A CAPSTONE PROJECT ON
BLOCKCHAIN BASED COUNTERFEIT MEDICINE AUTHENTICATION SYSTEM

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A Project/Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science of the Bangladesh University of Business and Technology (BUBT)

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Abstract

A series of significant drug security incidents rising in recent years in Bangladesh. Additional awareness is paid to standard drug and security. A senior scientist Joel Breman said "The penalties are a clap on the hand, but we are talking about murder by duplicate medicine here,". 250,000 children are died in a year after receiving duplicate medicines and antibiotics that is apply to defense critical condition and infections. Majority of the death cases in our countries wherever strong demand for medicines integrate with faulty monitoring, standardises checking, internal control and rules to from it straightforward and simple for offender groups and cartels to pass into the drug merchant (the independent, Thursday, 2 July 2020). Poor supply network management is main cause for duplicate medicine in the drug production. Drugs change ownership step by step from producer to wholesaler, Supplier and then drug house since it comes out patient hand. That's why we are using a blockchain network where everyone will be connected and can participate in the network, using unique code, hash value. Finally, the main purpose of cumulative dissertation is trying to confirm standard medicine, transaction safety and information security applying blockchain technology.

Acknowledgments
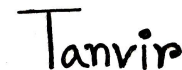
Declaration

We hereby declare that the capstone project entitled blockchain based counterfeit medicine authentication system submitted in partial fulfillment of the requirements for the degree of Bachelor of Science in Computer Science and Engineering of Bangladesh University of Business and Technology (BUBT) is our own work and that it contains no material which has been accepted for the award to the candidate(s) of any other degree or diploma, except where due reference is made in the text of the project. To the best of our knowledge, it contains no materials previously published or written by any other person except where due reference is made in the project.

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Copyright

Dedication

Dedicated to our parents and teachers for all their love and inspiration.

Certificate

This is to certify that Nazmul Alam (16172103365), Md. Rabiul Hasan Tanvir (16172103383), Aysha Rahman (16172103320), Fateha Israt (16172103066) and Sabrina Momotaj (16172103290) were belong to the department of Computer Science and Engineering, have completed their capstone project work titled Blockchain based counterfeit medicine authentication system codes satisfactorily in partial fulfillment for the requirement of Bachelor of Science in Computer Science and Engineering of Bangladesh University of Business and Technology in the year 2021.

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List of Abbreviations

PoW   Proof of Work

SHA   Secure Hash Algorithms

QR   Quick Response Code

RFID   Radio Frequency Identification

SCM   Supply Chain Management

POMS   Product Ownership Management System

DFS   Distributed File System

EVM   Ethereum Virtual Machine

HTML   Hypertext Markup Language

CSS   Cascading Style Sheets

DoS   Denial-of-Service attack

UI   User Interface

WHO   World Health Organization

IoMT   Internet of Medical Things

EHR   Electronic Health Record

EMRs   Electronic Medical Records

Contents

Bibliography

List of Tables

List of Figures

Chapter 1

Introduction

1.1 Introduction

The concept of medicine safety and traceability is gaining popularity and it helps in reducing human problems and protect their life in this system. Reliable, a good-quality medicine supply is essential for health, but it is frequently lacking in countries with regulatory systems. Counterfeiting various product creates a problem for different manufacturing companies that is the reason of significant warning to medical goods [3]. This threat has created a particularly dangerous risk for good physical condition also this is the main causes to loss in manufacturing industry to gain revenue [4]. For example, a local drug firm named Rid Pharmaceuticals Ltd is used diethylene glycol to made drossy paracetamol syrup. taking adulterated syrup 24 children's affected by intensive renal collapse and died in 2009. Government medical report of that children's probe that a dyeing chemical is used to made that syrups which is actually used in tannery company (New Humanitarian, 4 November 2013). To overcome such problems we want to control the side effect of the twin medicine and detect medicine, which is original or duplicate and also provide security of medicine and patient health. In this strategy, we want to use blockchain technology for dealing with security and information safety. We will build this system to avoid duplication of medicine by producer, packager, wholesaler, pharmacies, and hospitals. Every product will have unique codes and hash value. They will be linked through the hash value and will

have a scanned code. Through this procedure, we can recognize original medicine and can detect counterfeit medicine with this system. Already a lot of research has been done, but we will implement this system and make it more efficient, valuable, and user friendly.

