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LALITPUR ENGINEERING COLLEGE

Kholcha Pokhari, Chakupat, Lalitpur

A PROPOSAL FOR THE FINAL YEAR PROJECT ON

"MSC System: A Blockchain Based Health Record Management System"

[CT 707]

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SUBMITTED TO:

Department of Computer Engineering

LALITPUR, NEPAL

2022

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Submitted as a partial fulfillment of requirement of the curriculum of Bachelor of Computer Engineering under TU

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26th May, 2022

ABSTRACT

Nowadays, each aspect of everyday human lifestyle has been digitized up to a certain extent to promote convenience and sustainability. The proposed project titled, 'MSC System: A Blockchain Based Health Record Management System' is a digital health record storage application which seeks to digitize health sector which has remained technologically primitive compared to other sectors. The proposed system aims to make use of blockchain technology to store health records of the patient. Blockchain is a distributed database shared among the nodes of the computer system which maintains a decentralized record of information. The health record entered to a block chain is immutable i.e. once entered the data is irreversible. It makes the health record permanent and viewable to anyone who has access to the data.

The proposed system will have three entities: patient, issuer and manager. Manager applies for the issuer status for the hospital. After being verified, manager registers doctors working in the hospital. Both patient and issuer need to verify their identity to register into the application. The issuer can view and enter the health record of a patient with the patient number using their health card. Patient numbers are assigned by the system to uniquely identify a patient. The health record added would be visible to the patient and verified doctors through the mobile application as well.

The users are not obliged to carry a copy of physical document everywhere as the whole document will be stored in the application itself. Moreover, the user will not misplace important medical documents.

Keywords*: Blockchain, Health Card, Decentralized Records*

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LIST OF ABBREVIATIONS

API	Application Programming Interfaces
BSD	Berkeley Software Distribution
CMS	Content Management System
CVS	Concurrent Version System
DFD	Data Flow Diagram
DLT	Distributed Ledger Technology
DOM	Document Object Model
iOS	iPhone Operating System
MSC	Mero Swasthya Card
MTV	Model Template View
MVC	Multi-Version Concurrency Control
NFC	Near-Field Communication
NMC	Nepal Medical Commission
PEP	Python Enhancement Proposal
QR	Quick Response
SDK	Software Development Kit
SQL	Structure Query Language
URL	Uniform Resource Locator

CHAPTER 1: INTRODUCTION

1.1 Background

Health record is an information that describes every part of a person's heath including their past and present medical condition, diseases as well as its treatment. For a doctor to treat a patient with the utmost care, it is essential for the patient to maintain their health record. As of today, health records has largely been maintained in physical documents. These documents are more likely to be lost or misplaced. It can also be very tedious to maintain and carry around documents to various hospitals every time a person needs any medical diagnosis. Instead of carrying such paper documents with us, we could digitize it and make it easily available through mobile application as it would provide both convenience and safety.

In this project, a simple user-friendly application and a web application is developed through which we can easily record and share health records about us to the required professionals. This will mitigate the inconvenience of carrying the medical documents and also ensures safety. Patient's health records are stored in blockchain as it makes the information immutable. This prevents loss of information. Patient will have a health card which they can share with the doctor and the doctor can access the medical records.

1.2 Problem Statement

Comprehensive and accurate health records helps healthcare professionals treat their patients to the best of their ability. Every single detail is important to diagnose a patient and treat them accordingly. But carrying important medical documents around can be inconvenient. There is a possibility that these documents will be lost or misplaced. Health records also provide clinical data for tracking and assessing the quality of healthcare.

But carrying physical medical documents can be risky. Medical documents can be lost or misplaced. It can also be tedious to carry medical documents to the hospital.

Thus, to tackle all said problems, instead of carrying paper documents with us, if we digitize the information by storing it in the blockchain and make it easily available through a single health card, it will provide both convenience and safety.

1.3 Scope

The proposed project can help patients to carry their whole medical history in the palm of their hands, i.e. a digital card, which is more convenient and safe to use than the traditional paper records. Patients are not required to start looking for their past medical records which they took several years ago. Even in an unfortunate case of accidents, medical professionals can easily access the medical history of the victim and give medicines accordingly as they might have allergies or any preexisting conditions. Also, the health card contains the emergency contact which is required in such conditions. This project helps the doctors to diagnose the patients accurately as even the smallest details of the patients medical history is stored.

1.4 Objective

- To provide a platform to store medical documents in blockchain and share it to medical professionals using health card.

CHAPTER 2: LITERATURE REVIEW

In the medical field, efficiency should be one of the keywords for what is happening.We all know about the amazing breakthroughs in the medical industry and the stunning advancements made in the healthcare ecosystem. Everyone also knows that good health costs money, and a lot of it. In this sector, however, we have to deal with the most sensitive data we have – our medical record. We offer a secure smart card solution that allows health networks to cut costs and improve patient healthcare while securing our medical records.

