
- **Pharma** – De-identified healthcare data for calibration of drugs and gap analysis for drug development.
- **Medical Research Organizations** – Partnerships for use of patient data to drive medical research and innovation.
- **Blockchain Providers** – Technology-forward partners supporting the creation of trusted infrastructure that is both secure and decentralized.
- **Regulatory Bodies** – Partnering with regulators and government policymakers to help ensure data privacy compliance such as GDPR and HIPAA.

3.1.2 Key Activities

- The development and administration of a blockchain-based ecosystem.
- Ensuring adherence to healthcare data protection regulations.
- Facilitating secure and consent-driven data sharing among stakeholders.
- Monetization of de-identified patient data for research objectives.
- Formulating strategic partnerships with healthcare and research institutions.
- Instructing stakeholders on the significance of decentralized data ownership.

3.1.3 Value Propositions

For Patients:

1. The possession and governance of individual healthcare information.
2. Augmented privacy facilitated by decentralized, blockchain-based systems.
3. An opportunity exists to capitalize on healthcare data, contingent upon obtaining unambiguous consent.

For Doctors and Hospitals:

1. Uninterrupted access to comprehensive patient histories is essential for facilitating accurate diagnosis and treatment.
2. Enhanced operational efficiency was achieved through the optimization of data exchange processes.

For Pharmaceutical Companies and Researchers:

1. Access to consistent, de-identified data for R&D, hastening of medication development and medical discoveries.

3.1.4 Customer Relationships

1. Patients: Direct engagement through a user-friendly mobile and web platform.
2. Stakeholders: Long-term agreements with healthcare institutions, pharmaceutical companies,

and research organizations. Personalized support and onboarding for all stakeholders.

3.1.5 Revenue Streams

1. From hospitals, insurance providers, and pharmaceutical businesses using the platform, subscription fees
2. Pay-per- Use Fees: For information gleaned from data sources accessible to pharmaceutical corporations and research facilities.
3. Charged for safe data exchanges amongst parties are transaction fees.
4. Licensing Fees: To provide the Patient Bio ecosystem to other companies' access.
5. Revenue from anonymised patient data distributed under permission for research uses is known as data monetization.

3.1.6 Operational Workflow

Patients enter, validate, and oversee their medical records using the Patient Bio app.
Patients give express permission to provide particular data to hospitals, clinicians, or researchers as needed.
Patients can choose to make money from their de-identified data, therefore guaranteeing openness and equitable pay.
By means of secure APIs, partner institutions access patient data, hence enhancing operational efficiency and research outcome.

3.2 Development model:

The **Agile development model** is adopted for the project due to its flexibility, iterative progress, and continuous feedback—essential for handling sensitive healthcare data securely and efficiently.

Key Modules:

- **User Registration & Profiles:** Secure sign-up (Google, Apple ID, biometrics), role-based profiles (Patient, Doctor, Admin, etc.), with bios and photos.
- **Data Discovery:** Smart search and filters by disease, doctor, or category; personalized data suggestions.
- **Connectivity:** Follow system, bookmarks, and communication between patients and healthcare professionals.
- **Community & Engagement:** Q&A forum, health blog/news section for user interaction and awareness.
- **Mobile Adaptivity:** Responsive design across mobile, tablet, and web platforms.
- **Privacy & Security:** End-to-end encryption, IPFS storage, multi-signature approval for sensitive data sharing, and active moderation.
- **Reporting:** In-app feedback/report system with admin dashboard for issue resolution.
- **Scalability & QA:** Scalable backend (Docker, Kubernetes, Hyperledger), with continuous testing and security audits.
- **Marketing:** Targeted campaigns, social media, and partnerships with healthcare providers.

- **Continuous Development:** Iterative updates driven by user feedback and agile retrospectives.

3.2.1 Functional Requirements:

1. **User Authentication & Authorization:**
    - Support for Apple ID, Google, and biometric authentication methods.
    - Implement Role-Based Access Control (RBAC) for patients, doctors, pathologists, labs, pharmacies, and administrators.
    - Enable Multi-Factor Authentication (MFA) for enhanced security.
2. **API Development:**
    - Develop RESTful APIs using Express.js.
    - Implement a service layer within the SVC architecture to manage business logic effectively.
3. **Permissions & Data Sharing:**
    - Provide QR code functionality for secure data and prescription sharing.
    - Establish an approval workflow for regulated access to data.
    - Implement multi-admin approval for secure data exchange using multi-signature confirmation.
4. **Animations:**
    - Utilize Reanimated 3 to deliver smooth gesture-based animations and UI/UX transitions.
5. **File Management:**
    - Allow secure, decentralized file uploads using Pinata (IPFS).
    - Manage and store data efficiently with Network File System (NFS).
6. **Blockchain Integration:**
    - Implement Hyperledger Fabric with Golang chaincode based on SOLID principles.
    - Monitor and manage blockchains in real-time using Hyperledger Explorer.
    - Facilitate transparent, blockchain-based consent management for data sharing.
7. **Analytics & Monitoring:**
    - Collect system metrics with Prometheus for real-time monitoring.
    - Visualize performance data and set up alerts through Grafana.
8. **User Interface:**
    - Develop a cross-platform React Native app supporting both iOS and Android.
    - Provide light and dark mode options to improve user accessibility.
9. **Scalability & Deployment:**
    - Ensure application scalability using Docker and Kubernetes.
    - Optimize performance through load balancing and reverse proxying with Nginx.

3.2.2 Non-Functional Requirements:

1. **Performance:**
    - The system should handle at least 10,000 concurrent users with minimal latency.
    - APIs should respond within 300ms under normal load.
2. **Scalability:**
    - Support horizontal scaling of services using Kubernetes.
    - Allow dynamic load balancing with Nginx for seamless scaling.
3. **Security:**
    - Adhere to OWASP security guidelines to protect against common vulnerabilities.
    - Implement data encryption both at rest and in transit.

    - Ensure secure authentication with MFA and role-based access controls.
4. **Availability:**
    - Maintain 99.9% system uptime with failover strategies.
    - Implement backup and disaster recovery processes.
5. **Reliability:**
    - The application should handle failures gracefully and recover automatically.
    - Enable multi-admin approval to reduce risks in critical workflows.
6. **Usability:**
    - Design a user-friendly interface with smooth animations and transitions.
    - Provide a consistent experience across iOS and Android platforms.
7. **Maintainability:**
    - Write modular, maintainable code following SOLID principles.
    - Use a microservices architecture to isolate and manage individual components.
8. **Compliance:**
    - Comply with relevant regulations, such as HIPAA for healthcare data management.
    - Implement blockchain-based consent management for auditability.
9. **Monitoring & Logging:**
    - Enable real-time system monitoring with Prometheus and Grafana.
    - Maintain detailed logs for API requests, errors, and system performance.
10. **Data Integrity:**

- Ensure data consistency across decentralized file uploads and blockchain records.
- Validate data before processing and during blockchain transactions.

Who can share data to others:

	Patient	**Doctors**	**Medical R.L**	**Pathologist**	**Pharmacy Company**	**Admin**
Admin			Yes		Yes	
Patient		Yes	Yes	Yes	Yes	Yes
Doctors	Yes			Yes		
Medical R.L						
Pathologist	Yes	Yes				
Pharmacy Company						

Table 3.1: Who can share data

3.2.3 Hardware specification:

Processor	2.6 GHz or faster process
RAM	4 GB
Memory space	4 GB

Table 3.2 : Hardware specification

3.2.4 Software specification:

Operation System	Linux
Frontend	Javascript, Typescript
Frontend JavaScript library/framework	React-native , React-native-paper, Reanimated3.0 ,IPFS
Backend	Node.js, HyperLedger Fabric,Docker , Kubernetes , NFS, Golang
Backend JavaScript library/framework	Express.js
Code Editor	Visual studio code, Lens IDE
Database	couchDB
Mobile operating system	Android , iOS
Web Server	Node server
tools	Draw.io, postman

Table 3.3 : Software specification

3.2.5 Project Architecture

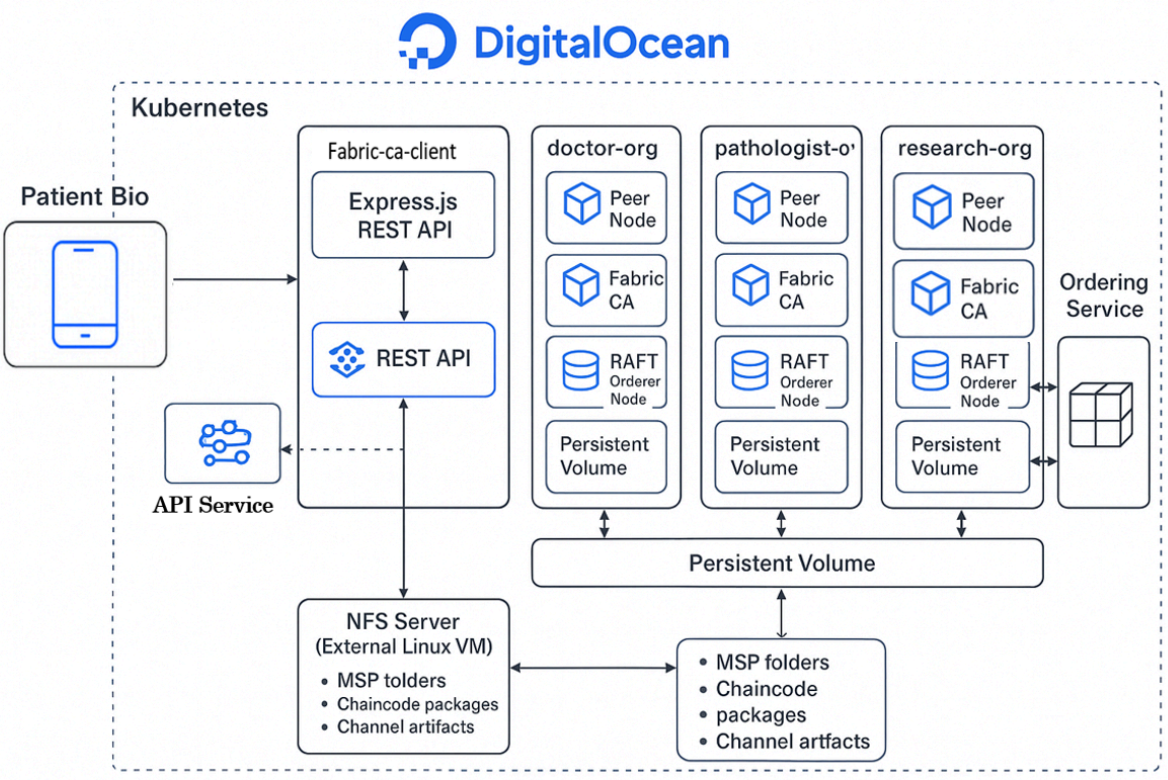


Figure 3.1 Project Architecture

The development of the Patient Bio system follows a modular and secure approach, integrating decentralized technologies, role-based access control, and modern deployment practices to ensure privacy, performance, and scalability.

1. Frontend Development

A cross-platform **React Native** mobile application was developed to provide users (patients, doctors, pathologists, etc.) with a seamless experience. The app supports:

- Multi-factor authentication (Google, Apple ID, biometrics),
- Multilingual interface,
- QR-based data sharing,
- UI enhancements like dark/light mode and real-time notifications.

2. Backend/API Layer

An **Express.js** server acts as the backend gateway, exposing REST APIs to:

- Authenticate users,

- Handle interactions with the blockchain (via SDK),
- Connect to CouchDB for reading ledger state data,
- Interface with wallets for identity management.

3. Blockchain Network (Hyperledger Fabric)

The blockchain is built on **Hyperledger Fabric** and consists of **five organizations**:

- Patient Org
- Doctor Org
- Pathologist Org
- Pharmacy Company Org
- Medical Research Lab Org

Each organization includes:

- A **Peer Node** to host the ledger and execute chaincode.
- A **Fabric Certificate Authority (CA)** for identity issuance.
- A **CouchDB** instance for chaincode state storage.
- A **RAFT Orderer Node** to maintain consensus and block ordering.
- A **Persistent Volume** for storing ledger data securely.

Additionally, an **Admin Role** is implemented with privileges to manage user analytics, multisig approvals, permission configurations, and category management.

4. Smart Contracts (Chaincode)

Custom chaincode written in **Go** enforces:

- Role-based access control,
- Data sharing logic (QR code-based and multisig-approved),
- Permission validation,
- Categorized storage and retrieval of metadata.

5. Distributed File Storage (IPFS + Pinata)

Medical documents are stored securely on **IPFS** via **Pinata**, ensuring tamper-proof distributed storage. Only the IPFS hashes are stored on the blockchain, preserving the integrity and immutability of records without bloating the ledger.

6. Identity & Wallet Management

Each user interacts with the blockchain via a registered identity stored in **Hyperledger Fabric wallets**. The API server handles wallet operations like enrollment, registration, and transaction signing.

7. Data Persistence and Artifacts

All cryptographic artifacts, MSP folders, chaincode packages, and channel configurations are centrally stored on a **Linux-based NFS server**. These volumes are mounted across all pods in Kubernetes for shared access and dynamic scaling.

8. Deployment Infrastructure

All services are containerized and deployed using **Kubernetes** on **DigitalOcean**. This ensures:

- High availability,
- Scalability,
- Isolation between services,
- Easy updates and monitoring.

