DISTRIBUTED HEALTH CARE FRAMEWORK FOR PATIENT HEALTH RECORD MANAGEMENT AND PHARMACEUTICAL DIAGNOSIS

Project ID: TMP-22-010

Project Proposal Report

Wickramarathna W.G.M.S – IT19004778

B.Sc. (Hons) Degree in Information Technology

Department of Software Engineering

Sri Lanka Institute of Information Technology
Sri Lanka

January 2022

DISTRIBUTED HEALTH CARE FRAMEWORK FOR PATIENT HEALTH RECORD MANAGEMENT AND PHARMACEUTICAL DIAGNOSIS

Project ID: TMP-22-010

Project Proposal Report

Wickramarathna W.G.M.S – IT19004778

Supervised by – Mr Jeewaka Perera

Co – Supervisor: Ms. Laneesha Ruggahakotuwa

B.Sc. (Hons) Degree in Information Technology

Department of Software Engineering

Sri Lanka Institute of Information Technology

Sri Lanka

January 2022

Declaration

We declare that this is our own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Name	Student ID	Signature
Wickramarathna W.G.M. S	IT19004778	

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

Name of supervisor:
Name of co-supervisor:

………………………..   …………………………

Signature of the supervisor: Date

()

………………………..   …………………………

Signature of the supervisor: Date

()

Dedication

The author wishes to dedicate this information to the scientific community, which is working persistently to find answers to improve healthcare results.

Acknowledgements

Abstract

Electronic Health Record (EHR) systems are growing day by day, but the main challenges in these systems are preventing unauthorized access and sharing with only authorized professionals; EHR systems should have backup servers, thus protecting patient details. Our goal is to overcome these issues and build a decentralized system as a solution. We use blockchain directly without relying on centralized technologies. The reason was choosing blockchain as our technology is the blockchain already has overcome the issues are mentioned above [1]. The blockchain uses a distributed ledger, and every participant has the exact same ledger, so blockchain has greater transparency. Using "smart contracts." we can even automate transactions. By storing individual patient medication history, doctors can prevent unnecessary time consumption for examining the patient from the beginning. There are a couple of pros storing data on the blockchain, such as cannot delete or alter data as well as can reduce the cost of backup data. According to our research plan, we are planning to store and share data using blockchain, and doctors are the people who can perform activities with blockchain. Always the last prescription will be shared with the relevant patient.

Keywords: Electronic Health Record, Patient Data Privacy, Computer Security, Decentralization

Table of Contents

List of Figures

List of Tables

List of Abbreviations

Abbreviations	Description
EHR	Electronic Health Record
GDP	Gross domestic product

List of Appendices

1. Introduction

1.1 Background Study

Heath is a preliminary need for human beings. Health care services are improving day by day worldwide. Every country spends a lot of money to give good health care facilities to their citizens. Sri Lanka spends about a shared GDP of around 1.5%, which is lower according to international standards [2].

According to Sri Lankan traditional health care services, the patient should keep a record book for storing past medication details, and if that book is misplaced, the patient's medication history will be lost forever. Furthermore, the patient has the right to seek treatment from a variety of doctors, which has resulted in a situation in which each episode of an illness or disease process is managed by a variety of specialists with varying levels of experience, which frequently causes problems. In such cases, every doctor should examine the patient from the beginning because there are no registered patient records in any healthcare institution in Sri Lanka. As a result, there is a communication gap between multiple caregivers, resulting in inadequate coordination of care.

In our research, we are suggesting a new technological solution for these issues. Here, we are proposing a health care application built using blockchain. Blockchain is one of the current trending technologies for distributed application development.

1.2 Literature Survey

The authors of the study "Application of Blockchain to Maintaining Patient Records in Electronic Health Records for Enhanced Privacy, Scalability, and Availability" [1] focused on employing chain code logic to improve performance. And their findings revealed that doctors may use their system to access patient data, and patients can view their previous health information via the system. For auditing purposes, the study team kept the access log immutable and transferred data via a proxy re-encryption mechanism.

According to a study published in 2019 by Yongbin Zhang, Meng Cui, Lijuan Zheng, Rui Zhang2,3, Lili Meng, Dong Gao, and Yu Zhang titled "Research on electronic medical record access control based on blockchain" [3], it is found that lack of interoperability and sharing in are some common issues in handling medical data. This group of researchers employed methods like access control technology and information entropy technology to improve data privacy. The blockchain's security is dependent on the private key, and if the private key is lost, the storage's security is also compromised. However, those concerns were not addressed in this study.

In the year 2021, Hassan Mansur Hussien, Sharifah Md Yasin, Nur Izura Udzir, Mohd Izuan Hafez Ninggal, and Sadeq Salman employed bibliometric analysis of dataset distribution to perform a research study on "Blockchain technology in the healthcare industry: Trends and possibilities"[4]. According to the research findings it is found that patients' data is truly held by patients, and blockchain can permit the health record to be time stamped. To put this another way, once data is placed in the distributed ledger, it cannot be tampered with by anyone. The research study emphasizes the need of focusing on the standardization of cross-border healthcare data.