2.1 Existing

Ayushman Bharat Yojana:

Ayushman Bharat Yojana, is a scheme that aims to help the economically weaker section of society who need health care facilities. [1] This plans to make secondary and tertiary healthcare completely cashless for the underprivileged section of society. The programme is part of the Indian government's National Health Policy and is means-tested. There has been misuse of the Ayushman Bharat scheme by private hospitals through submission of fake medical bills. Under the Scheme, surgeries have been claimed to be performed on persons who had been discharged long ago and dialysis has been shown as performed at hospitals not having kidney transplant facility.

Smart Health Cards:

Smart health cards are digital versions of your clinical information, such as vaccination history or test results. They allow you to keep a copy of your records on hand and share this information with others if you choose. Smart health cards can be imported into CommonHealth, so you can easily store them and your other health records all in one place.

2.2 Proposed

In this proposed project, a representative of a hospital will be able to apply for the issuer status by sending certain hospital documents such as hospital name, address, registration number, and representative's email and phone number. After manual verification, the representative will receive login information to the website. The representative will then be able to register doctors working in their hospital, which will be verified through their NMC number. Their details will be shown in the website after they are verified as it is public knowledge.

The doctors will be able to login to the website and/or a mobile app through which they can enter the patient number using a NFC card. All medical history of the patient can be viewed or a new record can be issued which is stored in a blockchain.

Finally, the patient can register and apply for the NFC card with Nagrikta card, emergency contact, phone number, email and certain other informations. They will be able to view their own records through the mobile app as well.

CHAPTER 3: FEASIBILITY STUDY

3.1 Economically Feasibility

Since the proposed system has a web application and a mobile application supported on both Android and iOS, we will be using free and open-source cross platform software development tools such as Flutter, Django, PostgreSQL and ReactJs. The only expense in this system will be the NFC card, which is affordable and easy to obtain. The card will be offered to the patients through which some benefit can also be obtained. So it's clear that our project is economically feasible.

3.2 Operational Feasibility

Operational feasibility is based on issues such as manager support, required training, workforce reduction, and adverse effects to users and customers. Since the proposed system is interactive, the user doesn't need any depth knowledge about the mobile app nor the web app to run. Its UI is user friendly.The NFC card is also very easy to use and you just tap it on the device and all the records of the patient is shown. This app doesn't require much technical support to maintain it as well. So it is feasible in operation.

3.3 Technical Feasibility

There are variety of technologies available for web development. For frontend development, we have React Native, Kivy, Flutter as cross platform frameworks. For backend development, we have Django, Node.js, Php. We have used Flutter and ReactJs for frontend and Django for backend development which are open-source. All the technologies used in our application are backed by big companies and have a huge community around it. So, it is always easy to get any technical support. So, the project is technically feasible.

CHAPTER 4: METHODOLOGY

4.1 Software Development Life Cycle

For the study of research methods, or, more formally, ‘a contextual framework' for research of this project, spiral model was chosen among all others as it enables gradual releases and refinement of a product through each phase of the spiral as well as the ability to build prototypes at each phase. Spiral model is one of the most important Software Development Life Cycle models, which provides support for Risk Handling**.** It has four phases: Planning, Design, Construct and Evaluation. A software project repeatedly passes through these phases in iterations (called Spirals in this model) as shown in the figure below. The Radius of the spiral at any point represents the expenses (cost) of the project so far, and the angular dimension represents the progress made so far in the current phase. In each phase of the Spiral Model, the features of the product dated and analyzed, and the risks at that point in time are identified and are resolved through prototyping.

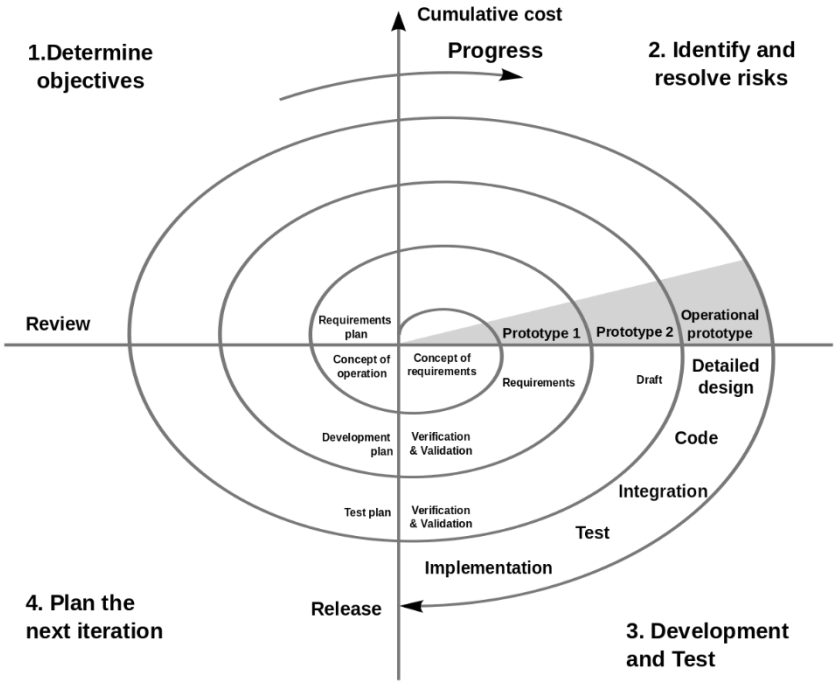

Figure 1: Spiral Modal

- **Planning Phase:**

  Requirements are gathered from the customers and the objectives are identified, elaborated, and analyzed at the start of every phase. Then alternative solutions possible for the phase are proposed in this quadrant.