1.2   Problem Statement

We can see normally over the years, people have to face a lot of problems due to having wrong or duplicate medicine and there are a lot of death cases too. They face security problems and provide security because medical data records are hacked and we came to know about this problem from this paper [1]. They face a problem in transaction security where data is not secured enough [7]. This problem is caused due to ignorance about original medicine. We have a deep concern about this matter. So we called up to make a new effective system to recognize original medicine.

1.3   Problem Background

Counterfeit medicines are spreading harmful effects in Bangladesh and other countries of the world [31]. This issue has a fetter problems on general people also in drug industry over world [15]. The main reason behind the lack of a comprehensive standard of falsified medicine across the world confession and the complexity within the market and globalization network [8]. Despite various efforts by regulatory bodies worldwide ignorance among partners, lack of protection of intellectual property, and socioeconomic factors, as well as the market for counterfeit drugs, have flourished. Although the use of strategies based on the pharmaceutical industry's invention pattern, encryption, and chromatography principles and authenticating original goods that is minimize the difficulty of finite range [14].

1.4 Research Objective

To analyze the current problem in drugs, we present the medicine traceability process using blockchain. The mentioned system is capable to track falsified and anomalies medical goods. Additionally this system is able to detect the expire and anomalies medicines. Traceability application will improve the product security and identify the original product. Blockchain makes the system safe and reliable for patient.

1.5 Motivation

Counterfeiting various product creates a problem for different manufacturing companies that is the reason of significant warning to medical goods [3]. This threat has created a particularly dangerous risk for good physical condition also this is the main causes to loss in manufacturing industry to gain revenue. So many method has been proposed to detect falsified drug, but there is no standard existing system. Blockchain is the greatest technology for data safety. For that we are trying to ensure the quality of medicine, transaction security and data safety through blockchain technology

1.6 Flow of the Research

We conducted the research work in multiple steps. First, we were looking for the research field. We confirmed that we were research on blockchain. Then we confirmed the research topic. After confirming the research topic, we first studied the basic theory of blockchain that is required to continue the research work. After the study, we found some promising work on medicine traceability, detecting counterfeit medicine and many more. We investigated the lacking of the proposed architectures and created our counterfeit medicine traceability architecture. After finalizing the design, we implemented the overall method. To test the proposed model, we applied in a small supply chain and ran tests and evaluations on our implemented architecture.

Finally, we completed our thesis writing. Figure 1.1 represent the whole process of research manner in a flow sketch.
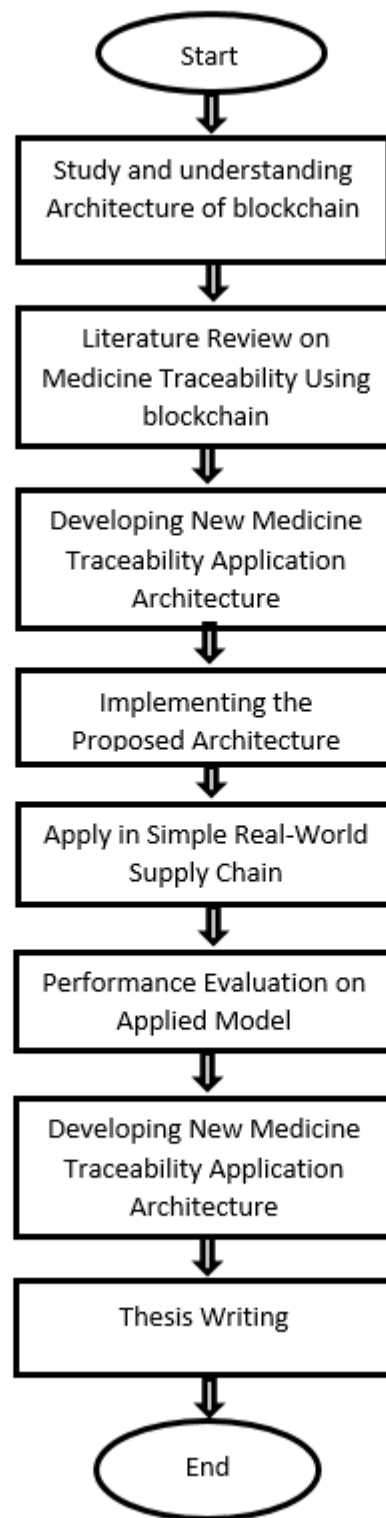
Figure 1.1: Research flow of the work