According to the study "Blockchain Technology in Healthcare: A Comprehensive Review and Directions for Future Research" conducted by a research team from Lakehead University in Canada [5], Blockchain can transfer traditional industry with properties such as decentralization and persistency. Furthermore, the research

indicates that an innovative strategy should be used to reduce the mining delays that occur when the number of transactions grows. The study highlights that Blockchain will be a vital tool for legitimate drug delivery to patients, billing, and payment administration in healthcare and to securely store patients' data preserving patients' privacy.

Previous research works have been focused on the interoperability of the data exchange between business entities and the research on "Blockchain Technology for Healthcare: Facilitating the Transition 3 to Patient-Driven Interoperability" is such [6]. The study focuses on how the transition takes through five mechanisms including data liquidity, data aggregation, digital access rules, patient identity and data immutability. The study demonstrates that blockchain technology may be used as a platform for digital exchange and that healthcare data can be stored in many systems, necessitating several interactions between institutions.

According to a 2019 research paper titled "Health Record Management using Blockchain Technology", the cost of data breaches in the healthcare industry is projected to be over $380 per record, with the 2016 Breach Barometer report revealing that 27,314,647 patient records were compromised [7]. This study emphasizes the necessity of the security of healthcare records. This article emphasizes the significance of patient-centric distributed healthcare solutions for securely storing patient data, as well as the value of using Blockchain to address these concerns. It also demonstrates that Blockchain not only provides decentralization, but also data confidentiality, real-time access, and data authentication and authorization.

According to the findings by Randhir Kumar and Rakesh Tripathi [8], maintaining privacy and openness are major problems when using central storage to hold patient data. Distributed on-chain and off-chain storage methods were proposed in this study. They did this with the use of a consortium blockchain and interplanetary file systems. They've solely placed content-addressable patient records within the blockchain to preserve scalability. Furthermore, the suggested solution is independent of third-party infrastructure.

Blockchain technology can be a superior option in biomedical research and teaching, as well as in keeping electronic medical health records, according to the study paper "Blockchain Technology in Healthcare: A Systematic Review" [9]. They also indicate that while various blockchain prototypes have been produced to date, not enough research has been done to solve the difficulties that blockchain technology offers, such as security and privacy. Latency and interoperability are two issues that need to be addressed, and more studies should be done in these areas.

1.3 Research Gap

Most of the research papers and products focus on storing their patient records. They are not sharing patient details among various hospitals. For example, there is a couple of patient records keeping systems in Kalubowila and the military hospital in Sri Lanka. Still, there is no way to access those data from another hospital. Private hospitals keep their patient details, such as Asiri hospital [10], but when patients change their hospital, there is no external connection between hospitals to share patient information.

There are two types of hospitals in a country: government and private hospitals. Under government hospitals, there are a lot of hospitals. Private hospitals may have some branches. According to this, civilians have many options. Instead of managing this many hospitals, doctors cannot give efficient service to their patients. Doctors need to understand and examine the patient from the beginning. Our proposed solution is to maintain individual patient records and share those among health care professionals.
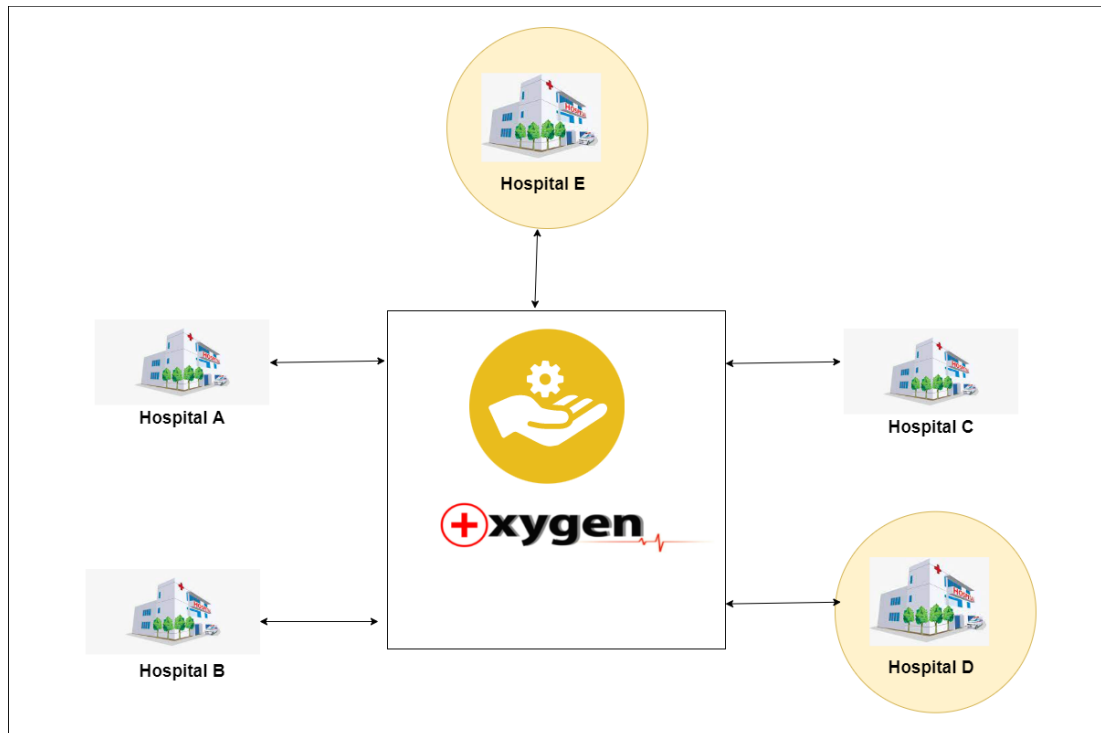