- **Risk Analysis Phase:**

  During the second quadrant, all the possible solutions are evaluated to select the best possible solution. Then the risks associated with that solution are identified and the risks are resolved using the best possible strategy. At the end of this quadrant, the Prototype is built for the best possible solution.

- **Development and Testing Phase:**

  During the third quadrant, the identified features are developed and verified through testing. At the end of the third quadrant, the next version of the software is available.

- **Evaluation and Planning of next Phase:**

  In the fourth quadrant, the Customers evaluate the so far developed version of the software. In the end, if the Customers are satisfied with the software, then, it is released, else, planning for the next phase is started.

4.2 System Development Tools

Blockchain:

A blockchain is essentially a digital ledger of transaction that is duplicated and distributed across the entire network of computer system of the blockchain. Each block in the chain contains a number of transaction, and every time a new transaction occurs on the blockchain, a record of that transaction is added to every participant's ledger. [2]The decentralized database managed by multiple participants is known as Distributed Ledger Technology (DLT). Blockchain is a type of DLT in which transactions are recorded with an immutable cryptographic signature called a hash.

Solidity:

Solidity is a programming language used by blockchain developers. It's one of the more popular programming languages used by developers because it works on the Ethereum Virtual Machine. C++, Python, and JavaScript are some languages that influenced Solidity, which is used to write smart contracts for Ethereum dApps. [3] The reason we like it so much is that it doesn't just work on the Ethereum Virtual Machine, but is designed with it in mind. It's a relatively young language that is constantly evolving and the team behind its development releases a new minor version every two weeks, and two major releases every year. Users like Laracle's team of blockchain developers are also encouraged to help with the development so that Solidity grows to suit our needs.

Truffle:

Truffle is a development environment and testing framework for Ethereum-based decentralised applications. It's a blockchain framework that comes with a vast library of custom deployments for writing smart contracts and other aspects of blockchain development. [3] With Truffle, we can inject smart contracts into web apps and develop front-end dApps as well. Truffle's testing framework can run automated tests written in Javascript, Typescript, and Solidity.

Ganache:

We cannot edit smart contracts once they go live on Ethereum. Hence, developers carefully test their apps using programmes like Ganache from the Truffle Suite of blockchain development tools. Ganache is a local memory blockchain used for development and testing. [3] The Ethereum blockchain created using Ganache simulates all the features and adds accounts with test Ether tokens. One of Ganache's key features is that we can get all the benefits of testing your dApp on the main Ethereum chain without incurring gas fees. Ganache allows us to take full control of the test blockchain we create with tools like the block explorer, advanced mining controls, and blockchain log.

React.js:

ReactJS is a declarative, efficient, and flexible JavaScript library for building reusable user inferface. [4] It is an open-source, component-based front end library which is responsible only for the view layer of the application. It was initially developed and maintained by Facebook and later used in its products like WhatsApp & Instagram. The main objective of ReactJS is to develop User Interfaces (UI) that improves the speed of the apps. It uses virtual DOM (JavaScript object), which improves the performance of the app. The JavaScript virtual DOM is faster than the regular DOM. We can use ReactJS on the client and server-side as well as with other frameworks. It uses component and data patterns that improve readability and helps to maintain larger apps.

Python:

Python is a high-level general purpose programming language which is easy to learn but has a lot of impacts in the software engineering field. It has efficient high-level data structures and object-oriented programming, which helps to emphasize code readability for small and large-scale projects. Python strives for a simpler, less-cluttered syntax and grammar while giving developers a choice in their coding methodology. It was designed to be highly extensible (with modules) which has made it particularly popular as a means of adding programmable interfaces to existing applications. The language's core philosophy is summarized in the document "The Zen of Python PEP 20". [5]

Flutter:

Flutter apps are written in the Dart language and make use of many of the language's more advanced features. While writing and debugging an app, Flutter uses Just in Time compilation, allowing for "hot reload", with which modifications to source files can be injected into a running application. Flutter's engine, written primarily in C++, provides low-level rendering support using Google's Skia graphics library. Additionally, it interfaces with platform-specific SDKs such as those provided by Android and iOS. It implements Flutter's core libraries, including animation and graphics, file and network I/O, accessibility support, plugin architecture, and a Dart runtime and compile toolchain. [6]

Django:

Django is a high-level Python-based free and open-source web framework that follows the model–template–views (MTV) architectural pattern and encourages rapid development and clean, pragmatic design. Django was designed to help developers take applications from concept to completion as quickly as possible while being reassuringly secure and exceedingly scalable. Django's configuration system allows third party code to be plugged into a regular project, provided that it follows the reusable app conventions. [7]

PostgreSQL:

PostgreSQL features transactions with Atomicity, Consistency, Isolation, Durability (ACID) properties, automatically updatable views, materialized views, triggers, foreign keys, and stored procedures. It is the default database for macOS Server and is also available for Windows, Linux, FreeBSD, and OpenBSD. PostgreSQL includes built-in synchronous replication that ensures that, for each write transaction, the master waits until at least one replica node has written the data to its transaction log. [8]

Git/GitHub

Git is a free and open-source distributed version control system designed to handle everything from small to very large projects with speed and efficiency. Git also makes collaboration easier, allowing changes by multiple people to all be merged into one source. [9] Git is software that runs locally. Your files and their history are

stored on your computer. You can also use online hosts (such as GitHub) to store a copy of the files and their revision history. Having a centrally located place where you can upload your changes and download changes from others, enable you to collaborate more easily with other developers. Git can automatically merge the changes, so two people can even work on different parts of the same file and later merge those changes without losing each other's work.