3.3 Use Case Diagram

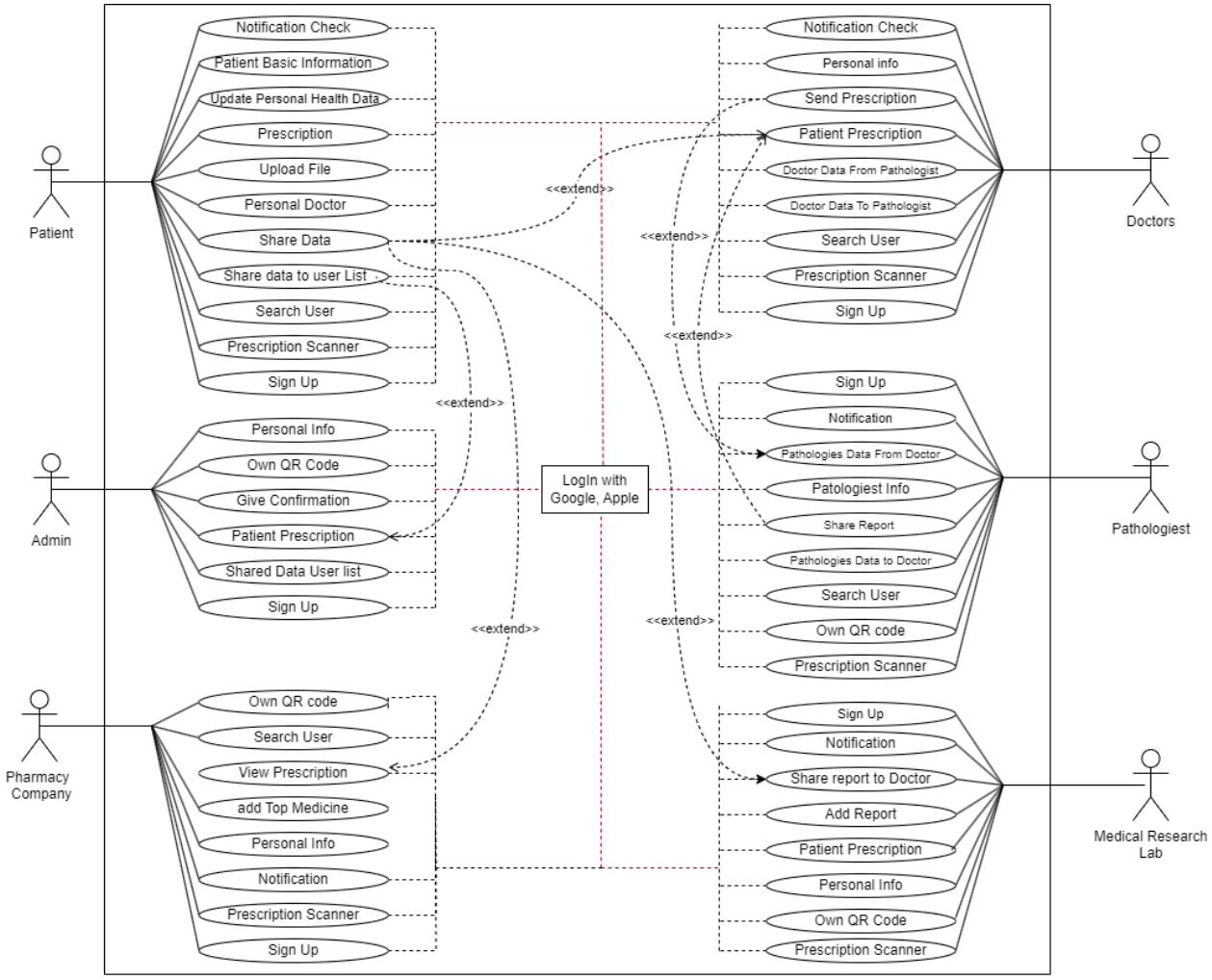


Figure 3.2 Use case Diagram

Use Case Name: **Patient Medical Data Management**

Primary Actor: Patient
Secondary Actors: Doctor, System Admin
Goal: To enable patients to securely store, update, and share their medical records.

Preconditions:

1. The patient must have an active account in the system.
2. The system is operational and accessible.

Postconditions:

1. Medical records are securely stored or updated in the blockchain-based system.
2. Shared data access is logged and tracked

Main Success Scenario:

- The patient logs into the system using Web3Auth or another secure authentication method.
- The system verifies the credentials and grants access.
- The patient uploads, updates, or views their medical records.
- If the patient chooses to share their data, they select a specific record and grant consent to the doctor.
- The system notifies the doctor and provides access to the selected data.
- The patient receives confirmation of the successful operation.

Use Case Name: Prescription Management

Primary Actor: Doctor

Secondary Actors: Patient, Pharmacist

Goal: To enable doctors to generate and share secure digital prescriptions with patients and pharmacists.

Preconditions:

1. The doctor and patient are registered in the system.
2. The patient has granted consent for the doctor to access their medical data.

Postconditions:

1. A blockchain-based digital prescription is securely generated.

2. Pharmacists can verify and dispense medications.

Main Success Scenario*:*

1. The physician logs into the system and selects a specific patient from the list.
2. The physician reviews the patient's medical history and generates a new prescription based on the current diagnosis.
3. The prescription is encrypted and stored securely on the blockchain. A **Unique ID (UID)** is generated and associated with the prescription.
4. The encrypted prescription and its UID are transmitted to the patient, accessible through their secure dashboard.
5. The pharmacist retrieves the prescription using the provided UID, verifying its authenticity and integrity via the blockchain.
6. Upon successful verification, the pharmacist dispenses the prescribed medicine. The system logs this action as a **dispensing event** on the blockchain for audit and traceability.

3.4 **Sequence Diagram**

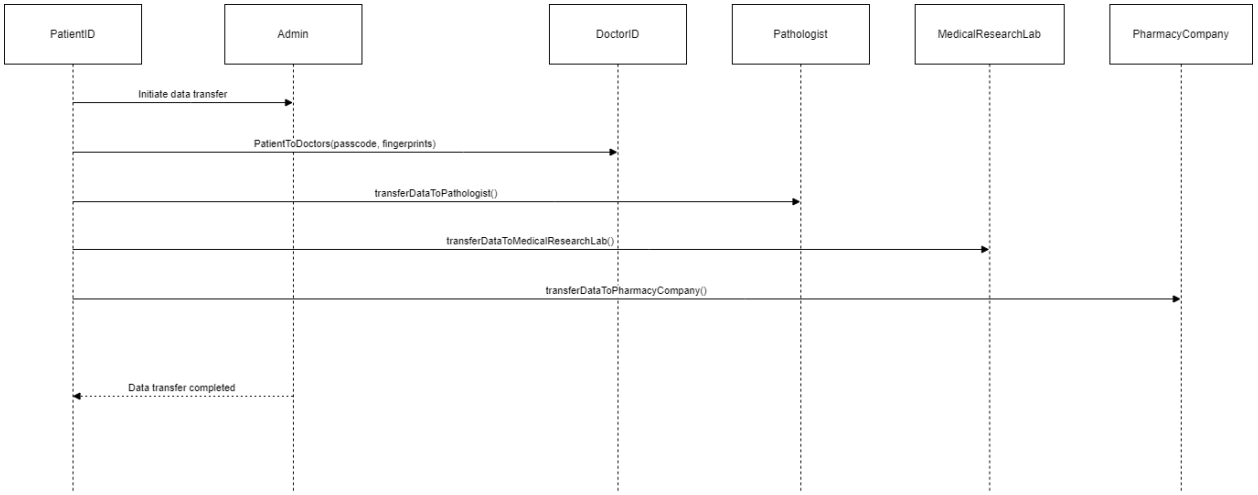


Figure 3.3 Sequence Diagram

This data transfer flow of the project:

Patient-initiated data transfer – Patient initiates the sending of medical data to approved entities.

Authentication & Authorization – The patient authenticates themselves with a passcode, fingerprint, etc.

Data Transfer to Doctor – After successful verification, the service securely and confidentially delivers the patient's data to the designated doctor for review and treatment.

Sharing the Data With Pathologist – The admin or doctor sends the healthcare data to a pathologist, if necessary.

Transfer to Medical Research Lab – Anonymized or categorized patient data may be transferred by the admin or pathologist to a medical research lab for use in research (improving healthcare).

Sharing of Information with a Pharmacy Company – If needed, the pathologist and/or admin shares information based on a need-to-know basis with a pharmacy company regarding prescriptions or research about drugs.

The Completion of Data Transfer – At the data's destination, the system will ensure and mark the transfer as complete so all actions are securely logged / audited.

3.5 Class Diagram

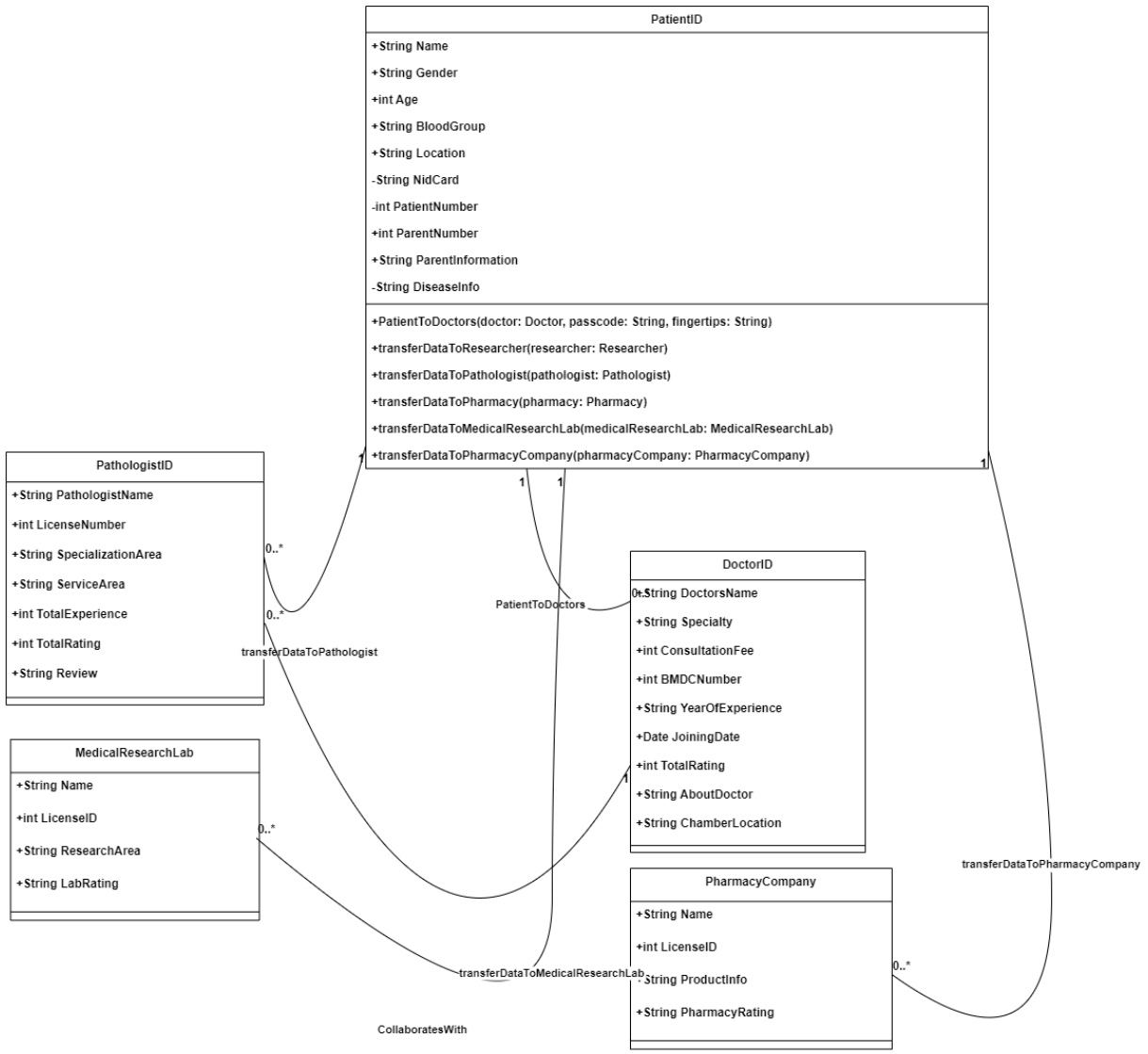


Figure 3.4: Class Diagram

The Patient Bio platform was designed in an incremental step-by-step process to ensure the secure, effective, and reliable control of medical data. The breakdown is as follows:

Discover Core Entities: The important entities that are crucial to the platform form the base. Patients, doctors, pathologists, medical research labs, pharmacies, and hospitals are just a few examples of such entities. Each of them represents different stakeholders in the healthcare ecosystem.

Find Relationships: The next step is to discover the relationship between entities. For example, there are many-to-many relationships between patients and research labs, or patients and pharmacies, for the sharing of medical data, and one-to-many relationships between patients and doctors (a patient may have more than one doctor).

Add Security Measures: In any system as important as healthcare, security should be a priority. Cutting-edge security features – including role-based access control (RBAC), data encryption, fingerprint and Face ID, and passcode – as well as ongoing regulatory compliance checks ensure the highest level of protection for patient data.

Ensure Cybersecurity Mechanisms: Healthcare systems must be secure. That means that when it comes to protecting patient data, everything from role-based access control (RBAC) and data encryption to fingerprint and Face ID to passcode and the ongoing monitoring of regulatory compliance is built right into the platform.

Effect On Design Data Flow: The data flow design of the platform forms a crucial part of it. This involves ensuring pathologists may share results with each other, patients may safely initiate a data transfer, doctors may submit changes to records, and research labs or pharmacies can fetch needed data with patient consent.

The Role of the Administrator: As the administrator is responsible for the system's functionality, security, and compliance, this is the most important position. They are responsible for ensuring the platform meets healthcare regulations, and for safeguarding data privacy and the security of the system.