Figure 1.3.1: Integration between Oxygen and other EHRs (Electronic Health Record)

According to the above diagram hospital, "D" and hospitals "E" have their own patient details management system but they are not sharing them with external hospitals. When a patient is requesting to share their details, doctors can share those details with our solution. Once they shared those data any doctor of the hospital can access those details. It means our proposed solution allows them to integrate their private systems.

If we assume hospital "A", hospital "B", and hospital "C" do not have a system for storing their patient details but our proposed solution allows them to store their data in our system.

1.4   Research Problem

According to the Ministry of Health, Sri Lanka has 1103 government hospitals [11]. Sri Lanka currently has a population of 21,556,478 people [12]. People have many options to take their medications. They can use either government hospital service or private hospital service. Instead of using these two services, they can also use the Ayurvedic hospital service. When doctors examine a patient, they ask about previous medications or refer patient medical history books such as clinic books.

Some institutions employ EHR systems instead of keeping data in a book or asking patients for details. Storing/ accessing, and sharing patients' details are critical; thus, patient history is crucial to caring for a patient well. Without knowing the patients' history, doctors cannot make correct decisions.

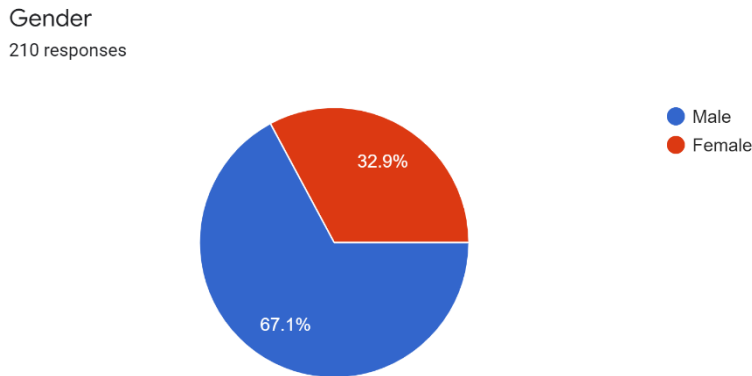We have done a simple survey using 210 participants.

Figure 1.4.1: participants gender

According to the above figure, most of the participants were male. As a percentage, it was 67.1%.
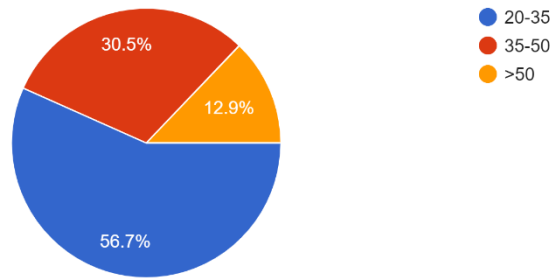
Age Group
210 responses

Figure 1.4.2: participants age group

Most of the participants were aged between 20-35. It was 56.7%.

We could see most of the participants had some health care issues during this pandemic. We could see, the governments are still taking some actions to provide a better health care service to their civilians. Also, some of the responsible parties are trying to automate some parts of health care services. By looking at the figure below, most of the participants have a medical logbook

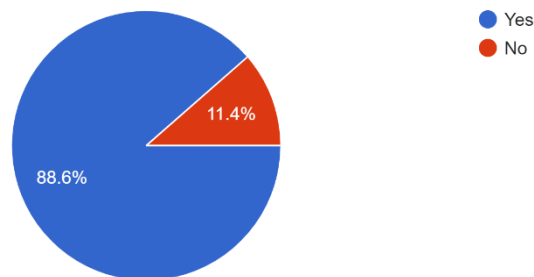Do you maintain a personal medical log book?
210 responses

Figure 1.4.3: Survey results regarding participant's medical logbooks

There are a bunch of problems that can occur. Such as,

- The logbook can be misplaced.
- The logbook can be damaged.