Jira

Jira is a tool used for bug tracking, issue tracking and product management. [10]According to Atlassian, Jira is used for issue tracking and project management by over 180,000 customers in 190 countries. [11]Some of the organizations that have used Jira at some point in time for bug-tracking and project management include Fedora commons, Hibernate, and the Apache Software Foundation, which uses both Jira and Bugzilla. Jira includes tools allowing migration from competitor Bugzilla. Jira integrates with source control programs such as clear case, concurrent version system (CVS), Git, Mercurial, Perforce, subversion, and Team Foundation Server.

CHAPTER 5: SYSTEM DESIGN AND ARCHITECTURE

5.1 System Overview:

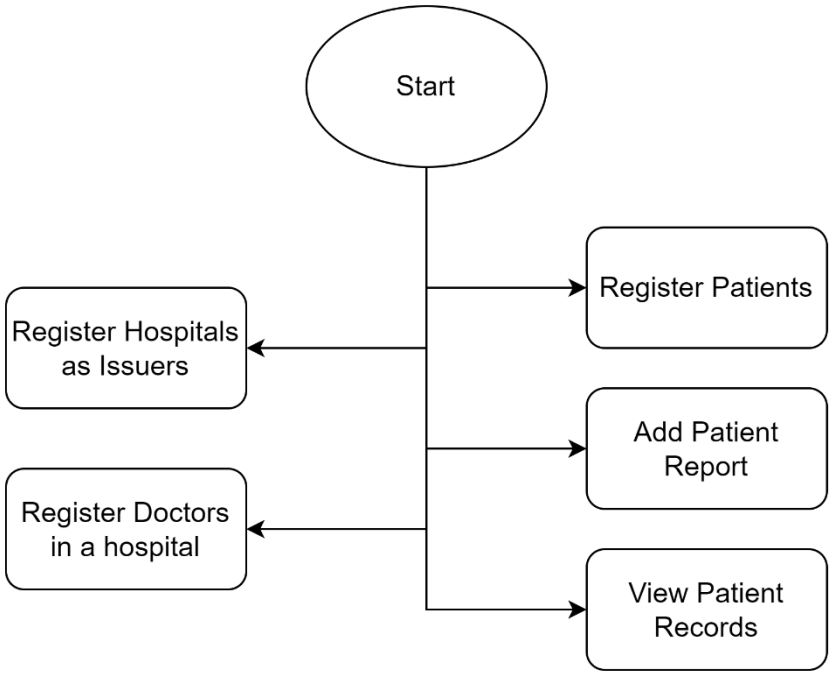