1.7   Significance of the Research

The invention of the study will recall to the benefit of the researchers that counterfeit medicine can be tracked and traced from the supply chain using the development of blockchain in network [4][7]. Study explains in detail how proposed technology will work in medicine storehouse network. Also, we experiment that there are many substandard medicine are available in the market that cause reactions in the human body and the system can easily find out those medicines. This work will influence the researchers to investigate the use of barcode or QR code on single drugs. Further research will be suitable for the present industry level implementation of a practical blockchain based medicine traceability application that will also be suitable for any kind of supply chain.

1.8   Research Contribution

In total achievement of research study includes,

- Our investigation says that most of the medicine or product tracing systems are depending on the RFID which is more costly.

- We implement a practical blockchain based medicine traceability application that is affordable and very easy to cope with existing industry architecture.

- We use barcode or QR code that can be used in a single unit of a drug.

- We make our system easier than existing applications.

- Our system will done high beneficiaries with low cost.

1.9   Thesis Organization

The capstone project work is organized as follows.

- Chapter 2 cover the background study and paper review on the topic of the authentication technique for medicine tracing using blockchain.

- Chapter 3 contains the proposed architecture of the authentication system for medicine tracing using blockchain, along with a elaborated process of the whole system.

- Chapter 4 highlights the details of the experiment and analysis that were represent to evaluate our design system.

- Chapter 5 describe the quality, moral strategy, and the limitation of the mentioned system as well as the overall field of our study.

- Chapter 6 contains the overall architecture and limitation of implementation of our resented capstone project work.

- Chapter 7 illustrates the period schedules that we takeed while the capstone project was carrying on.

At the end, Chapter 8 contains the conclusion of our capstone project work.

1.10   Summary

The Introduction section briefly describes the summary of the difficulty which is specifically target. The purpose of our capstone work with motivation of the goal of the capstone work. This part also explains the overall steps on which we complete our capstone work.

Chapter 2

Literature Review

2.1 Introduction

Researchers are highly interested in the medicine traceability system and still they are working effectively on this field. Most of the researchers are trying to trace original medicine [14]. Medicine traceability detects original medicine and duplicate medicine through barcode or QR code. Some researchers have detected from manufacturers to retailers and more research is going on to develop this system to make users comfortable in this system. In this chapter, we represent the theme which is implemented by the researcher

2.2 Existing System

Asaph Azaria et al. [1] Discuss the implementation of medical data access and permission, separated information regulation method used by them to operate Electronic medical records through blockchain technology. sufferer are given by the system a magnificent constant log. The system is simple to enter their clinical data crosswise supplier and attitude positions. They secure their network through proof of work.

Asad ali siyal et al. [2] They discussed about blockchain technology in medicine and healthcare. Blockchain technology has a high activeness in medicine and healthcare

services where it brings a digital solution of present medical practice problems. In this paper, they provide safe data sharing, secure medical treatment and effective personalization in this sector. Data transparency and privacy are confirmed by blockchain.

Radhir kumar et al. [3] Discuss the implementation of drug safety and finding counterfeit drugs. This implementation based on advance features of blockchain and encrypt QR code security, blockchain based secure prototype for drug supplier network in authorised contributor. PKI and digital signatures method have also been used in this research, those can stop out of respond and middle path invadesion.