Traditional health care services cannot give a proper answer for the above-mentioned issues. In such situations, the only option is to replace the medical book. Not only that there are a couple of hospitals that have EHR systems, but they are not sharing those patient details with other hospitals. According to the Sri Lankan, health care service patients have multiple options to choose from. This problem cannot solve only by storing their information but also need to be shared with authorized professionals.

Which problem do you think will occur if we propose an automated solution to store patient data in digital format?
210 responses

Legend:
● Storing sensitive data will lead to data breaches
● Unauthorized individuals can access the data
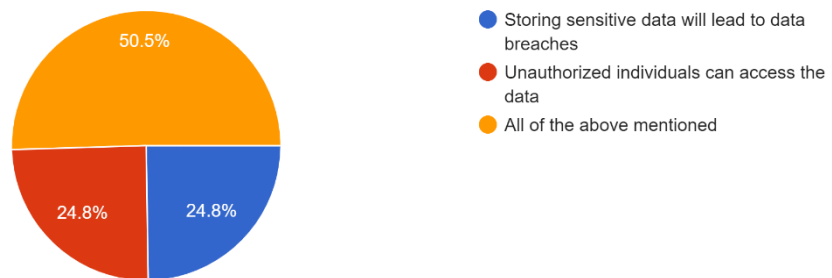● All of the above mentioned

50.5%
24.8%
24.8%

Figure 1.4.4: Participant's personal opinions

Storing / sharing and accessing patient information is most critical thus patients' lives depend on their medications. According to the above diagram, people are worrying to share their information with EHRs thus the malicious attacks. Data privacy is a key factor of the EHR system.

2. Objectives

2.1 Main Objective

As an EHR system main objective is to address the primary issues in the health care industry. Apart from that this component stores/access and share patient details among the health care professionals such as doctors while protecting data privacy.

2.2 Specific Objectives

The following specific objectives address the different areas of the main objective.

1. Storing patient information while protecting data privacy.

   There are many issues in storing patient information in medical logbooks and storing information in a centralized server. Those drawbacks will be omitted in this component.

2. Prevent unauthorized access to the system data.

   Access control mechanisms will be used here to control unauthorized access to the system.

3. Use smart contacts to automate the execution

   Smart contracts will be used for executing the predesigned procedures.

4. Prevent unauthorized apply changes to the system data

   There will be several user levels with several privileges. Such as doctors will be able to add a new record, edit and view but nurses/pharmacies' staff will only be able to view the record.

5. Accessible from anywhere

   This is not focusing on a specific institution. Any authorized organization can use this service from anywhere.