3.6 Entity Relationship Diagram

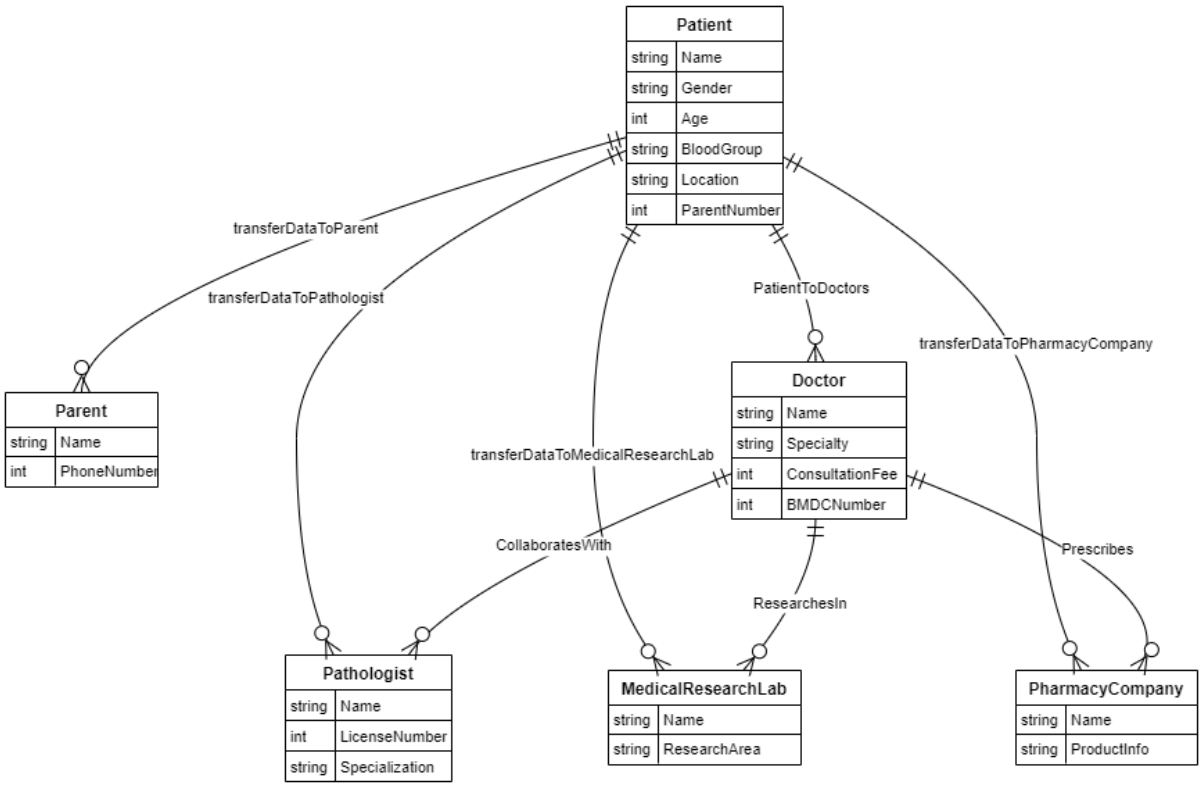


Figure:3.5 Entity Relationship Diagram

Simplified Healthcare Process

1. **Patient Registration:** A patient has to register with the system to feed in his name, sex, age, blood group, and location.
2. **Consultation With the Doctor:** The patient schedules an appointment and consults the physician for his/her medical condition. The doctor diagnoses and treats the patient.
3. **Prescription & Treatment:** If necessary, the doctor gives medicines. The patient obtains the medications from a pharmacy.

4. **Medical Tests (If Necessary):** If more tests are needed, the doctor will refer the patient to the relevant tests. The patient goes to a medical lab for testing.
5. **Research & Partnership:** Physicians might work with medical research laboratories for conducting studies. (30734) Medical laboratories engage in investigative activities for the purpose of improving treatments.
6. **Follow-Up & Recovery:** In follow-up, the patient sees the doctor as required. The patient is discharged from the process following cure and drug withdrawal.

CHAPTER 4

DESIGN SPECIFICATION

4.1 FRONT-END DESIGN

My project is an easy-to-use smartphone application that securely manages and shares medical data, ensuring privacy and availability. The platform's interface is well designed to provide a seamless and engaging experience to patients, doctors, pathologists, medical research labs, and pharmacy corporations.

An easy-to-use interface:

They'll find a modern, attractive design and easy-to-use navigation.
Top-bar search makes it easy for users to quickly find shared medical data, doctors, or patient records.
The well-organized and concise structure ensures that consumers can learn what they need to know about medical matters.

Users' profiles :

It includes a separate profile page for every user type (Patient, Doctor, Pathologist, Admin, Medical Research Lab, Pharmacy Company).
Patients may store information online such as personal medical information, prescriptions, and treatment facts.
Physicians and pathologists may also control patient cases and medical data that are shared.
Admins can look after user activities, analytics, and multisig wallet management.
Write to Patient Information Medical Records only if you have questions regarding your medical records.
Medical records can be safely uploaded, stored on IPFS, and managed by patients on Pinata. Both physicians and doctors can edit orders and patient reports.
With a basic QR code-sharing system, magnets can be safely swapped.
Administrators may classify the medical data, and they are in charge of approving data-sharing requests.

Medical Data Detail screen:

You can tap on a medical record to see the whole picture, from treatment plans and test results to prescriptions.
Pathologists, physicians, and patients alike may all post comments, provide updates, or pose questions.
Structuring and filtering of medical records can be facilitated by classifying into disease types.

Seamless Data Sharing:

Patients have the option to forward their medical records to administrators, pathologists, and physicians.
The sharing of data and prescriptions helps doctors and pathologists collaborate.
Demanding classified information from medical research laboratories and drug companies requires patient consent.
An approval process ensures patients' consent before data is released to third parties.

Dark Mode & Light Mode:

Integrated theme-switch toggle between dark and light mode for ease of use.
If low-light, high-contrast is your thing, the UI has been prettied up for you.

Notifications :

Data-sharing requests and approvals appear in real-time for users.
New tests and drug orders.
Critical medical announcements and system alerts.

High-Quality Subscription Management:

Users have the option of upgrading to a paid premium version for additional features such as advanced

analytics about shared medical information.
Early access to new features.
Additional protection for medical record extra.

Security and Privacy:

Users' information is protected by robust privacy rules.
People determine how much they want to protect their own privacy.

Fully Responsive Design:

The quality of UI, which is powered by React Native, ensures seamless performance on tablet and mobile devices.
Adaptive UI with some adaptive elements of UI ensures the best experience on all dimensions of the screens.
The frontend code behind Patient Bio is built to be secure, friendly, and community-driven so doctors, researchers, and patients can manage their records with ease. An engaging and dynamic experience, the platform ensures private preparing, smooth collaboration, and availability, allowing users to own their health data.

4.2 BACK-END DESIGN

The backend of *Patient Bio* is built using **Express.js (REST API)** and **Hyperledger Fabric**, enabling secure, decentralized management of sensitive medical data. Scalability, reliability, and availability are ensured using **Docker**, **Kubernetes**, and **NFS**, while **IPFS (via Pinata)** handles distributed file storage.

Core Technologies

- **Express.js** – RESTful API development
- **HyperLedger Fabric** – Permissioned blockchain with chaincode in **Golang**
- **Docker & Kubernetes** – Containerization and orchestration for modular and scalable deployment
- **NFS & IPFS (Pinata)** – Hybrid storage system for medical data
- **Redis** – Caching and performance optimization
- **JWT & OAuth (Google, Apple ID)** – Secure authentication system

Key Features

- **User Authentication** – Supports login via Google, Apple ID, Face ID, and Touch ID
- **Role-Based Access** – Custom access levels for Patients, Doctors, Pathologists, Admins, Researchers, and Pharma Companies
- **Blockchain Transactions** – Data exchanges are executed via smart contracts
- **QR Code Sharing** – Encrypted QR codes enable secure data sharing
- **Multisig Wallet (Admins)** – Sensitive actions require approval from multiple admins
- **Data Classification** – Users must categorize medical files before sharing
- **Real-Time Notifications** – WebSocket integration for instant updates

Security & Performance

- **Kubernetes Auto-Scaling** – Ensures efficient resource management
- **Continuous Monitoring** – Infrastructure designed for privacy, compliance, and reliability

Deployment & Scalability

- **Microservices Architecture** – Each service runs in isolated Docker containers
- **Load Balancing** – Kubernetes ensures high availability and fault tolerance

My project is an easy-to-use smartphone application that securely manages and shares medical data, ensuring privacy and availability. The platform's interface is well designed to provide a seamless and engaging experience to patients, doctors, pathologists, medical research labs, and pharmacy corporations.

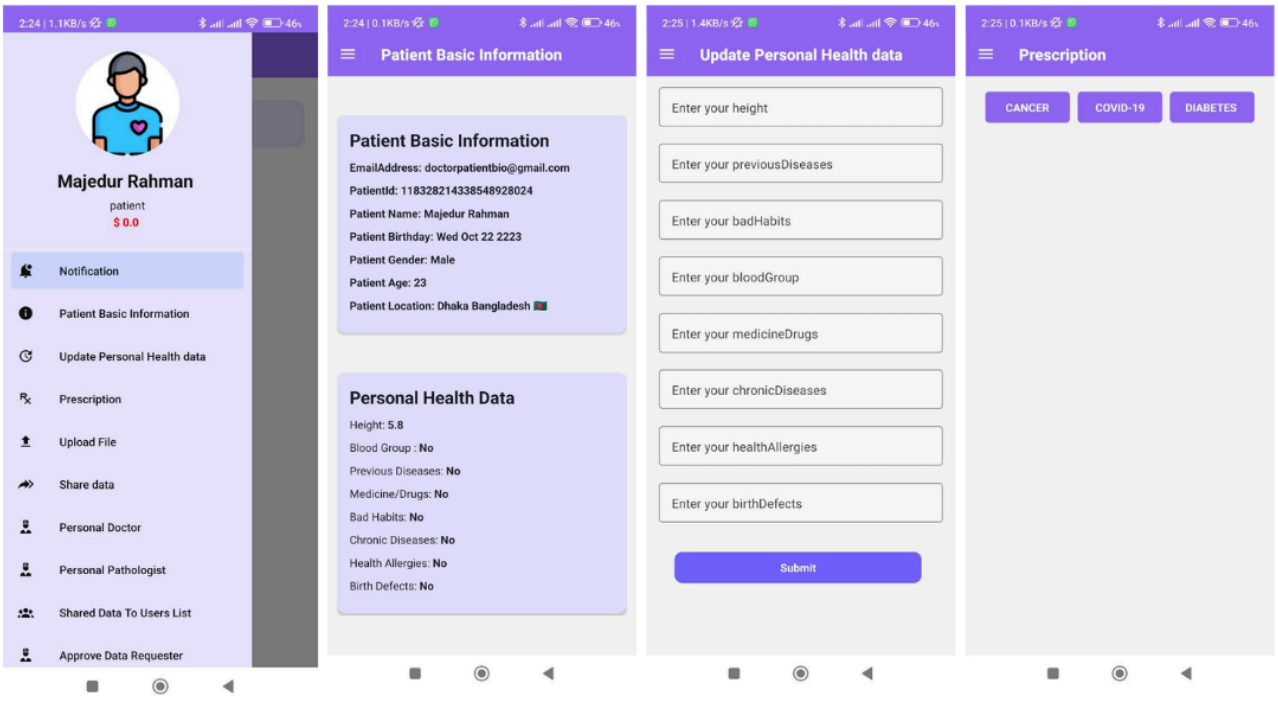
CHAPTER 5
IMPLEMENTATION & TESTING

5.1 Implementation of Patient Profile

The patient profile in the decentralized healthcare app brings in a suite of features that help patients have control over their health data. The complete set of options are:

- **Notifications** – Alerts and reminders regarding prescriptions, sharing requests, approvals and system messages.
- **Patient Basic Information** – Shows basic info, including email, ID, name, date of birth, age, location, gender.
- **Update Personal Health Data** – A screen to add or modify information such as height, blood group, prior diseases, vices, medications, chronic diseases, allergies, and birth disorders.
- **Prescription** – Displays aligned categories (eg Cancer, COVID-19, Diabetes etc) prescriptions of Doctors to view.
- **Upload File** – Patient can upload medical reports or any such document securely.
- **Data Sharing** – Enables controlled data sharing (for example, medical data) with physicians, pathologists, research labs, etc., through QR code and smart contract for authorization.
- **Personal Doctor** – See and manage connected assigned or personal doctors.
- **Your Pathologist** – See and control relationships with someone else's pathologist or your own.
- **Shared Data to Users List** – Show list of entities (doctors, pathologists, researchers) with who data is shared.
- **Approve Data Requester** – Displays data access requests from third-parties (research labs, pharma, etc.) and enables patients to approve or deny these requests.

Patients have full control over all their personal medical data in a transparent, secure and convenient way.