Ijazul Haq et al. [4] Analyzes the blockchain technology that is used medical industrial supply network. their proposed model will be implemented in the real life industry level to detect the medicine it's manufacturing until it's delivery to patient. SCM system doesn't provide visibility and regulatory authority over drug distribution and it cannot provide cyber security threats. Blockchain technology can prevent counterfeit drugs by developing a perfect supply chain management (SCM) system.

Kentaroh et al. [5] Now a days drugs can easily be cloned and substandard. To trace the anomalies drugs, in this paper, propose a novel product ownership management system (POMS) of Radio frequency identification (RFID)-attached products for anti-counterfeits that can be used in the post supply chain. To evaluate cost performance a proof-of-concept experimental system employing blockchain-based decentralized application. Results have been shown that the cost of managing the ownership of products with up to six transfers is less than the U.S. 1.

Patrick et.al. [6] Falsified and substandard drugs are dangerous. Medicine traceability systems have been proposed to confirm the security, standardises, and usefulness's of drugs. In this model, every kind of pedigrees is stored in a Distributed Database. A unique identification code is tagged in drugs using Radio frequency identification (RFID). A scanner can trace the RFID code. Distributed applications is able to trace falsified, invalid, and absent medical products by matching distributed file system

(DFS) quantity with recorded file.

Yan Huang et al. [7] There are many drug traceability system exists, but every system has some disadvantages. Some of have a lake of security and privacy, some of has storage they issued in this paper and proposed a structure-based blockchain model for counterfeit medicine tracing named Drugledger, ensuring the originality and data safety. It will works in two flows one is real medicine supply network and another in blockchain network which maps each other. They separate the network in three-part, one certificate provider, and demand service provider, and access provider. The system will input data in every stage of the supply chain (package, repackage, un-packaged, production, arrival, and departure) and add to them in the blockchain. They implement a prototype with C++ in Ubuntu 16.04 LTS and some popular open-source libraries.

Feng Tian [8] He propose a new system with the hazard analysis to trace food supply and crucial control point. There are many companies whose are worked with food safety but nobody try to work it without and kinds of database. It has no database. It works with bar code or the RFID code attach on the body of the food. So food tempering is so tough. Though RFID implementation is so costly. Sometimes the shipping charge may higher than the food charge. The system will have transparency, openness, security, scalability, and neutrality.

Liu et al. [9] A" Quality Marker" new technology is introducing here to trace herbal product like as DNA bar coding, chemical marker, finger print technologies. The system is designed to confirm the safety and quality of drugs and detect the product. Also ensure the risk management for maintain the quality of herbal drugs.

Ding Wei and Yang [10] the combination of public chain and private chain estab-lish a double chain system for tamper proof function and distributed file book using block chain. To traceability drugs, all can verify the data in the double chain system where all are interconnected in the data chain.

Alok et al. [11] In this system, the authors developed a model using blockchain to detect counterfeit drugs from manufacturer to customer. Customer can check the drugs using smart device to scanning QR code. Also tracing medicine effect will recorded in database for statistics.

Adsul et al. [12] In this model, the developer portrays a blockchain system which have 4(four) module manufacturer, supplier, pharmacist and patient. All module needs to register in the system. Scanning QR code suppliers, pharmacist and patient can detect the genuine drugs.

Mackey et al. [13] They discussed present and latest technologies to fight the worldwide business in counterfeit drugs. As medicine distributing system is complex so it requires a technology based modern solution to save patients all over the world. To fight against the fake medicine they conducted many reviews of health science. There are 5 individuals group of technology contains mobile, RFID, latest computational technique, online validity and blockchain technique were identified by them.

Prokofieva et al. [14] They discuss about blockchain in healthcare. Blockchain is the main system for the cryptocurrency, bitcoin and capabilities and applications of blockchain have yet to go through beyond cryptocurrencies. They noticed about potentiality of applications of the blockchain technologies in healthcare. Blockcahin technology can be used in healthcare system to improve its services, data management and cutting cost etc. Based on peer-to-peer networks, the most significant feature of it is, it updates with real-time and no cost of time for intermediates which is described by them.