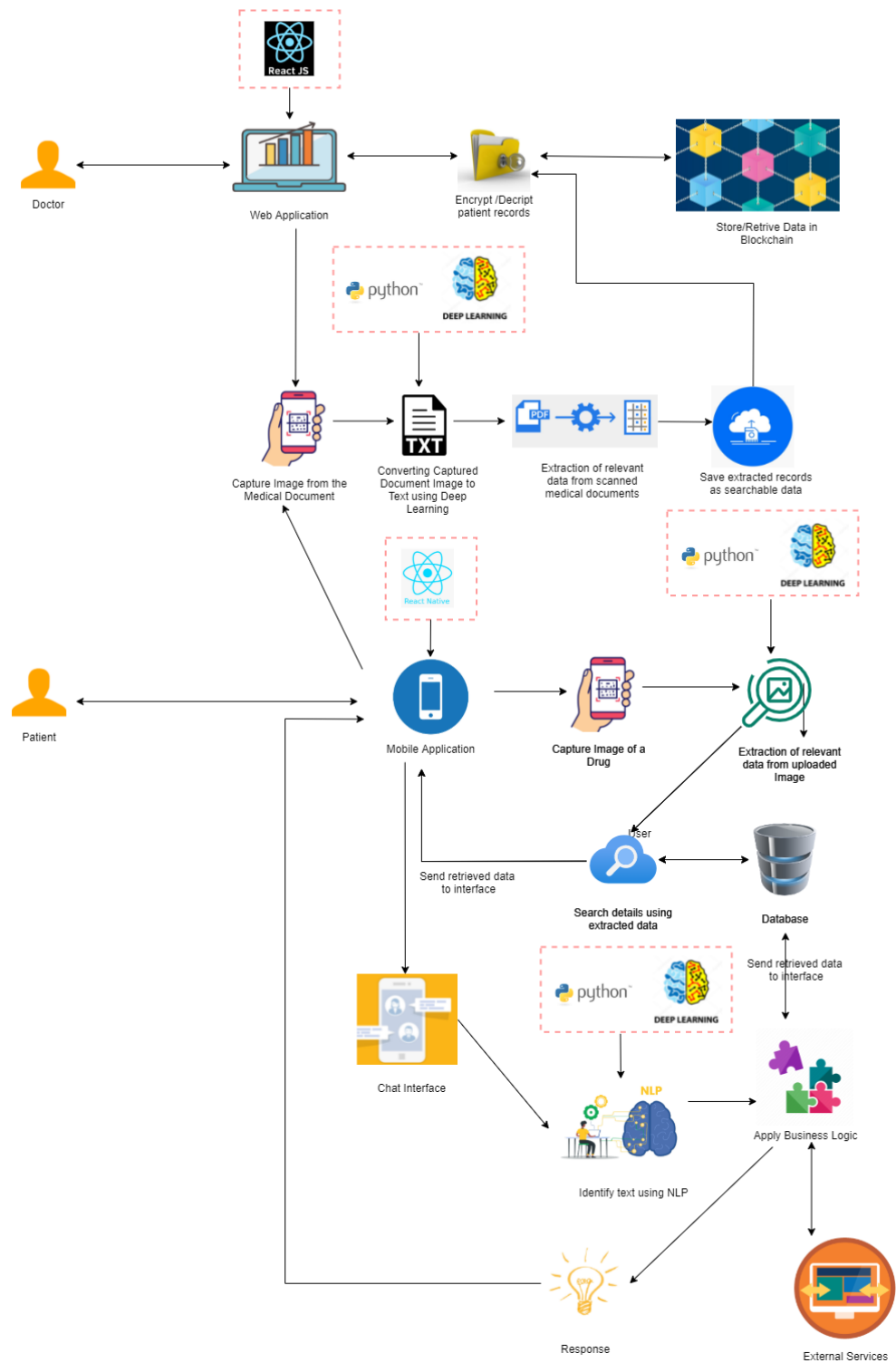# 3. Methodology

3.1 Project Overview

Figure 3.1.1: Project Overview Diagram

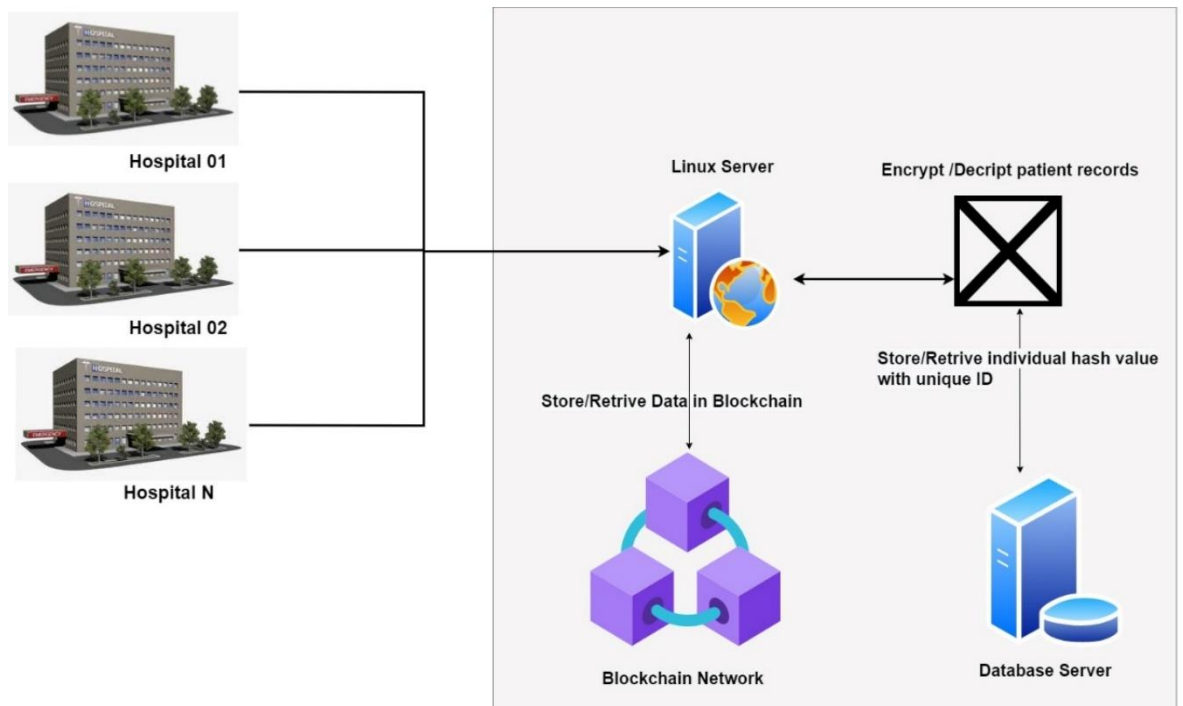**System Overview Diagram**

Figure 3.1.2: System Overview Diagram

3.2   System Overview

This component is responsible for storing/accessing and sharing patient information among health care professionals. Only authorized doctors can perform the storing task in this system. Patient records will be encrypted before storing the patient record. The Hash function will be used for encrypting the record. Once encrypted record will be pushed to the blockchain and it will be stored in a centralized database server with a unique key. Only the hash value and the unique key is stored in the centralized server.