Majedur Rahman
patient
$ 0.0
Notification
Patient Basic Information
Update Personal Health data
Prescription
Upload File
Share data
Personal Doctor
Personal Pathologist
Shared Data To Users List
Approve Data Requester
Patient Basic Information
Patient Basic Information
EmailAddress: doctorpatientbio@gmail.com
PatientId: 118328214338548928024
Patient Name: Majedur Rahman
Patient Birthday: Wed Oct 22 2223
Patient Gender: Male
Patient Age: 23
Patient Location: Dhaka Bangladesh
Personal Health Data
Height: 5.8
Blood Group : No
Previous Diseases: No
Medicine/Drugs: No
Bad Habits: No
Chronic Diseases: No
Health Allergies: No
Birth Defects: No
Update Personal Health data
Enter your height
Enter your previousDiseases
Enter your badHabits
Enter your bloodGroup
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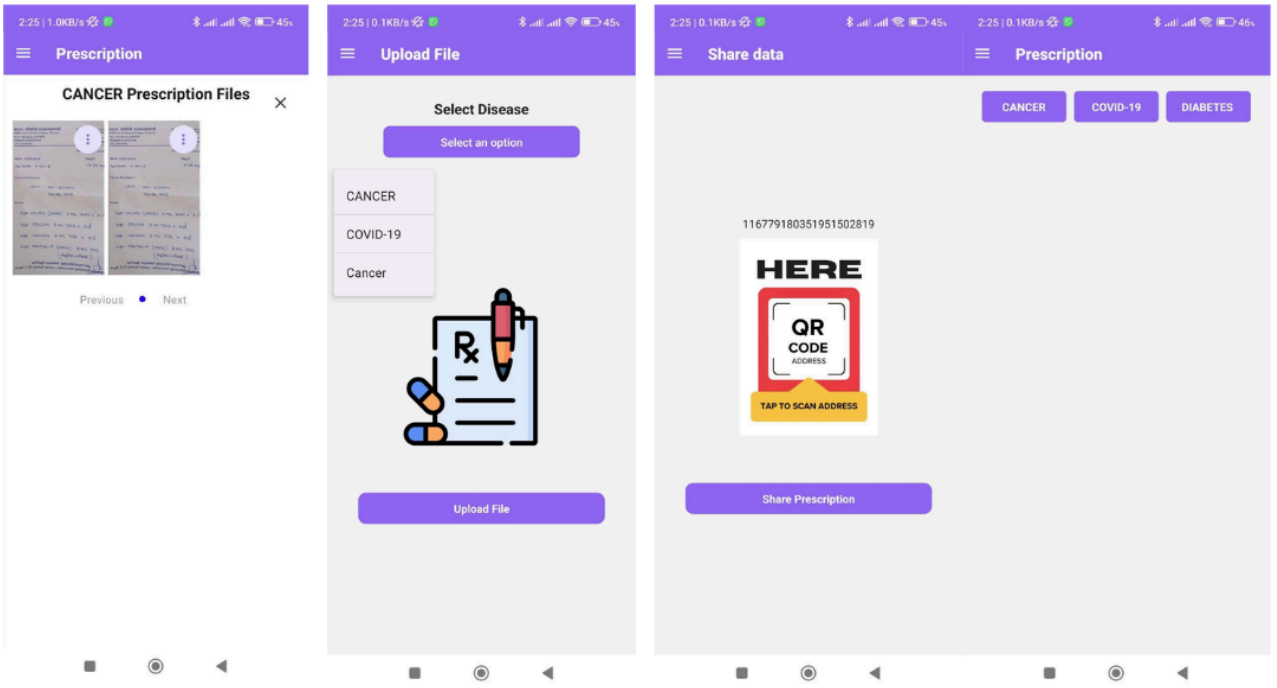
Enter your chronicDiseases
Enter your healthAllergies
Enter your birthDefects
Submit
Prescription
CANCER
COVID-19
DIABETES


Prescription
CANCER Prescription Files
Previous
Next
Upload File
Select Disease
Select an option
CANCER
COVID-19
Cancer
Upload File
Share data
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HERE
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TAP TO SCAN ADDRESS
Share Prescription
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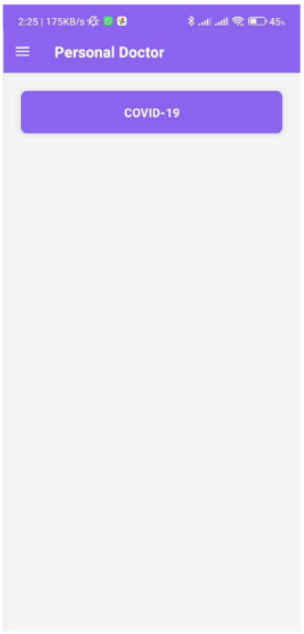
COVID-19
DIABETES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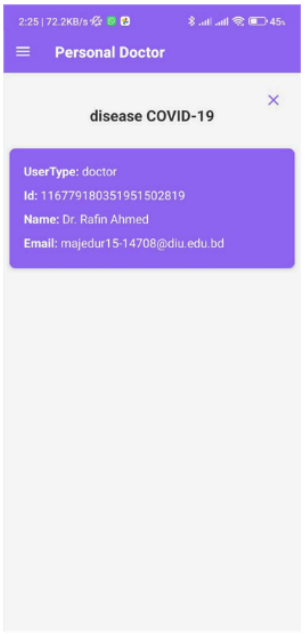
COVID-19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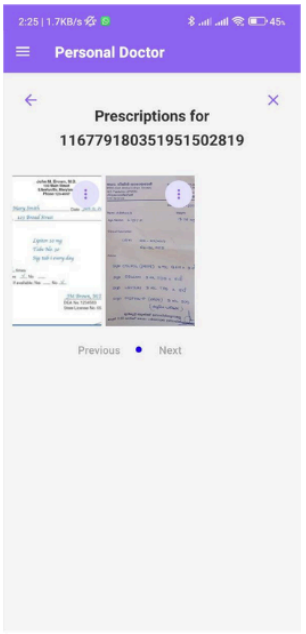
disease COVID-19
UserType: doctor
Id: 116779180351951502819
Name: Dr. Rafin Ahmed
Email: majedur15-14708@diu.edu.bd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Prescriptions for
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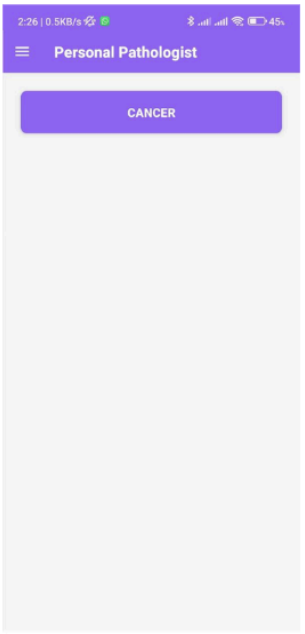
Previous
Next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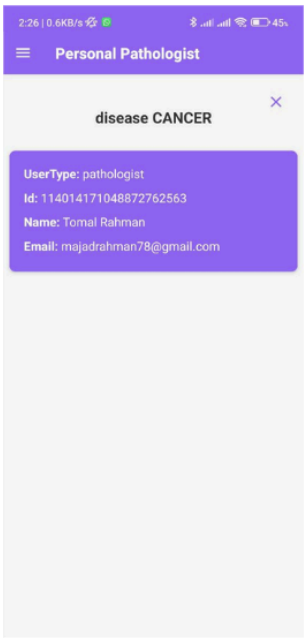
CANCER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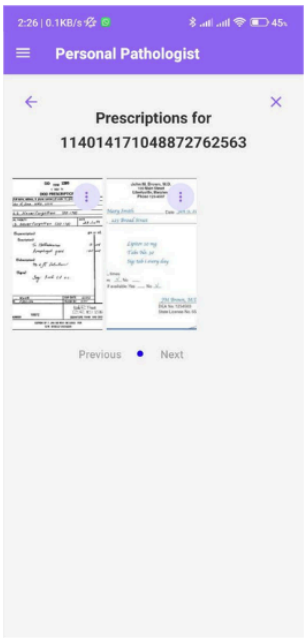
Name: Tomal Rahman
Email: majadrahman78@gmail.com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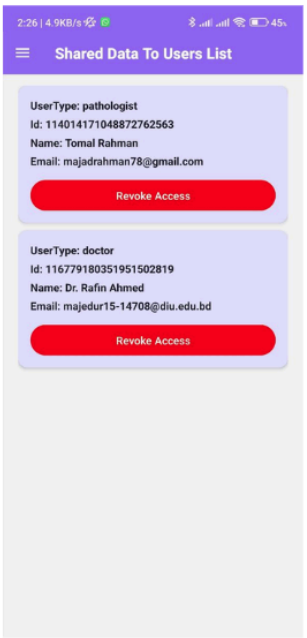
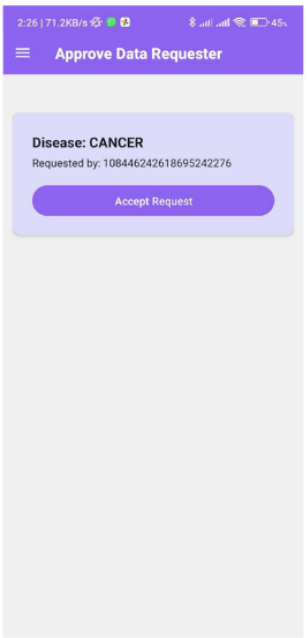
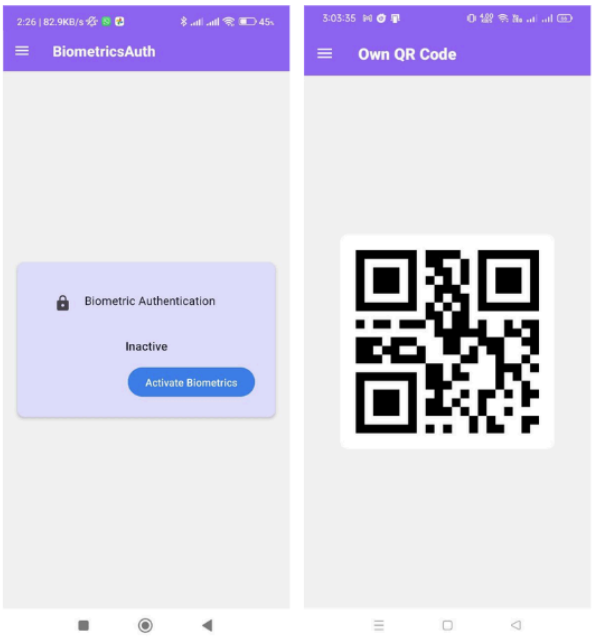

Shared Data To Users List
UserType: pathologist
Id: 114014171048872762563
Name: Tomal Rahman
Email: majadrahman78@gmail.com
Revoke Access
UserType: doctor
Id: 116779180351951502819
Name: Dr. Rafin Ahmed
Email: majedur15-14708@diu.edu.bd
Revoke Access


Approve Data Requester
Disease: CANCER
Requested by: 108446242618695242276
Accept Request

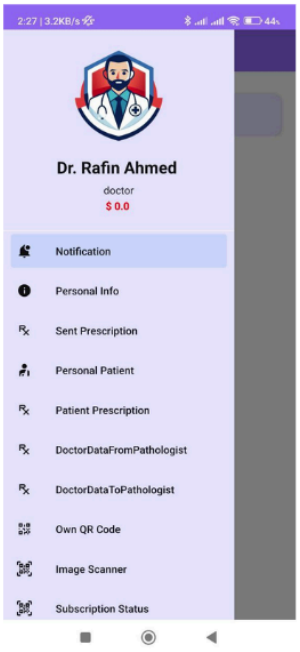


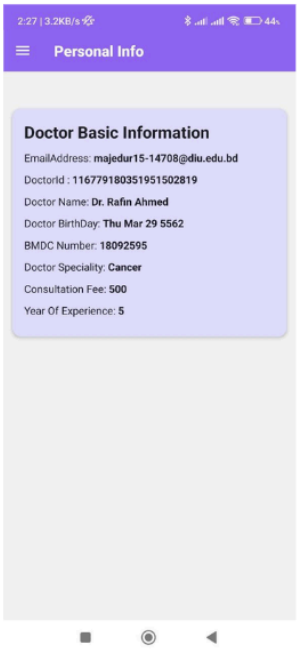
5.2 Implementation of Doctors Profile

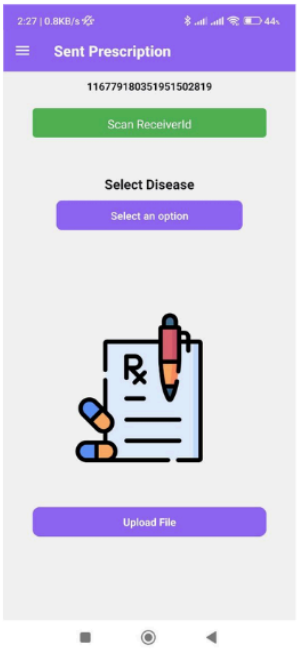
The application doctor profile is designed to assist doctors to manage the patient data, prescriptions and health records with clarity and ease. The complete list of options is:

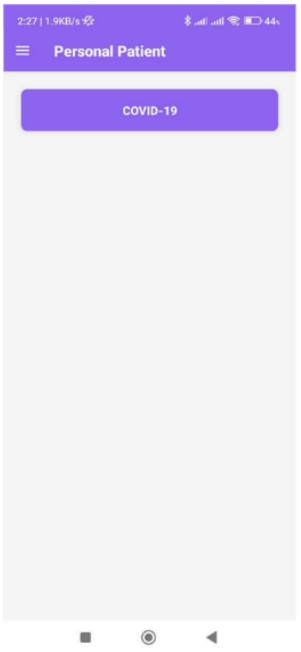
- **Notification** – Shows instant notifications for drugs, patient profile updates, and data exchange activities.
- **Personal Info** – You will be able to view detailed doctor information including his/her name, e-mail, ID, date of birth, BMDC number, specialization, consultation fee, and experience.
- **Send Prescription** – Doctors can send the prescription to patients by scanning their ID and uploading the required documents which are disease related.
- **Personal Patient** – The doctor could view a list of patients he is responsible for categorized by a disease (e.g., COVID-19).
- **Patient Prescription** – Allowing doctors to see or change cigarettes who have been previously prescribed to patients.
- **Doctor Data From Pathologist** – Provide doctors' access to diagnostic or lab data provided by pathologists.
- **Doctor Data To Pathologist** – Easy For Sharing Medical Data Or Prescribed Files From Doctor To Pathologist.
- **Own QR Code** – Creates the QR Code of the doctor for instant identifying and secured transaction.
- **Image Scanner** – In built scanner to upload physical prescription/diagnostic reports digitally.
- **Subscription Status** – The subscription and/or premium access status of the doctor's profile.

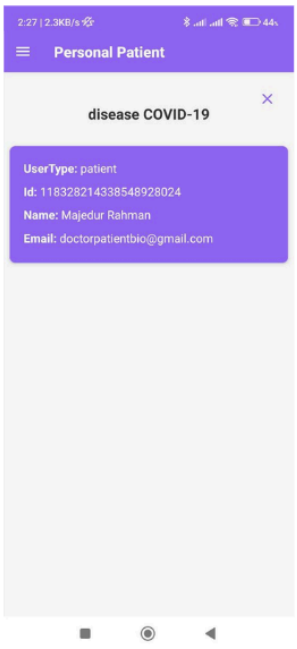
These features facilitate a smooth communication between the doctor and the patient by ensuring a secure and ethical given and take of medical information in a decentralized environment.