Erwin A. et al. [15] They discussed about the health and financial effects of substandard medicines. This ample reviews of the literature environed a search of the PubMed, google scholar, and ProQuest using the keywords "counterfeit drugs", "counterfeit medicines", "fake drugs" and "fake medicines". They also conducted a

search of the various fierce pharma daily newsletter series on the healthcare market. Besides that, they reviewed the United State FDA and the WHO websites to collect more data.

Moniruzzaman et al. [16] They discuss about a wide analysis and regulations for posterior research through blockchain. Blockchain are the link of blocks that enclose data and keep faith between separates, new application opportunities have been provided by it including healthcare applications. A magnificent evaluation of the new blockchain-based technology is provided by this survey. Healthcare, information control, reserve network regulation; IoMT through blockchain technique were applied by them. They verify the data in each blocks and it is known as proof of work.

Zhijie Li et al. [17] Network underlying supply chain complexity causes more cost of goods and their availability. In this paper, they address two issues in the distribution phase, affordability and pseudo real-time visibility of truckload activities. That's help the system make transparent to the stakeholders every shipment. They proposed hybrid P2P physical distribution (HP3D) framework consists of index server, peers and administrative nodes. IP addresses are collected and shared by the index server, peers consist of two element one is X86 another is mobile peer that is use for scan QR code of the shipment. There also used semi-public ledger and a private ledger blockchain to enhance the validity and security of the information being exchanged.

Feng Tian [18] Discuss about the importance of food safety and causes for the food contamination. In this paper he introduce a RFID and Blockchain dependable agri-food detection process. He divides agri-food in two types one vegetables, fruits another is meets. In every product package, there tagged RFID in the body of package. Every information of product will be in the RFID tag. Blockchain network take input data from RFID. He focus more attention on RFID, it can add high cost to the product.

Q. Lu and X. Xu [19] Proposed a blockchain based product traceability application

and they named it as Origin Chain. In this system they propose a smart contract which consist of traceability managers who manage and regulate the information in the network. Mainly it represents the legal agreement. On chain data will visible to all in the network and the privet data will store in the off chain. Retailer or suppliers can store their important data like customers information securely in off chain. The traceability service provider and the supplier or retailer are managed by monitory authority of the network.

Matthias and HSG [20] Mainly this is a survey paper. They discuss many things about blockchain use in Healthcare. Firstly, they discuss about what is the blockchain and how can blockchain use in healthcare. History of blockchain with bitcoin. Then they add the financial sector where blockchain is used. Blockchain change the healthcare management and make it smarter than the traditional system. Every clinic in the blockchain network can access metadata from others clinic. Blockchain also reduce the counterfeit medicine from the market.

Kamanashis Biswas et al. [21] discuss securing smart cities using blockchain technology. Smart city residents and sustainable governments are interacting with innovative solutions and more direct interactions through the proliferation of different technologies but despite these benefits, digital security and privacy are being compromised. This paper proposed blockchain technology with smart devices to enable data privacy and strong information transmission in the modern town. The principal benefits of using blockchain is flexible opposed to numerous warnings.

Lanxiang Chen et al. [22] discuss a blockchain-based desirable protection design for electronic health records. they mostly concentration on how easily construct the repertory from electronic health records and extend it in digital agreement a blockchain is able potentially applied to ease the sharing of information. This paper illustrate the strong of implementing digital agreement like Ethereum in their model.

Radanović et al. [23] Discussed the opportunities for health care through the use

of blockchain. Although the blockchain era is truly in its infancy, they said we're already seeing development concerning its implementation in regular life, specifically in banking and financial industries, as, there had been the technique of examples of these era for digital transaction, virtual agreement, financial and general documents, also assets owned. Some of the best blessings that utility of this technology in healthcare should carry are getting admission to a massive pool of anonymized healthcare facts that might be used for customized drug development, explanation of healthcare and medical health insurance costs, in addition to the development of public fitness policies.