When accessing the individual patient record, initially the record will be searched from the centralized server. The record is searched from the blockchain only when the record is existing. Only authorized doctors can alter the records. After altering the record, it will be again updated the database server before pushing the record into the blockchain network. Different authorized stakeholders can use the system from any place where the system operates. The smart contract will help to get the latest prescription of the individual patient and will be shared with them.

3.3 Project Requirements

3.3.1 Functional Requirements

1. Store patient details in an accurate way

   Encrypted data will be stored in the blockchain and centralized database with a unique key

2. Access patient details

   Authorized stakeholders can access the system from different areas.

3. Share patient details through the system

   Any authorized stakeholder can share patient details through the system

4. Modify patient details

   According to the access privileges, only doctors will be able to alter patient records.

3.3.2 Non-Functional Requirements

1. Security and Transparency

   Since using blockchain data secure and transparent than centralized systems.

2. Scalability

   The nature of blockchain is decentralized therefore scalability is easy than centralized applications.

3. Availability

   The system will be available 24/7 with minimum downtime for only authorized users.

4. Usability

   Different users will be able to perform different tasks under user privileges.

5. Performance

   The system will respond to the user fast and efficiently.

3.4   Work Breakdown Structure and Gantt Chart

3.4.1   Work Breakdown Structure

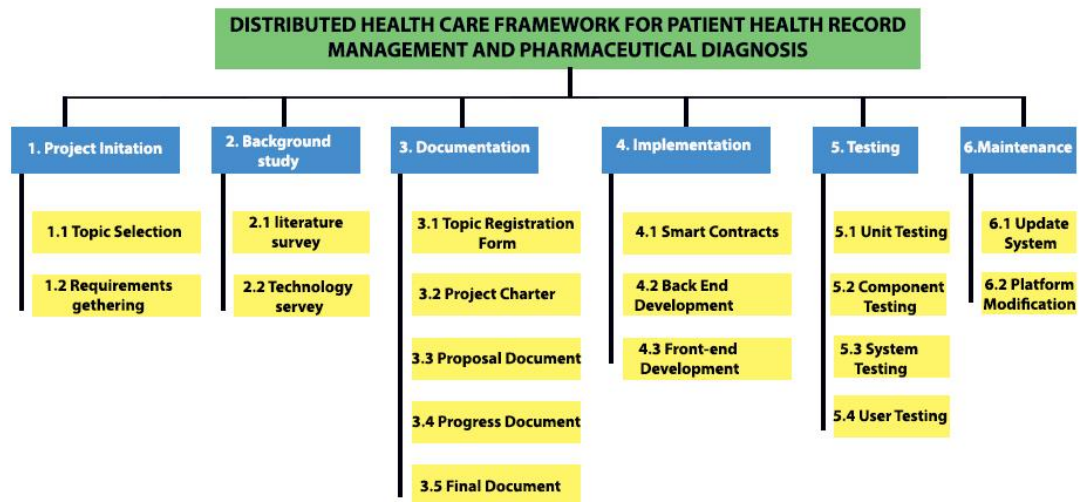Figure 3.4.1.1 shows the Work Breakdown Structure of the Blockchain-based sub-component.

Figure 3.4.1.1: Work Breakdown Structure

3.4.2 Gantt Chart

Figure 3.4.2.1 shows the Gantt Chart of the project.

Figure 3.4.2.1: Gantt Chart

4. Business Potential

4.1 Targeted Audience

This study is mostly focused on the healthcare industry. Physicians, healthcare workers, and patients are the primary audience.

4.2 Benefits from the system

1. Rather than having specific EHR consumers can store / access and share patient details.
2. Any EHR system can integrate the system easily and share patient details through the system accurately.
3. Medical document scanner will extract text from the reports and annotate special values.
4. Patients can identify the drugs using user friendly application.
5. 24/7 virtual chat bot for guide the patient according to the latest prescription.

5. Conclusions and Recommendations

The COVID19 epidemic has exposed the flaws in conventional healthcare and highlighted the significance of healthcare automation. Although electronic health records are growing increasingly popular, securely accessing patient data distributed across several EHRS remains a challenge. Blockchain technology has progressed over time, and its distributed nature will aid in the resolving of data privacy concerns. We intend to introduce a distributed healthcare framework in the proposed solution that may deliver healthcare services to both doctors and patients. Patient data will be maintained on the blockchain, and the proposed solution would use medical document scanners to reduce the amount of data that must be manually entered into the blockchain.