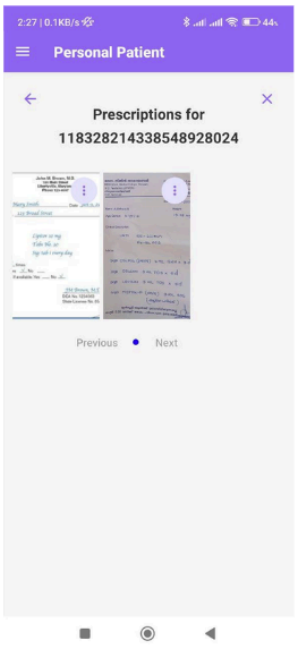

Dr. Rafin Ahmed
doctor
$ 0.0
Notification
Personal Info
Sent Prescription
Personal Patient
Patient Prescription
DoctorDataFromPathologist
DoctorDataToPathologist
Own QR Code
Image Scanner
Subscription Status

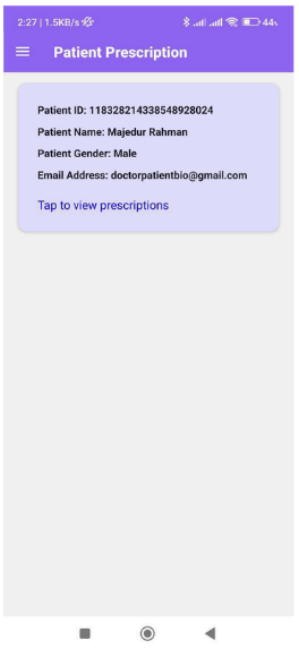

Personal Info
Doctor Basic Information
EmailAddress: majedur15-14708@diu.edu.bd
DoctorId : 11677918035195150 2819
Doctor Name: Dr. Rafin Ahmed
Doctor BirthDay: Thu Mar 29 5562
BMDC Number: 18092595
Doctor Speciality: Cancer
Consultation Fee: 500
Year Of Experience: 5

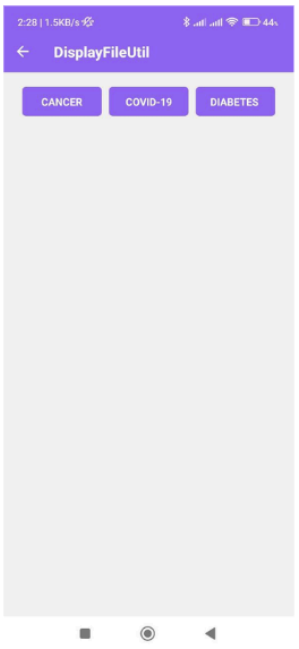

Sent Prescription
11677918035195150 2819
Scan ReceiverId
Select Disease
Select an option
Upload File

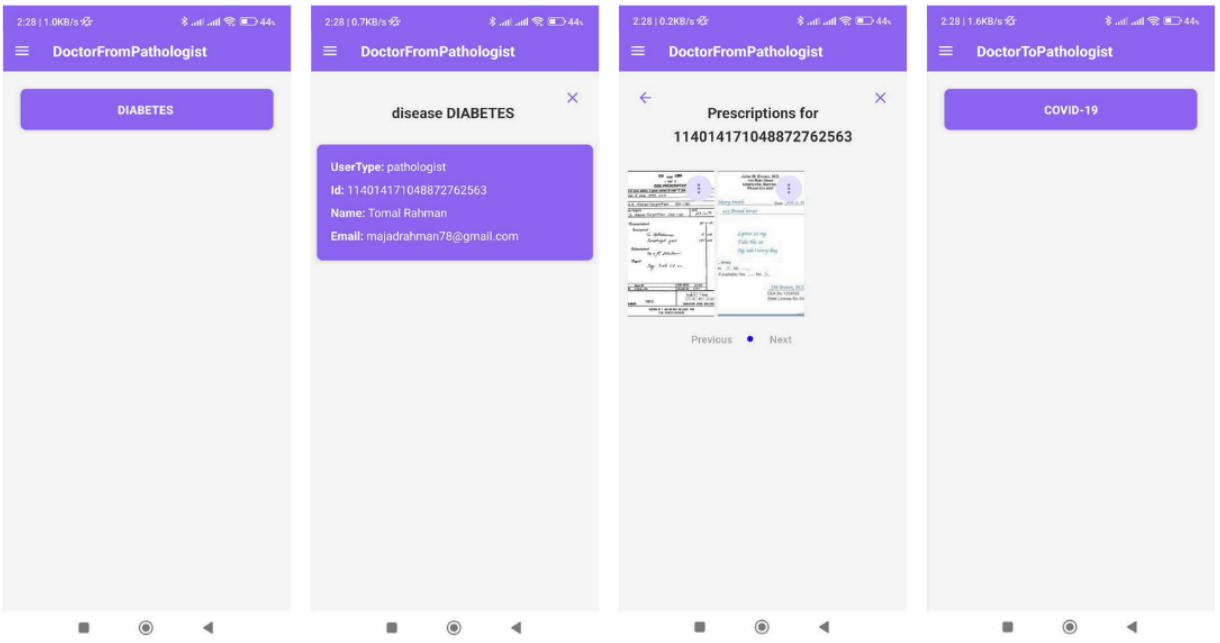

Personal Patient
COVID-19

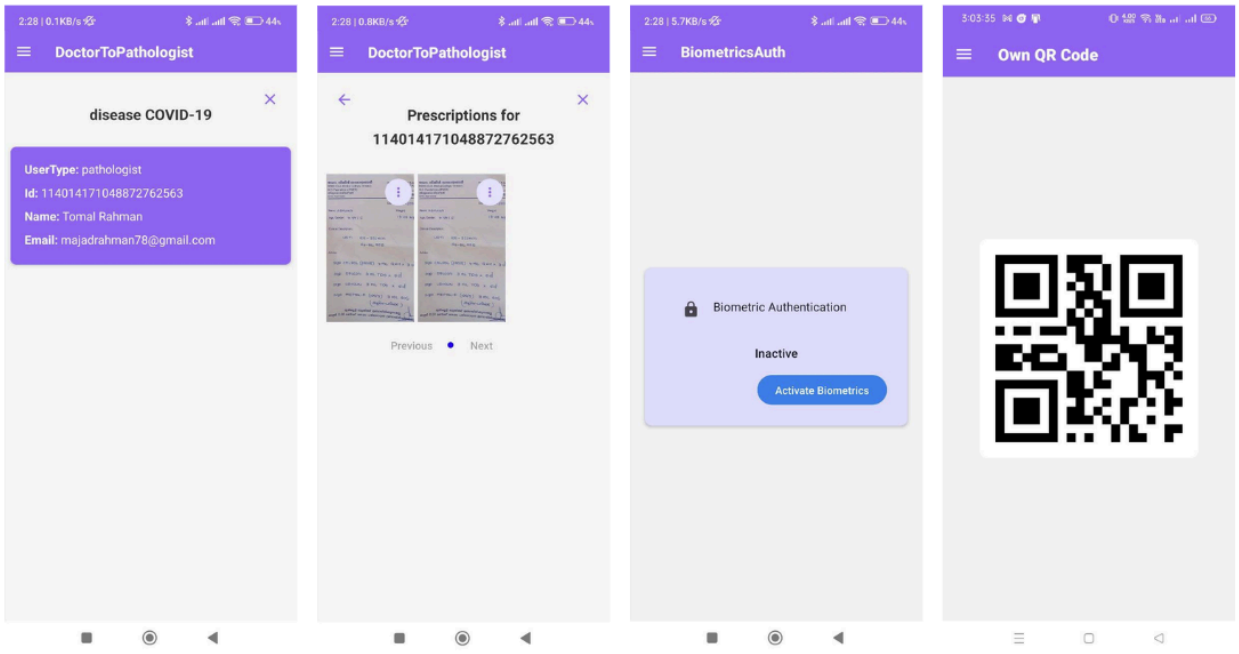

Personal Patient
disease COVID-19
UserType: patient
Id: 118328214338548928024
Name: Majedur Rahman
Email: doctorpatientbio@gmail.com


Personal Patient
Prescriptions for
118328214338548928024
Previous
Next


Patient Prescription
Patient ID: 118328214338548928024
Patient Name: Majedur Rahman
Patient Gender: Male
Email Address: doctorpatientbio@gmail.com
Tap to view prescriptions


DisplayFileUtil
CANCER
COVID-19
DIABETES


DoctorFromPathologist
DIABETES
DoctorFromPathologist
disease DIABETES
UserType: pathologist
Id: 114014171048872762563
Name: Tomal Rahman
Email: majadrahman78@gmail.com
DoctorFromPathologist
Prescriptions for
114014171048872762563
Previous
Next
DoctorToPathologist
COVID-19

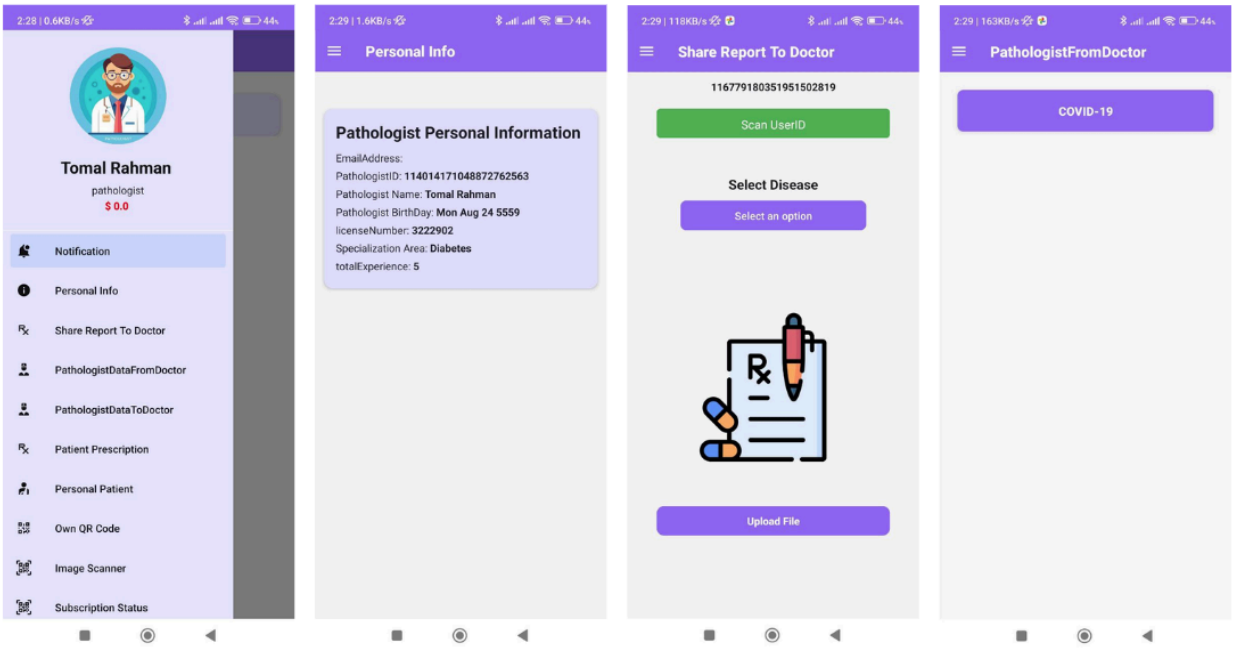

DoctorToPathologist
disease COVID-19
UserType: pathologist
Id: 114014171048872762563
Name: Tomal Rahman
Email: majadrahman78@gmail.com
DoctorToPathologist
Prescriptions for
114014171048872762563
Previous
Next
BiometricsAuth
Biometric Authentication
Inactive
Activate Biometrics
Own QR Code

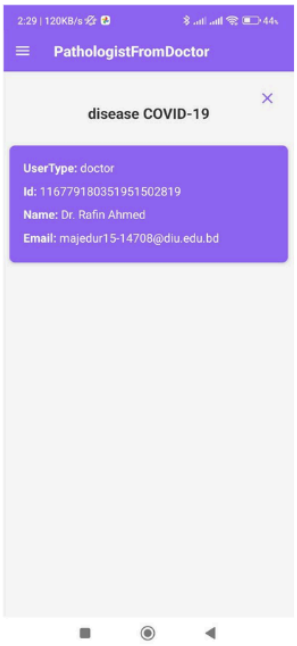
5.3 Implementation of Pathologist Profile

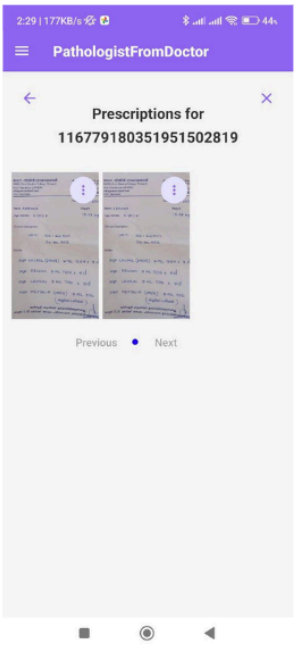
The Pathologist profile is created to provide both a secure and effective way to exchange diagnostics information between pathologists, doctors, and patients. This is a critical role to bridge accurate diagnosis, test report dissemination and lab data management. Available features are:

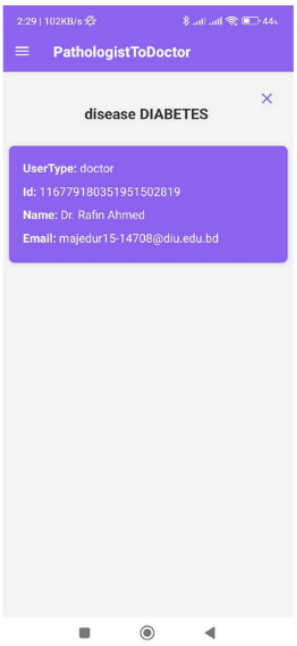
- **Notification** – Shows alerts when you have new data, doctor requests, and system updates.
- **Personal Info** – It displays basic information of pathologist like name, email, id, and their role.
- **Share Report To Doctor** – Enabling the pathologist to upload various lab test results or diagnostic reports for securely sharing with the concerned doctor.
- **PathologistDataFromDoctor** – Allows reading medical records, prescriptions and notes sent by doctors.
- **PathologistDataToDoctor** – Allows pathologists to send diagnosis files, lab results or any medical data to a doctor.
- **Patient Prescription** – Lists the prescription orders which are categorized with the patients in management.
- **Personal Patient** – Shows the list of patients of this pathologist for quick monitoring and access.
- **QR Code Own** – Generating an own QR code for safe identification and roll adapted access.
- **Image Scanner** – It can quickly scan & digitize your hand written or printed lab reports & upload them.