Anupam Kumar et al. [24] Discussed how to prevent the supply of counterfeit drugs through blockchain technology and they are also researching the cure for counterfeit medicines in India. They suggest a private, permission blockchain database maintained through the Department of Pharmaceuticals, Government of India for use as an allotted drug stock which continues a listing of transactional facts of the delivers chain, prepared into blocks. As those blocks are immutable and allotted, a transaction recorded in it may by no means be modified and any tampering or forging activity will be invalidated through the gadget of mutual consensus.

Mettler, M. [25] he discuss about the potentialities and influences of the blockchain techniques in the pharmaceutical industry. Production process can be monitored using this technology as like bitcoin transaction. Basing on this disruptive technology, the healthcare system can be securely digitalized avoiding hack of confidential data of the medical and pharmaceutical sectors. There is not used enough statistical tools. Only English language is used to publish it. These kind of limitations are noticed here.

Sahoo, M et al. [26] They discussed about curbing drug counterfeiting using blockchain. How drug counterfeiting is happening and how useful is the technology to stop the harmful practice. Many topic connected to medicine supply network are discussed and how a model of decentralized blockchain architecture with shared ledger system will prevent drug counterfeiting. Customer are health and safety. There are several

limitations of this study, such as only English language use, access limitation of the paper, limited publisher.

Shen, M. et al. [27] Propose secure SVM to connect the lack between ideal assumption and realistic constrains. For this they construct safe and reliable data sharing platform through using blockchain technology. Also build secure SVM training algorithm for removing third party and stable polynomial multiplication and safe comparison, by employing homomorphic cryptosystem, pillar are also designed .

Liang, X et al. [28] They presented ProvChain, a blockchain based data provenance architecture to provide assurance of data operations in a cloud storage application, while enhancing privacy and availability simultaneously. According to them the blockchain based data provenance can provide integrity and trustworthiness. They kept the hashed identity of users in order to protect their privacy from rest of the nodes in blockchain network.. The design of ProvChain, based on data provenance architecture also the detailed implementation. Performance evaluation of ProvChain in different sections. Finally, they concluded that they made a record with unalterable timestamp and generate blockchain receipt for each of the data records for validation their evaluation shows that provenance enabled own cloud brings a low overhead. In future their target will be to implement the validation on top of an open source architecture that will not only improve overall performance but also security and flexibility.

Alonso et al. [29] They discuss about challenges in using blockchain technique for medical industry. Blockchain technique has high demand in E-Health technology. Blockchain technology creates a huge research field that is connected with EHR and EMR. Limitation of the paper is, there are not clear idea about EHR and EMR.

Surjandy et al. [30] They have discussed on the security and traceability of 23 essential components and major required elements to taking blockchain techniques for the drug industry. Using encrypted data, countrified drugs is being possible to avoid ownership of medical data can be protected. Limited access in the paper and limited

publisher, these are the drawbacks of the paper.

2.3 Problem Analysis

Now the existing system is working well enough but still struggling with some short-comings. Researcher have provided security till supply chain [32]. But they are yet to make this system available in the public level. Despite the fact that they use RFID or QR code, they haven't able to take this to mass people [6]. Therefore, researcher can't provide standard security for medicine.

2.4 Summary

This chapter represents the latest implementation of the medicine traceability system using blockchain. The goal of the capstone work is to trace the defect and counterfeit drugs. Detection of substandard medicine is very helpful to save the public lives.

Chapter 3

Design and Implementation

3.1   Introduction

In this chapter we know the theoretical background which is related to the project development. We use blockchain technology for transaction security and data safety. We will build this system to avoid duplication of medicine by manufacturer, packager, wholesaler, pharmacies and hospitals. Everyone has unique code and hash value. They will be connected through hash value and will have scan code. Through this procedure, we can recognize original medicine and can detect counterfeit medicine with this system. In our system we use SHA-256 hashing algorithm. It's a protected and confided in industry standard: SHA-256 is an industry standard that is trusted by driving public-area organizations and utilized broadly by innovation pioneers. Crashes are unbelievably improbable: There are 256 potential hash esteems when utilizing SHA-256, which makes it almost unimaginable for two unique reports to circumstantially have precisely the same hash esteem. These two hashing algorithms (SHA-512. SHA-224) could have been implemented there.