Figure 2: Block Diagram of System

5.2 Use Case Diagram:

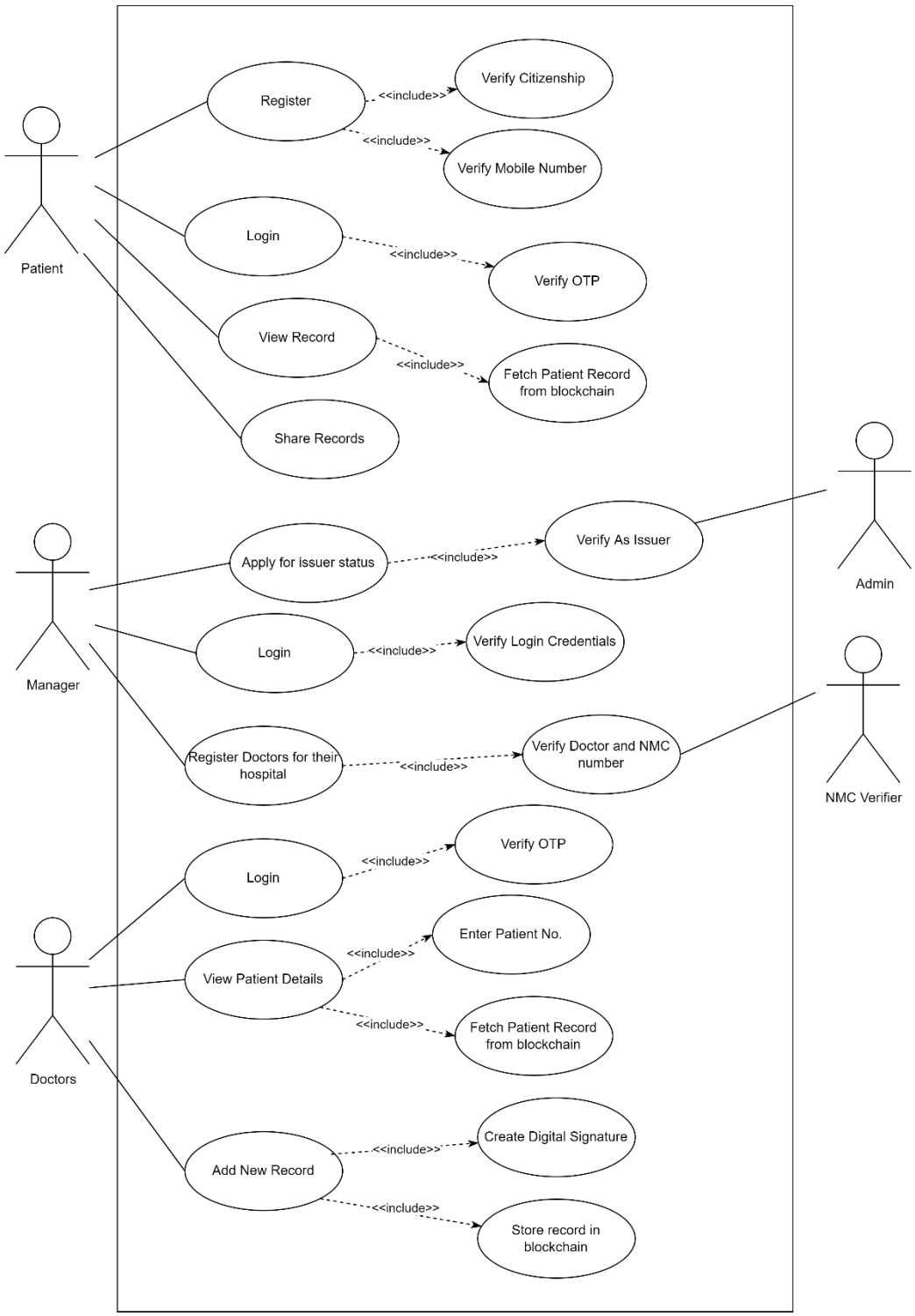

Figure 3: Use Case Diagram

5.3 Data Flow Diagrams:

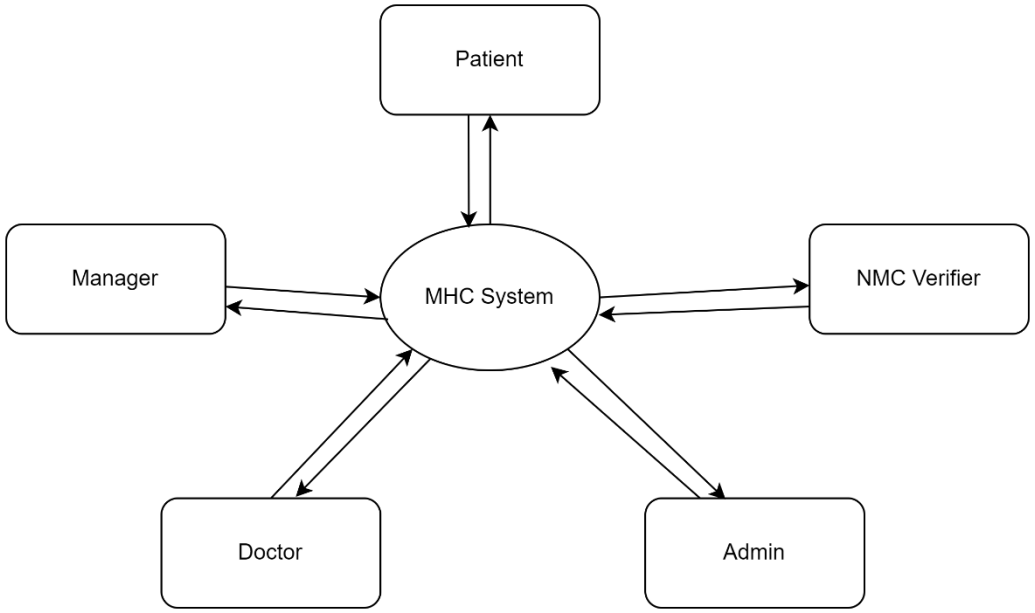

Figure 4: Level 0 DFD

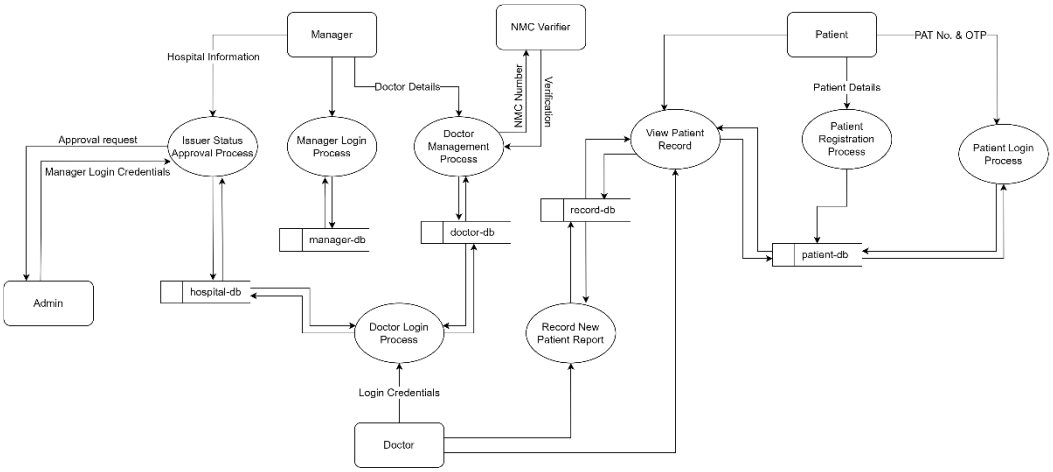

Figure 5: Level 1 DFD

5.4 Activity Diagram:

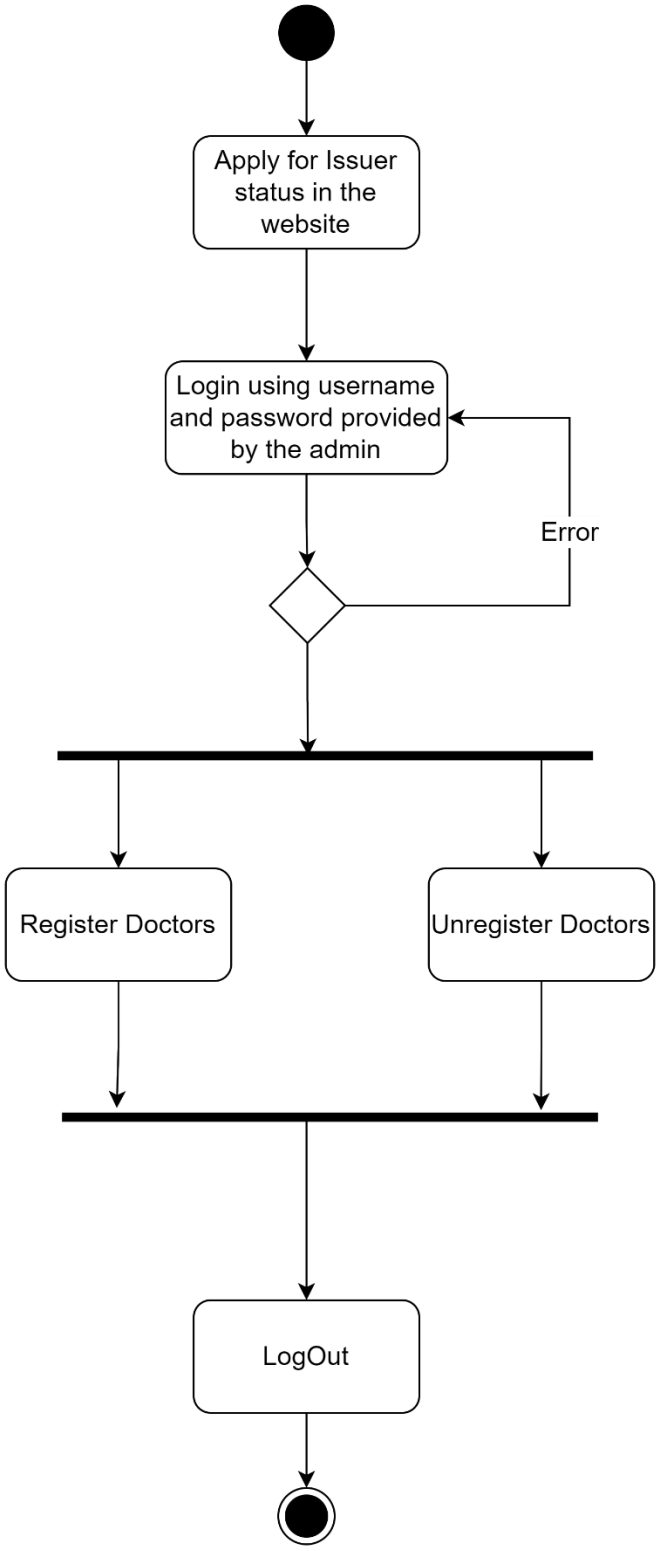

Figure 6: Activity Diagram (Managers Perspective)