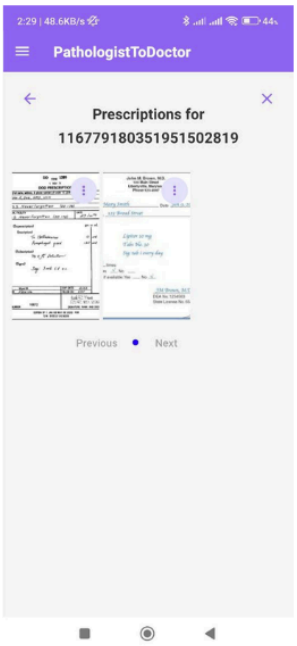
These capabilities enable pathologists to work seamlessly within the health care network while ensuring data privacy, traceability and patient consent.

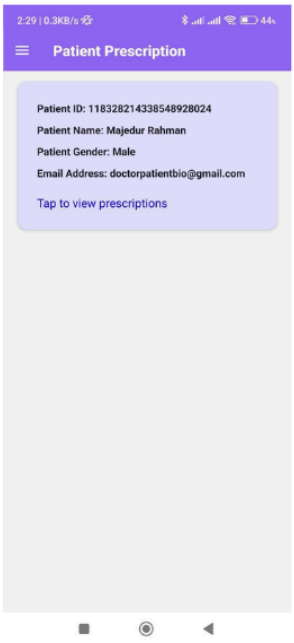


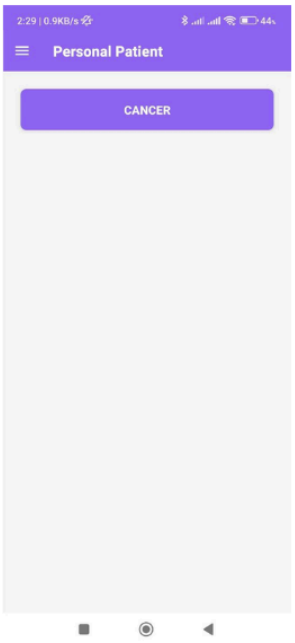

PathologistFromDoctor
disease COVID-19
UserType: doctor
Id: 116779180351951502819
Name: Dr. Rafin Ahmed
Email: majedur15-14708@diu.edu.bd

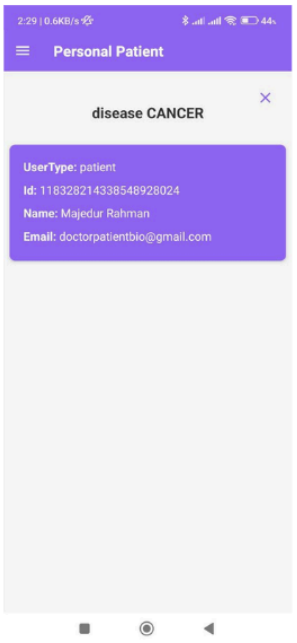

PathologistFromDoctor
Prescriptions for
116779180351951502819
Previous
Next

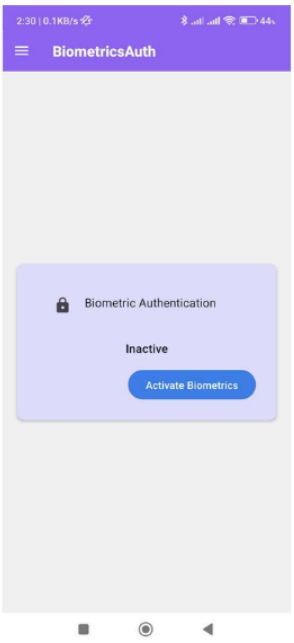

PathologistToDoctor
disease DIABETES
UserType: doctor
Id: 116779180351951502819
Name: Dr. Rafin Ahmed
Email: majedur15-14708@diu.edu.bd


PathologistToDoctor
Prescriptions for
116779180351951502819
Previous
Next


Patient Prescription
Patient ID: 118328214338548928024
Patient Name: Majedur Rahman
Patient Gender: Male
Email Address: doctorpatientbio@gmail.com
Tap to view prescriptions


Personal Patient
CANCER


Personal Patient
disease CANCER
UserType: patient
Id: 118328214338548928024
Name: Majedur Rahman
Email: doctorpatientbio@gmail.com

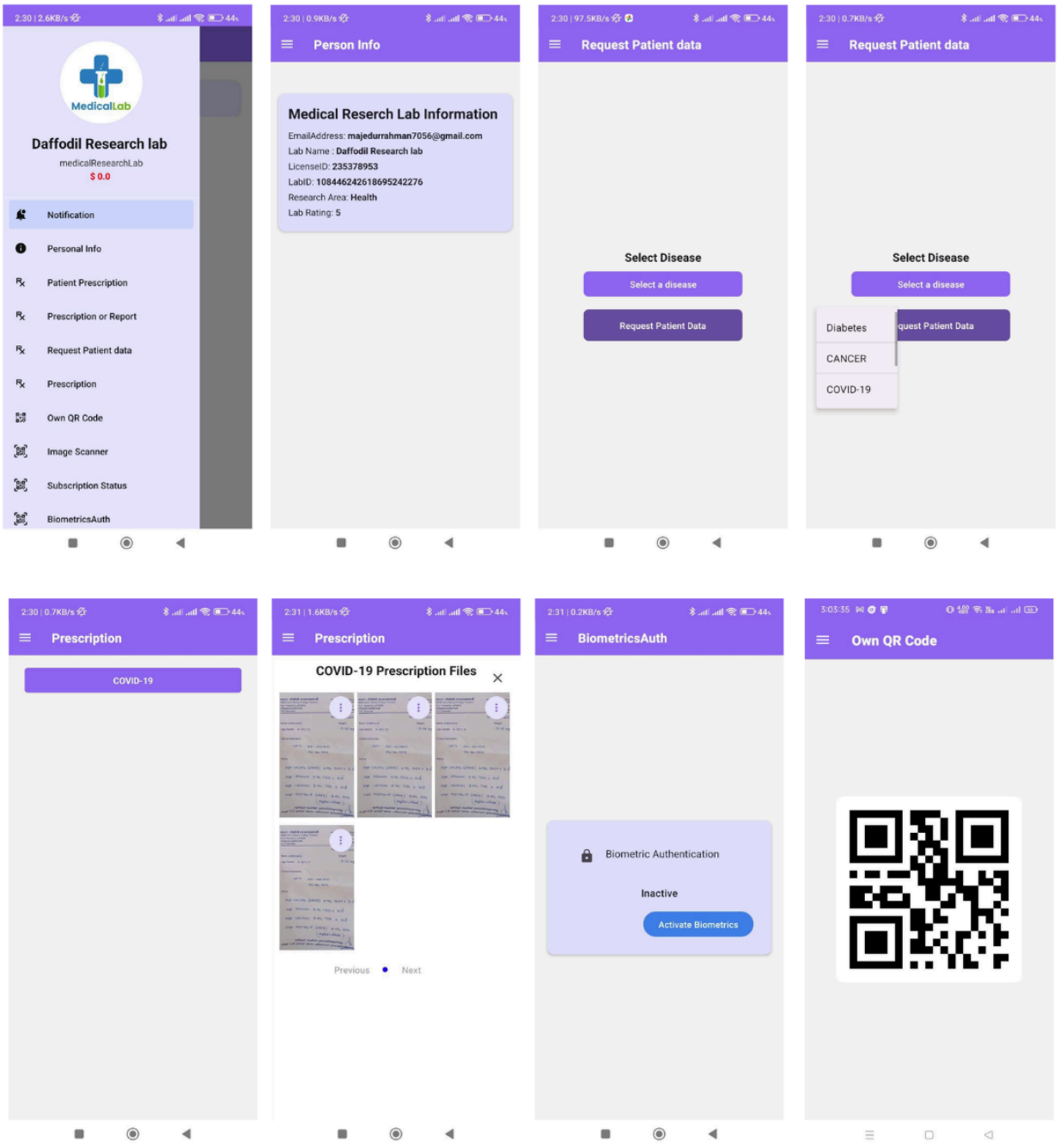

BiometricsAuth
Biometric Authentication
Inactive
Activate Biometrics

5.4 Implementation of Research Lab Profile

The authorization profile of the Medical Research Lab allows authorized labs to retrieve, request and handle patient records for research purpose enforcing strong privacy control. The interface is designed to keep transparency and security for authenticate and permission based access. The features that are being made available are:

- **Notification** – Pops an alert up about data access approval, system update or research interaction.
- **Contact Info** – Includes the name of the lab, address and credentials.
- **Patient Prescription** – Allows you to show the lab the prescriptions for a particular patient (after obtaining permission).
- **Report or Prescription** – It Process If drugs are prescribed Inform and reports upload and download for analysis or studies.
- **Request Patient Data** – Permits the lab to formally file a request for categorized patient data – needs patient/admin approval.
- **Prescriptions** – Displays the list of prescriptions transmitted or accessed by lab.
- **My QR Code** – Create a personal lab QR code for secure login and identity confirmation.
- **Image Scanner** – Scans hard copies of lab reports, documents or data for electronic storage.
- **Subscription Status** – Shows the current access of the lab, the subscription level and its expiration.
- **BiometricsAuth** – This gives you the opportunity to log in to a secure area by verifying with your fingerprint or face.

These capabilities allow labs to ethically participate in medical research all while meeting privacy standards.

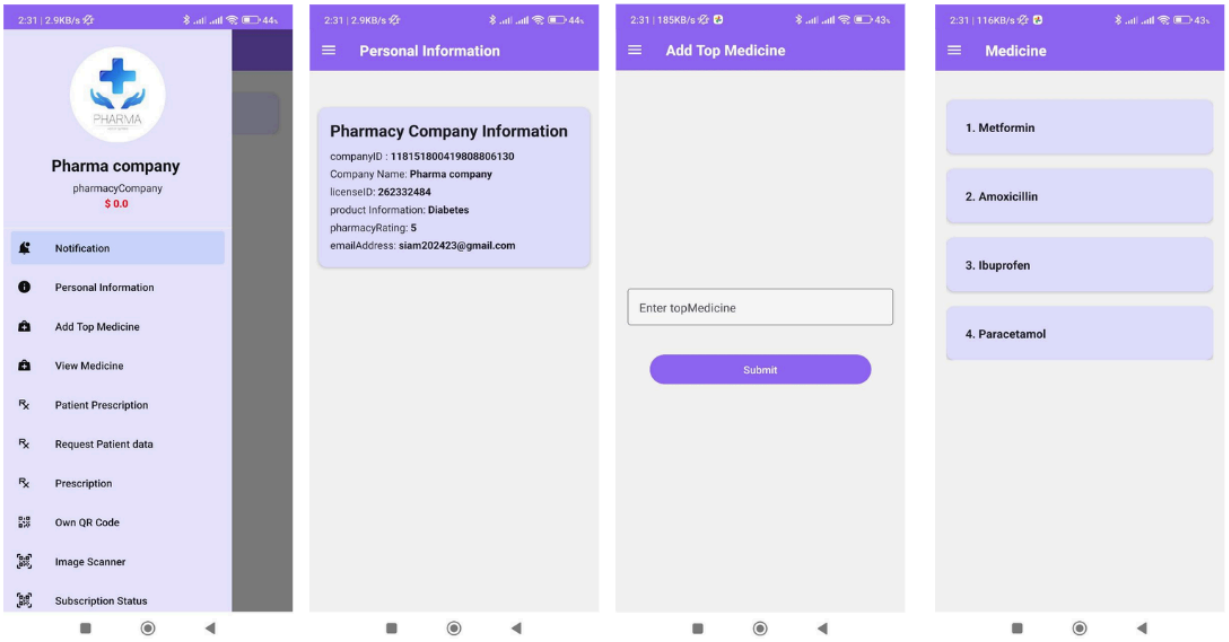


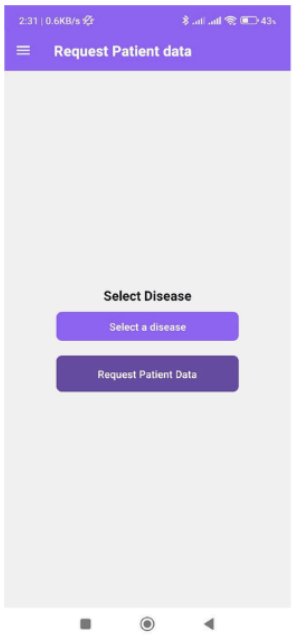
5.5 Implementation of Pharmacy Company Profile

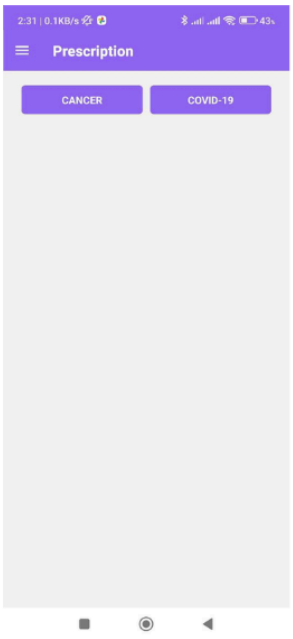
The Pharmaceutical Company Dashboard is designed for medication listing, prescription interacting, and securely asking for patient information. It focuses on permission-based content, data security and ease of use. The main features include:

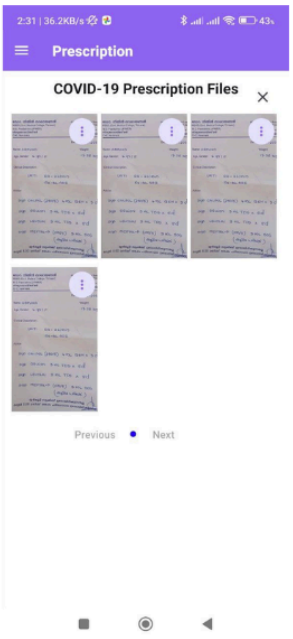
- **Notification** – A signal that there are messages, prescriptions or data strings to be approved.
- **Company information** – Indicates the credentials and registration information of the pharma company.
- **Top Medicine** – Provides the facility for the company to add, edit their top medicines.
- **View Medicine** – List down all the inserted medicine with edit and update option.
- **Patient Prescription** – Allows the company to see the prescriptions regarding their medicines (with consent).
- **Request Patient Data** – For looking to request categorised and anonymised patient data for research or development (Subject to approval).
- **Prescription** – Shows the list of prescriptions the company have access to / the company is affiliated with.
- **Custom QR Code** – Secure and scannable with all of your personal information.
- **Image Scanner** – Upload scanned documents, like printed prescriptions or test report.
- **Subscription Status** – Displays active permissions, the type of subscription, and renewal information.