A virtual conversational chatbot will deliver healthcare services as part of the proposed solution. The medical chatbot can receive the most up-to-date prescription information from the Blockchain and send reminders to patients to take their medications on time. Not only that, but the chatbot can recognize pharmaceuticals based on their image and offer details such as dosage and adverse effects.

The solution is offered to reduce healthcare limitations and to assist in the resolving of difficulties that arise during the COVID19 pandemic.

6. Budget and budget justification (if any)

Component	Amount (USD)	Amount (LKR)
Document Preparations (Hard Copy)	Rs. 500	$2.48
Internet usage for researching	Rs. 2000	$9.91
Hosting Charges (Server)	Rs. 3800	$18.83
Other Expenses (Travelling)	Rs. 1500	$7.43
Total	**Rs. 7800**	**$38.65**

Table 6.1: Budget Justification

6. Reference list

[1] Tith, D., Lee, J.S., Suzuki, H., Wijesundara, W.M.A.B., Taira, N., Obi, T. and Ohyama, N., 2020. Application of blockchain to maintaining patient records in electronic health record for enhanced privacy, scalability, and availability. *Healthcare informatics research*, *26*(1), pp.3-12.

[2] Health.gov.lk. 2022. *Ministry Of Health - Hon. Minister*. [online] Available at: <http://www.health.gov.lk/moh_final/english/others.php?pid=92> [Accessed 6 February 2022].

[3] Zhao, Y., Cui, M., Zheng, L., Zhang, R., Meng, L., Gao, D. and Zhang, Y., 2019. Research on electronic medical record access control based on blockchain. International Journal of Distributed Sensor Networks, 15(11), p.1550147719889330.

[4] Hussien, H.M., Yasin, S.M., Udzir, N.I., Ninggal, M.I.H. and Salman, S., 2021. Blockchain technology in the healthcare industry: Trends and opportunities. Journal of Industrial Information Integration, 22, p.100217.

[5] Khezr, S., Moniruzzaman, M., Yassine, A. and Benlamri, R., 2019. Blockchain technology in healthcare: A comprehensive review and directions for future research. Applied sciences, 9(9), p.1736.

[6] Gordon, W.J. and Catalini, C., 2018. Blockchain technology for healthcare: facilitating the transition to patient-driven interoperability. Computational and structural biotechnology journal, 16, pp.224-230.

[7] Harshini, V.M., Danai, S., Usha, H.R. and Kounte, M.R., 2019, April. Health record management through blockchain technology. In *2019 3rd International Conference on Trends in Electronics and Informatics (ICOEI)* (pp. 1411-1415). IEEE.

[8] Kumar, R. and Tripathi, R., 2020, November. A Secure and Distributed Framework for sharing COVID-19 patient Reports using Consortium Blockchain and IPFS.

In *2020 Sixth International Conference on Parallel, Distributed and Grid Computing (PDGC)* (pp. 231-236). IEEE.

[9] Agbo, C.C., Mahmoud, Q.H. and Eklund, J.M., 2019, June. Blockchain technology in healthcare: a systematic review. In *Healthcare* (Vol. 7, No. 2, p. 56). Multidisciplinary Digital Publishing Institute.

[10] Ltd., A., 2022. *In-Patient Services*. [online] Asirihealth.com. Available at: <https://www.asirihealth.com/services-and-centres/facilities-amenities/in-patient-services> [Accessed 6 February 2022].

[11] Ltd., A., 2022. *In Patient Services*. [online] Asirihealth.com. Available at: <https://www.asirihealth.com/services-and-centres/facilities-amenities/in-patient-services> [Accessed 6 February 2022].
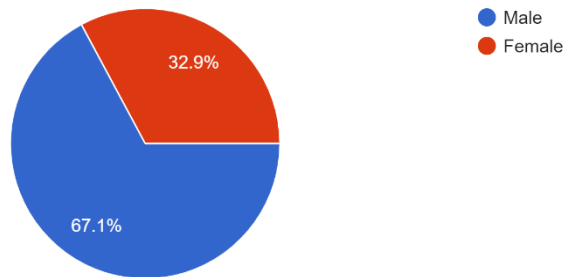
[12] Ltd., A., 2022. *In Patient Services*. [online] Asirihealth.com. Available at: <https://www.asirihealth.com/services-and-centres/facilities-amenities/in-patient-services> [Accessed 6 February 2022].