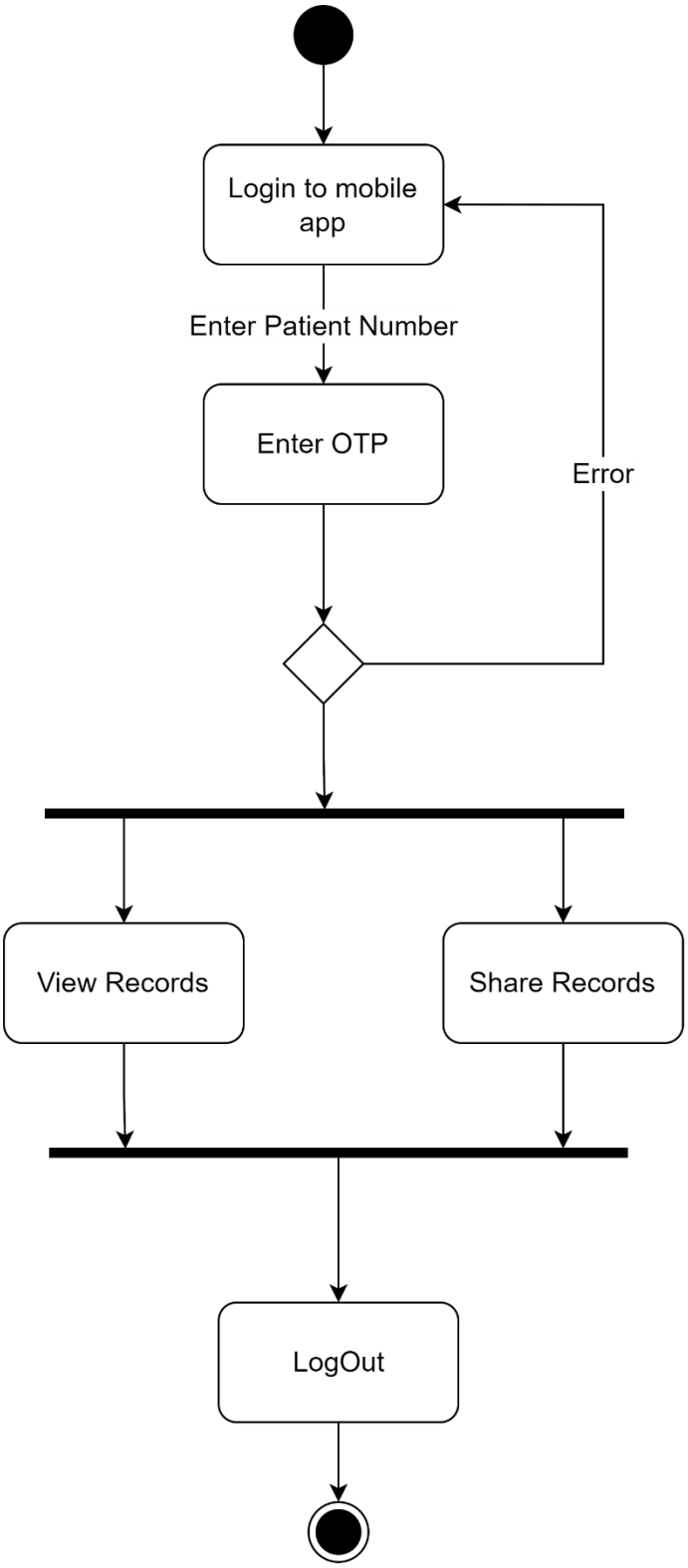

Figure 7: Activity Diagram (Patient Perspective)