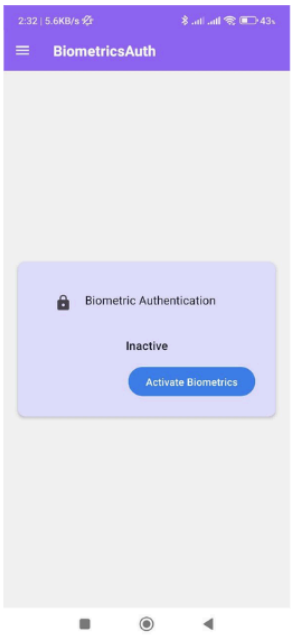
Pharmaceutical operations are made secure, efficient and in compliance with data-sharing protocols by this role-based panel.




Request Patient data
Select Disease
Select a disease
Request Patient Data


Prescription
CANCER
COVID-19


Prescription
COVID-19 Prescription Files
Previous
Next


BiometricsAuth
Biometric Authentication
Inactive
Activate Biometrics

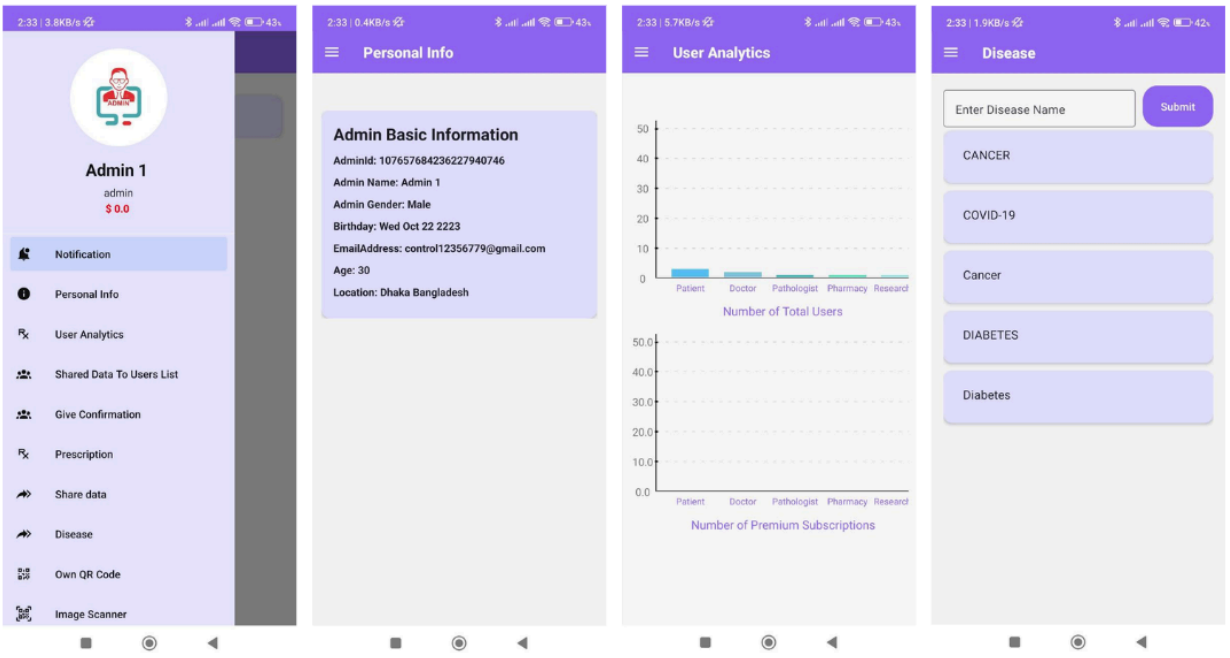

Own QR Code

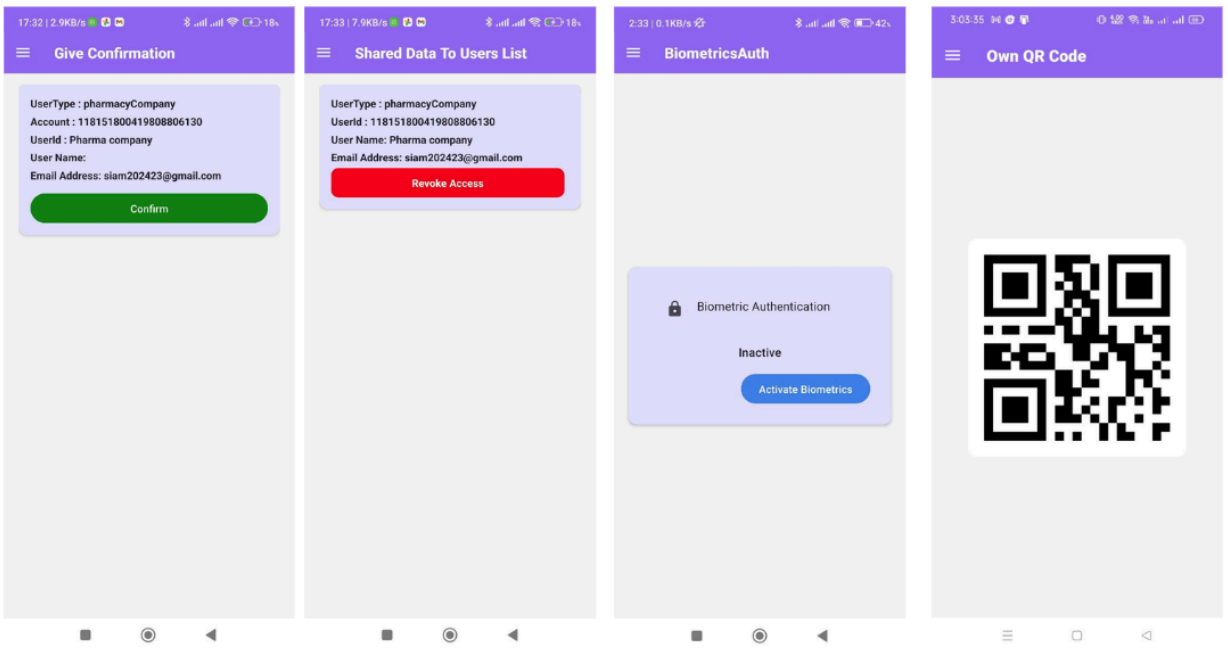
5.6 Implementation of Admin Profile

The full "Admin Panel" allows full control of the platform by the admin to monitor users' activity, validate the sharing of data, administer diseases configurations. It's meant to be a tool for good governance, transparency, and efficiency. The main features include:

- **Notification** – Show popup notifications such as system messages, pending requests, or updates that need administrator attention.
- **Personal Info** – Displays the user name and the role of the admin.
- **User Analytics** – Shows user interactions and platform usage stats.
- **Share Data To Users List** – See all sharing events from role-to-role available in the detail view (ex: from doctor to pathologist).
- **Give Confirmation** – Approve Or Decline Requests Almost with more than one admin confirmation necessary.
- **Prescription** – View and track all prescriptions given through the solution.
- **Share Data** – Admin can share the classified data with labs or pharma companies on the requested categories.
- **Disease** – Organize the different types/categories of disease (for tagging and filtering medical records).
- **Your QR Code** – You own the QR Code, your secure gateway to identity verification and controlled data access.
- **Image Scanner** – Import and maintain your scanned records or reports.

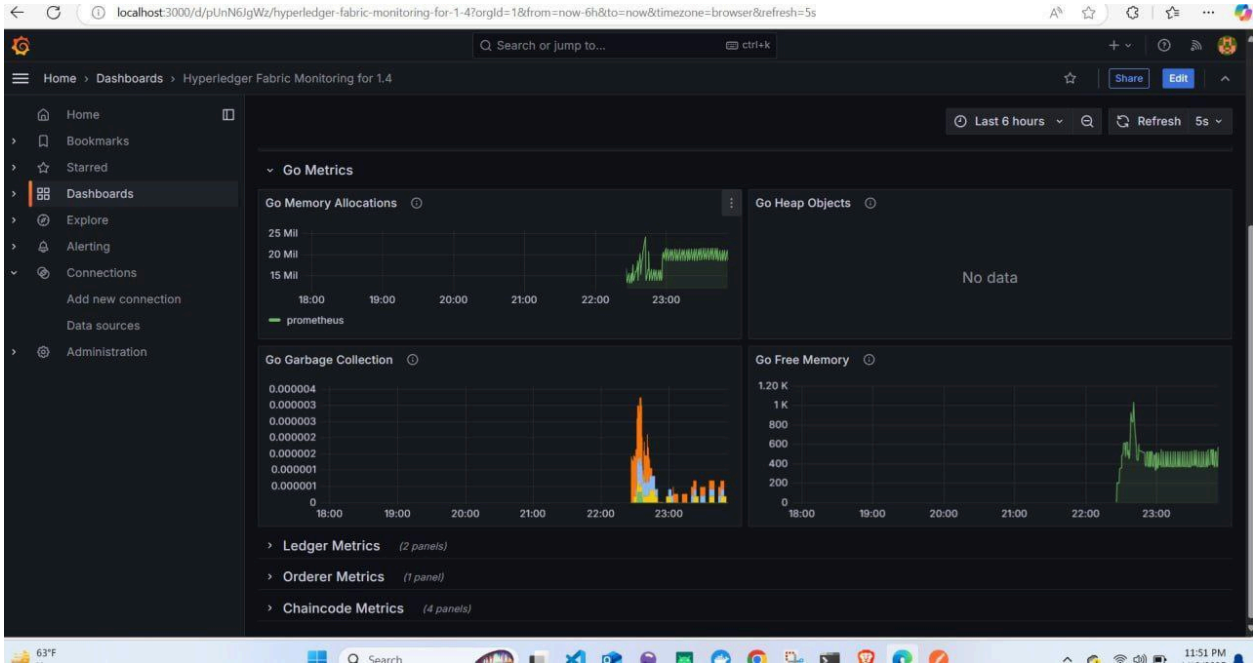
With this admin dashboard, you'll be able to manage everything in one place, keep your data secure, and your platform running smoothly.


Admin 1
admin
$ 0.0
Notification
Personal Info
User Analytics
Shared Data To Users List
Give Confirmation
Prescription
Share data
Disease
Own QR Code
Image Scanner
Personal Info
Admin Basic Information
AdminId: 107657684236227940746
Admin Name: Admin 1
Admin Gender: Male
Birthday: Wed Oct 22 2223
EmailAddress: control12356779@gmail.com
Age: 30
Location: Dhaka Bangladesh
User Analytics
Patient
Doctor
Pathologist
Pharmacy
Number of Total Users
Number of Premium Subscriptions
Disease
Enter Disease Name
Submit
CANCER
COVID-19
Cancer
DIABETES
Diabetes


Give Confirmation
UserType : pharmacyCompany
Account : 118151800419808806130
UserId : Pharma company
User Name:
Email Address: siam202423@gmail.com
Confirm
Shared Data To Users List
UserType : pharmacyCompany
UserId : 118151800419808806130
User Name: Pharma company
Email Address: siam202423@gmail.com
Revoke Access
BiometricsAuth
Biometric Authentication
Inactive
Activate Biometrics
Own QR Code

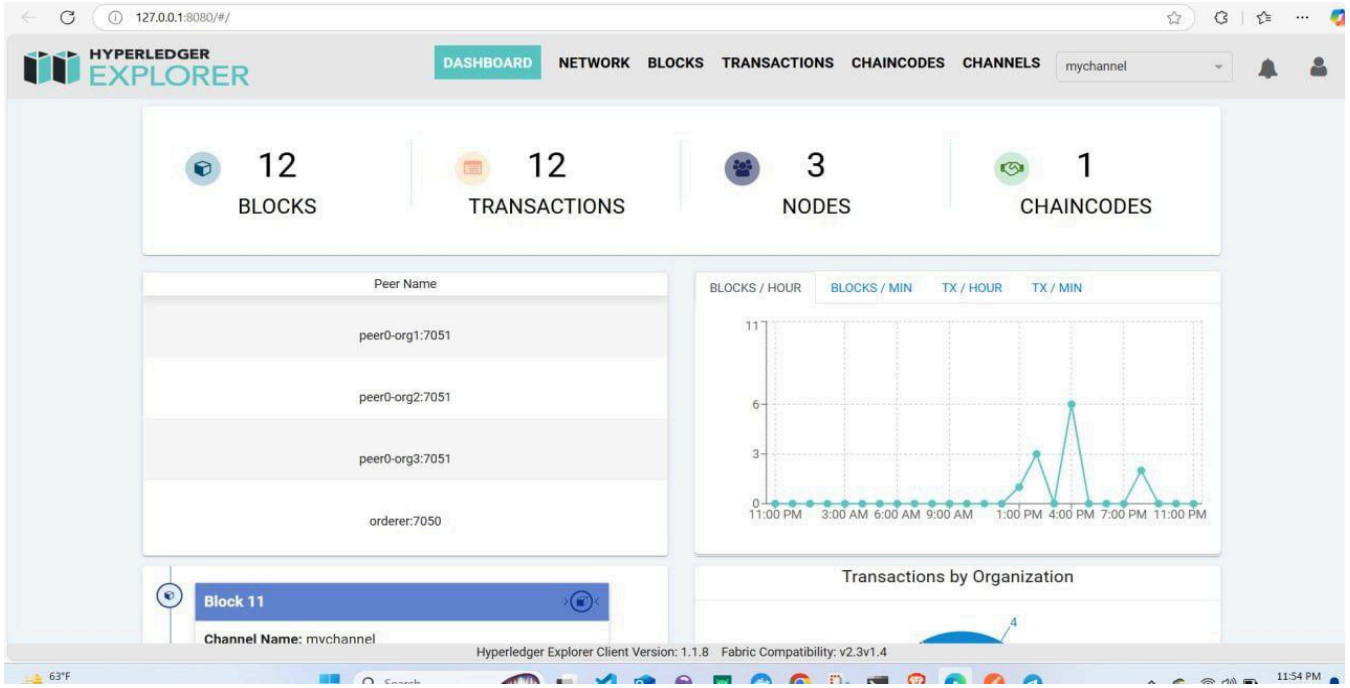
5.7 Implement of Grafana and Prometheus

Prometheus collects metrics; Grafana visualizes them. Together, they enable real-time monitoring and alerts. Ideal for system performance insights.