7. Appendices

Appendix A –Research Survey

Gender
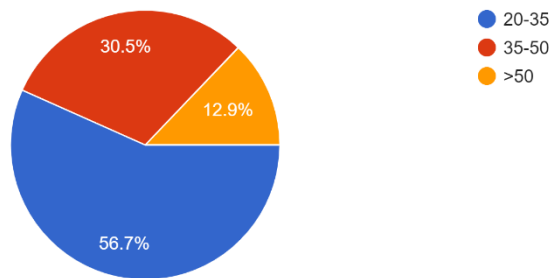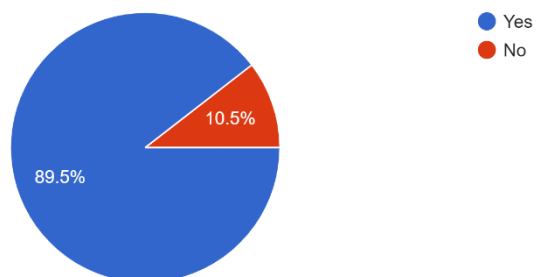210 responses

- Male
- Female

32.9%

67.1%

Age Group
210 responses

- 20-35
- 35-50
- >50

30.5%

12.9%

56.7%

Do you believe that healthcare automation is critical in the occurrence of a pandemic?
210 responses

- Yes
- No

10.5%

89.5%

Do you maintain a personal medical log book?

210 responses

- ● Yes
- ● No

88.6%   11.4%
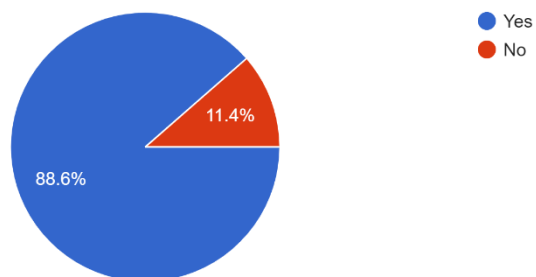
If Yes, Have you ever misplaced your medication history logbook?

210 responses

- ● Yes
- ● No

85.7%   14.3%
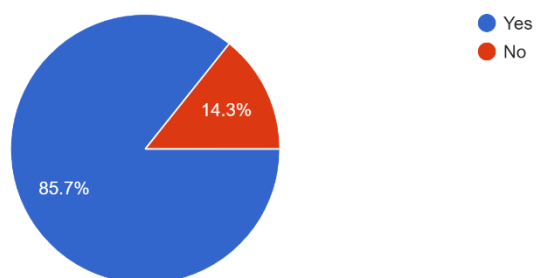
Do you like to keep track of your medication history in an electronic format?

210 responses
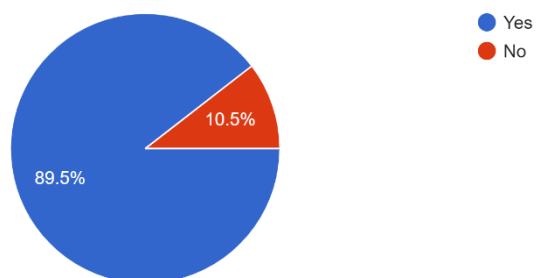
- ● Yes
- ● No

89.5%   10.5%

Which problem do you think will occur if we propose an automated solution to store patient data in digital format?

210 responses

- ● Storing sensitive data will lead to data breaches
- ● Unauthorized individuals can access the data
- ● All of the above mentioned
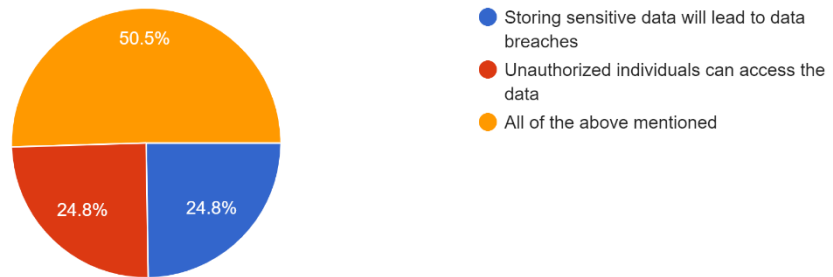
Appendix B – Supervisor and Co-supervisor's Endorsement

Jeewaka Perera <jeewaka.p@sliit.lk>
12:55 PM

To: Wickramarathna W.G.M.S. it19004778

[EXTERNAL EMAIL] *This email has been received from an external source – please review before actioning, clicking on links, or opening attachments.*
Dear Students,

I am Happy with the changes you have made to the document, and you can submit this document now.

Regards,
Jeewaka

Laneesha Ruggahakotuwa <laneesha.r@sliit.lk>
11:40 AM

To: Wickramarathna W.G.M.S. it19004778

[EXTERNAL EMAIL] *This email has been received from an external source – please review before actioning, clicking on links, or opening attachments.*
Dear Students,

I consent to co supervise this project.

Thanks and Best Regards.

Laneesha Ruggahakotuwa,
BSc, MSc (Cyber Security)
Assistant Lecturer

Department of Computer Systems Engineering
SLIIT | Malabe Campus

0764104458
laneesha.r@sliit.lk