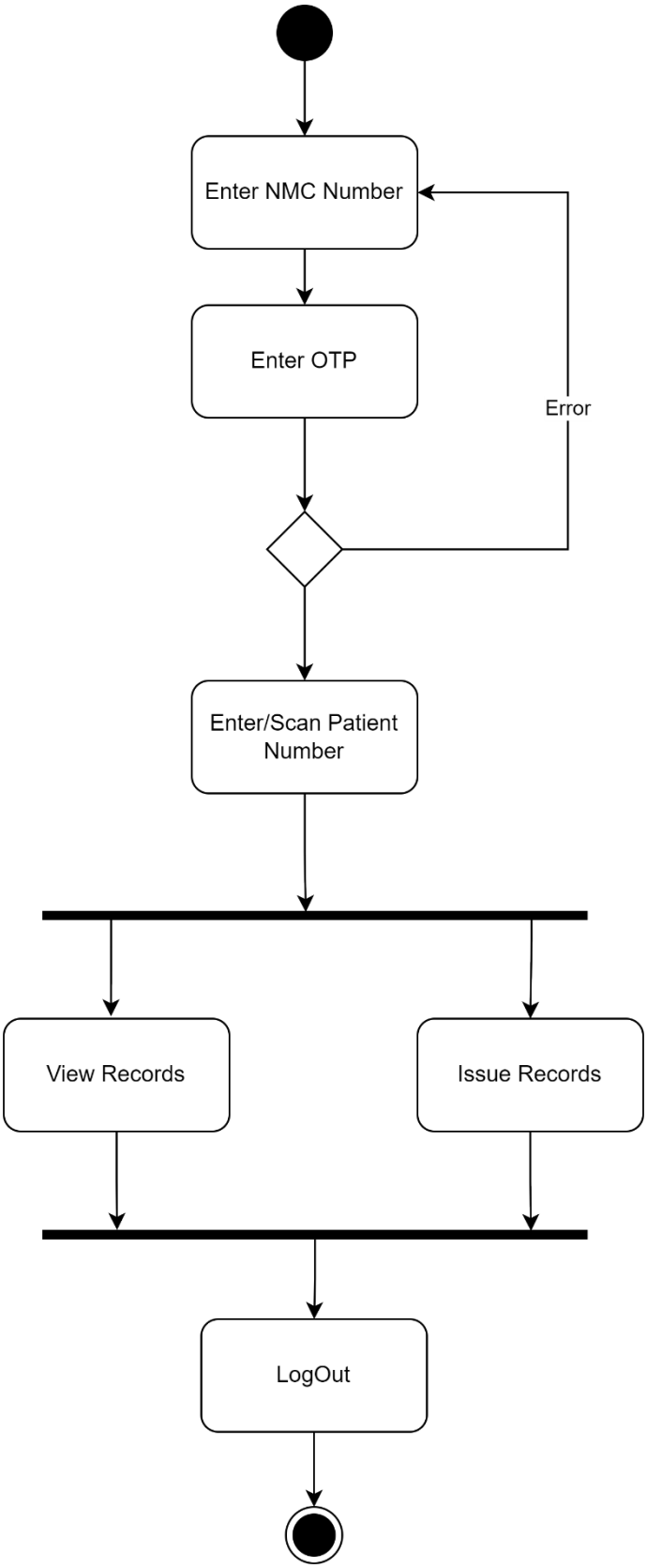

Figure 8: Activity Diagram (Share Document)

CHAPTER 6: EXPECTED OUTCOMES

After the completion of our project, we expect that maximum number of patients and doctors will get benefit from this project. Our system offers more privacy and security for managing personal data like personal health data. In addition, this system validates a patient's identity at the time of medical care and helps in health system management. In additions, the surging usage of these health card decreases the chances of medical errors and reduce healthcare costs, which are estimated to surge the adoption of health card in the healthcare sector. Along with that, these health cards have an embedded electronic chip with an integrated circuit, which decreases incidence regarding medical identities like fraud and theft. Due to these aspects, the health card in healthcare market will witness a surge in demand. We also expect this project will mitigate the use of traditional paper reports in the medical field. Each person who carries the health card are expected to get diagnosis whenever required without having to look for medical reports which was taken several years ago.

CHAPTER 7: EXPECTED COMPLETION TIME

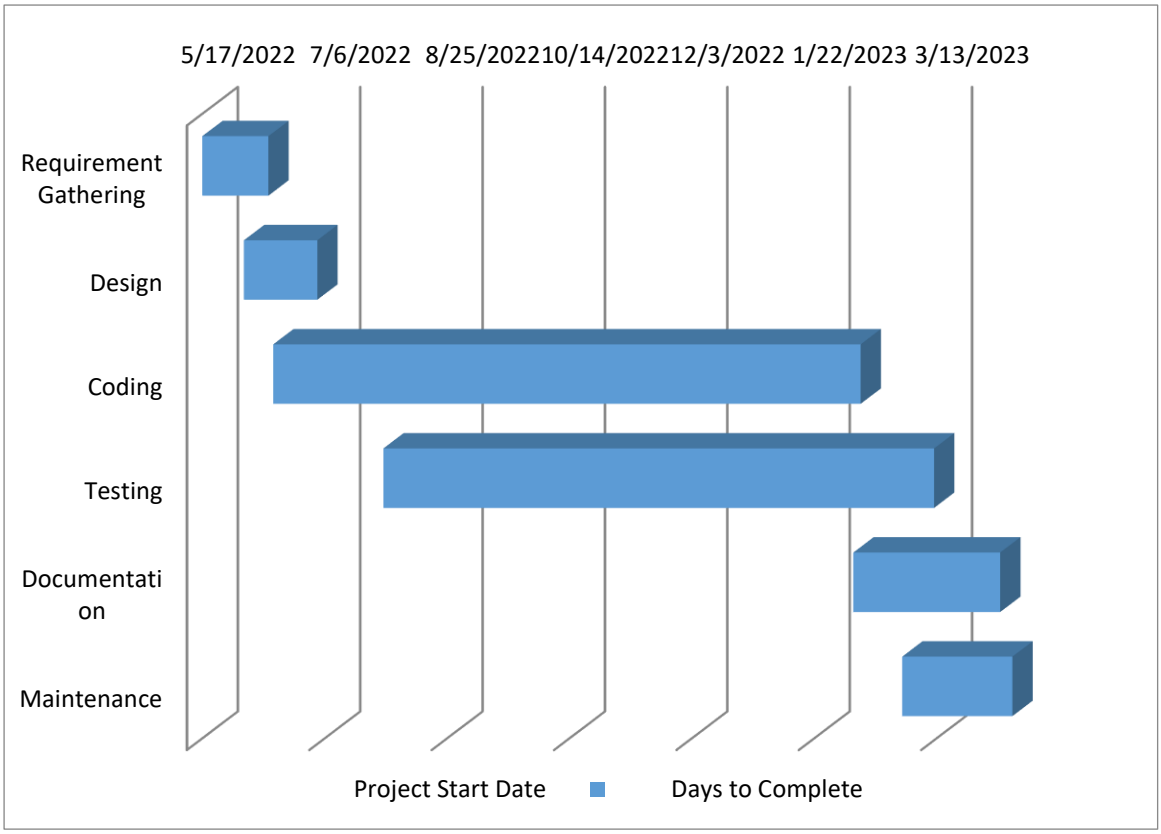

Figure 9: Gantt Chart

CHAPTER 8: LIMITATIONS

- Our system doesn’t have offline report viewing feature.
- Since reports are prepared by different parties in the hospital, it is difficult to provide patient’s health card to every party every time the report are to be stored.
- Certain outdated medical records are permanently stored in the blockchain, which can cause cluttering of blockchain storage.

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