5.8 Implement of Hyperledger explorer

Hyperledger Explorer monitors Hyperledger Fabric blockchains, showing blocks, transactions, nodes, and chaincodes. Ideal for debugging and analytics.



5.9 Feature Testing

My project is a Decentralized Electronic Health Record (DEHR) storage platform that aims to empower every patient to store and access their medical records in complete privacy and security. It is critical to the platform that all roles are, ultimately, using features that are functionally complete, secure, and offer a good user experience. Below is a complete feature testing spreadsheet specifically for this project:

Test Case	Expected Input	Expected Output	Actual Input	Actual Output	Pass/Fail	Notes
Email Registration	Valid email address, password	Successful account creation and redirection to the dashboard	user@example.com, password123	Account created, redirected to dashboard	Pass	Test with valid email format, invalid emails
Google Registration	Google sign-in button click	Google account info should pre-fill registration details	Click Google login, valid Google account	Account created with Google info	Pass	Test with valid Google account, expired token
Biometric Authentication	Fingerprint/Face ID/Touch ID	Successful login and access to the platform	Fingerprint input successful	Login successful, accessed platform	Pass	Test across devices, different fingerprint data
Role-Based Account Creation	Role selection during registration (Patient)	Correct role assigned based on user input	Role selected: Patient	Account created with Patient role	Pass	Test with different roles (Patient, Doctor)
Login/Logout	Valid credentials for registered user	Successful login/logout, no session after logout	user@example.com, password123	Login successful, logged out successfully	Pass	Test session timeout, multi-device login
Data Upload and Storage	PDF, images, test results	Files uploaded to IPFS & Pinata, categorized correctly	Uploaded PDF, image of test results	Files stored, categorized by disease type	Pass	Test with multiple file types (PDFs, images)

QR Code Data Sharing (Patient)	Patient selects doctor to share data with	QR code generated, data shared securely with doctor	QR code generated for Doctor	Data shared successfully	Pass	Test sharing with Doctor, Pathologist, Admin
Profile Management	User updates name, bio, photo	Profile updated and changes saved	Name changed to "John Doe", bio updated	Profile updated, new details displayed	Pass	Test profile editing and photo upload
Notifications (Data Sharing)	Data sharing request sent to patient	Patient receives notification of request	Data sharing request from Doctor	Notification received successfully	Pass	Test with real-time notifications
Privacy & Security (Encryption)	Health data and credentials	Data is encrypted and stored securely	Test data encrypted using AES-256	Data stored in encrypted format	Pass	Test security scanning for vulnerabilities

Table 5.1 : Feature Tesing

My project ensures a secure, accessible, patient-friendly experience through rigorous testing of these features. Combining trust, transparency, and effective health data control makes for a pleasant experience for both patients and healthcare providers alike.

5.10 Test Schedule:

Test Phase Time
Testing plan create 1 Week
Unit testing During development time.
Component test During development time.
Testing user interfaces 1 Week
Performance testing 1 Week
Accessibility testing 1 Week

Table 5.2: Test Schedule

CHAPTER 6

SOCIAL, ENVIRONMENTAL, SUSTAINABILITY EFFECTS & COMPLEX ENGINEERING PROBLEM

6.1. Impact on Society

Transforming Healthcare Access

Patient Bio enables secure, real-time, 24/7 access to medical records, allowing patients and providers to manage healthcare more efficiently and collaboratively.

Greater Access to Healthcare

Traditional systems suffer from fragmented records, causing treatment delays. *Patient Bio* ensures instant access to history, test results, and prescriptions—improving care coordination and eliminating paperwork losses.

Empowering Patients

Patients gain full control over their health data. This autonomy enables second opinions, provider switching, and confident decision-making, independent of any single institution.

Accelerating Medical Innovation

Researchers can securely access anonymized, consent-based data, helping identify disease patterns and develop treatments without compromising patient privacy.

Fostering Interconnected Healthcare

The platform supports collaboration among doctors, pathologists, researchers, and patients—facilitating accurate diagnoses and personalized treatment plans through secure data exchange.

Data Protection and Fraud Prevention

Using Hyperledger Fabric, all medical data is immutable and tamper-proof. This strengthens trust, combats fraud, and prevents identity theft and fake prescriptions.

6.2. Impact on the Environment

Reducing Paper Use and CO_2 Emissions

By digitizing medical records and prescriptions via blockchain and IPFS, *Patient Bio* reduces paper dependency, lowering printing costs and carbon emissions, and supporting forest conservation.

Optimizing Medical Resources

With complete digital histories, *Patient Bio* minimizes unnecessary tests and procedures—maximizing lab, equipment, and medicine utilization efficiently.

Energy-Efficient Blockchain

Unlike power-intensive public blockchains, my project uses Hyperledger Fabric, a low-energy, private blockchain ideal for sustainable healthcare infrastructure.

6.3. Ethical Considerations

- **Patient Autonomy:** Patients fully own and control their data.
- **Privacy & Security:** Data is protected with end-to-end encryption and stored via IPFS.
- **Consensual Access:** Only authorized parties can access data with patient consent.
- **Fraud Prevention:** Blockchain ensures tamper-proof records.
- **Equity & Inclusion:** Promotes fair access to healthcare and data protection.
- **Regulatory Compliance:** Adheres to HIPAA, GDPR, and global medical ethics standards.

6.4. Sustainability Plan

Technological Sustainability

Built on **Hyperledger Fabric** (energy-efficient), **Docker**, **Kubernetes**, and **IPFS** to support scalable, low-resource digital infrastructure.

Economic Sustainability

Flexible subscription plans, cost-effective operations, and strategic partnerships drive long-term growth.

Operational Sustainability

Minimizes paper and energy use; integrates AI for performance optimization and resource efficiency.

Social Sustainability

Upholds ethical data use, promotes health equity, and supports responsible research collaboration

6.5. . Complex Engineering Problem

6.5.1 Complex Problem Solving

This section outlines the alignment of our research project with relevant problem-solving categories.

EP1 Dept of Knowledge	EP2 Range Of Conflicting Requirements	EP3 Depth of Analysis	EP4 Familiarity of Issues	EP5 Extent of Applicable Codes	EP6 Extent Of Stake-holder Involvement	EP7 Interdependence
✔	✔	✔	✔	✔	✔	✔

Table 6.5.1: Mapping with complex problem solving.

Addressing Complex Engineering Problems (EP):

SN	EP definition	Attachments	Justification(with knowledge profit)
1	EP1: Depth of Knowledge Required	Yes	The project applies blockchain, IPFS, Docker, Kubernetes, biometric auth, and smart contracts—spanning K3–K8 knowledge areas—showcasing deep integration of diverse domains.
2	EP2: Range of Conflicting Requirements	Yes	Balances privacy, accessibility, regulatory compliance, and technical complexity. Users must control data securely while enabling authorized

			access.
3	EP3: Depth of Analysis Required	Yes	Implementing multi signature wallets and role-based access via smart contracts required in-depth threat analysis and security model validation.
4	EP4: Familiarity of Issues	Yes	Addresses challenges in EHR interoperability, data redundancy, ethical sharing, and scalability, grounded in real-world healthcare concerns.
5	EP5 Extent of Applicable Codes	Yes	Follows HIPAA/GDPR-compliant design and data-handling practices, ensuring legal data protection standards are met.
6	EP6: Extent of Stakeholders Involved and Conflicting Requirements	Yes	Involves patients, doctors, researchers, and pathologists; built through active engagement and validation loops with all stakeholder groups.
7	EP7: Interdependence	Yes	Integrates edge-cloud computing, blockchain, components rely on each other to maintain trust, scalability, and real-time accessibility. previous one.

Table 6.5.2: Addressing Complex Engineering Problems.

Mapping with Knowledge Profile for EP1

K3 Engineering Fundamentals	K4 Specialist Knowledge	K5 Engineering Design	K6 Engineering Practice	K8 Research Literature
✔	✔	✔	✔	✔

6.5.3: designed to map the EP1 to the Knowledge Profile.

Justification:

- The system applies blockchain, encryption, and biometric identification, reflecting solid engineering fundamentals (K3) and specialist knowledge (K4) in cryptography, smart contracts, and decentralized identity management.

- It employs engineering design (K5) to create a scalable architecture combining IPFS, Docker, and multi-layer encryption, while ensuring real-time data control for patients and role-based access for healthcare stakeholders.

- Through engineering practice (K6), the project integrates tools like Docker, Kubernetes, and smart contract development (e.g., Solidity) for deployment and data governance across distributed nodes.

- It uses research literature (K8), referring to state-of-the-art EHR systems, privacy-preserving ML models, and decentralized storage research, to innovate over traditional hospital-centric systems.

6.5.2. Engineering Activities

This section provides a detailed discussion of the engineering activities involved in my project.

EA1 Range of resources	EA2 Level of Interaction	EA3 Innovation	EA4 Consequences for society and environment	EA5 Familiarity
✔	✔	✔	✔	✔

Table 6.5.4: Mapping with complex engineering activities.

Addressing Engineering Activities (EA):

Engineering Activity	Attainment	Justification
EA1: Range of Resources	**Yes**	Utilizes decentralized storage (IPFS), blockchain platforms, smart contract frameworks, biometric authentication tools, and containerized deployment (Docker, Kubernetes), reflecting a wide range of modern computational and cryptographic resources.
EA2: Level of Interaction	**Yes**	Involves multi-stakeholder interaction between patients, healthcare providers, and data systems; integrates front-end interfaces, secure APIs, and backend blockchain logic, enabling real-time, role-based data exchange.
EA3: Innovation	**Yes**	Implements a novel combination of blockchain, smart contracts, IPFS, and biometric security in a healthcare context to provide patient-owned EHR systems, enabling a trustless, decentralized alternative to traditional systems.
EA4: Consequences for Society and Environment	**Yes**	Enhances patient autonomy and data privacy, with potential to revolutionize digital healthcare delivery; supports cloud-native deployment and efficient resource usage, contributing to environmental sustainability.

EA5: Familiarity	**Yes**	Builds on existing technologies (e.g., blockchain, EHR standards, Docker) and applies them innovatively within the healthcare domain to address well-known data security and interoperability challenges.

Table 6.5.5: Addressing Engineering Activities.

CHAPTER 7
CONCLUSION AND FUTURE SCOPE

7.1CONCLUSION

Patient Bio is a world-leading health data management ecosystem developed on an enterprise-grade blockchain solution in which patients maintain complete ownership of their medical records. With the help of decentralized storage by IPFS and Pinata, the platform ensures indestructible database data, secured sharing, and access for verified role-based data: patients, doctors, pathologists, pharmacies, research labs.
Security is a focus with the platform, supporting two-factor authentication, including Google and Apple Touch ID or Face ID. The network is built on permissioned blockchain Hyperledger Fabric, which provides energy efficiency, scalability, and privacy compared with public chains. Everything you do can be traced to a smart contract and multisignature wallet, which guarantees that all data-sharing transactions are open and verified.
Patient Bio also performs well in terms of its technical implementation – employing Docker, Kubernetes, and NFS to guarantee availability and easy deployment at cloud/edge. The frontend, made in React Native, offers a contemporary responsive feel with dark/light theme support and subscription options for premium features and multi language that I consider very important.
Besides the tech stack, Patient Bio provides immense social and environmental impact as well by creating paperless inefficiencies, preventing medical fraud, reducing administrative overhead, and making it possible for secure and ethical sharing of anonymized data for research purposes. Both health equity and environmental sustainability were served in its design.
This project will provide the bedrock for secure, decentralized, patient-owned health data, paving the way for a more efficient, transparent, and patient-centered future in health tech.

7.2FUTURE SCOPE

The long-term vision of the Patient Bio platform includes a scalable solution for hospitals, clinics, and research institutions that can serve patients and clinical investigations globally irrespective of the healthcare regulation context. It will include predictive analytics based on AI for early disease discovery, risk assessment and personalized treatment to improve preventive medicine. The real-time tracking of disease outbreaks based on anonymized patient data is expected to help in quick public health responds. Interoperability with the EHRs in use today will facilitate rapid adoption and concise information sharing. That kind of granular data access control will mean patients can indicate what data is shared with whom for how long. These dynamic consent mechanisms will allow patient permissions to be updated in real time, laying the foundation for ethical and adaptable data sharing. DIDs will also provide a more secure and patient centric approach toward managing their digital health identity. Offline capabilities will enable use in remote areas, and compatibility with health wearables will enable real-time tracking of vitals for ongoing observation. The platform will further develop health data tokenization, with patients receiving rewards for sharing anonymized data to research or pharma establishments. Partnership with public health authorities will lead national scale digital health transformation.

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