3.2   Feasibility analysis

Feasibility analysis is the way toward affirming that a methodology, plan or configuration is conceivable and bodes well. This can be utilized to approve suspicions,

imperatives, choices, approaches and business cases.

3.2.1 Technical feasibility

- In our system we use mobile for scanning QR code. If mobile is not working then it cannot scan QR code and then whole blockchain is useless

- The approval of all updates needed by every person so every person will wait for validation.

- In tracing time if the drug administrator is fraud then the whole system will be fraud.every person gets fake medicine.

- If the server is down so the whole system will be down.

3.2.2 Operational feasibility

Operational feasibility is the measure of how well a proposed system solves the problems, and takes advantage of the opportunities identified during scope definition and how it satisfies the requirements identified in the requirements analysis phase of system development.

- We proposed a mobile-phone scanner for tracking original medicine. Our proposed system is operationally feasible in real time because our system has been used to track original medicine.

- Our system can track counterfeit medicine, acceptable and valid medicine in a shorter time than other systems. Our system is more secure than other systems so it is operationally feasible.

- Since we are completing the operation during the implementation at low cost by scanner of the mobile phone that's why our system is available. So in case of real time system our system is acceptable at any phase.

- We are using blockchain, QR code and mobile phone scanner system,we can call it a developed system, thus it is more acceptable.

3.2.3 Economical feasibility

Economic feasibility is a kind of cost-benefit analysis of the examined project, which assesses whether it is possible to implement it. It consists of market analysis, economic analysis, technical and strategic analysis.

- In our project we use a scanner which is available in mobile and every person has mobile so the cost is inexpensive. if we use RFID which is very costly so we can say that, scanner is better than RFID.

- In a short time we can confirm any medicine validation .

- In this system we reduce operating costs, transaction costs errors.

3.3 Requirement Analysis

Every software and app needs some requirements. We need some software and hardware requirements to build our project. In our project some requirement we are needed there are:

Software : To build the project we need some software.

- HTML.

- CSS.

- JavaScript.

- Bootstrap.

Hardware : We need some hardware there are,

- Processor requirement: Intel i3 (7th Gen, 3GHz)

- Memory requirement: 4GB (DDR3, 1600 bus)

- Camera requirement: 2 Mega pixel Digital Camera

To run these apps, we need some devices,

- Windows 10

- Android phone.

Hardware:

- 32 GB Ram/4 GB ROM.

3.4   Research Methodology

We aim to develop a complex medicine authentication system which will be easier to manage with built in security and fault tolerance using blockchain. We have four decentralized databases in our system. That is, drug administrator, manufacturer, distributor, pharmacy. Drug administrator has basically used it for validated medicine. A block is created for a box of medicine, that block first goes to the drug administered, the drug administrator is validating it. At the same time the block is going to the other three phases or decentralized database. Since the drug reaches the client through some other phase.

We have seen before that drug administrators go to the product or medicine manufacturing after validation. At the time the manufacturer was able to validate the product itself and use a mobile scanner to validate. First scan the QR code and check if the block chain value is correct then validate it. After validation it will be sent to the distributor. The distributor will have the QR code because the data was already sent from the database, if it matches the database, if it matches, the distributor will give validation. After validation sends it to the pharmacy. If the pharmacy wants, then the pharmacy can find out or check which manufacturer or distributor has come via. It can be checked mainly by scanning the QR code through mobile scanner. QR code scans also find out whether the product or medicine is original. If the medicine is original then the pharmacy will give validation, then if the customer wants to take medicine, the customer can know through QR code scan who has given validation. Suppose if it is not the original medicine, then the customer can
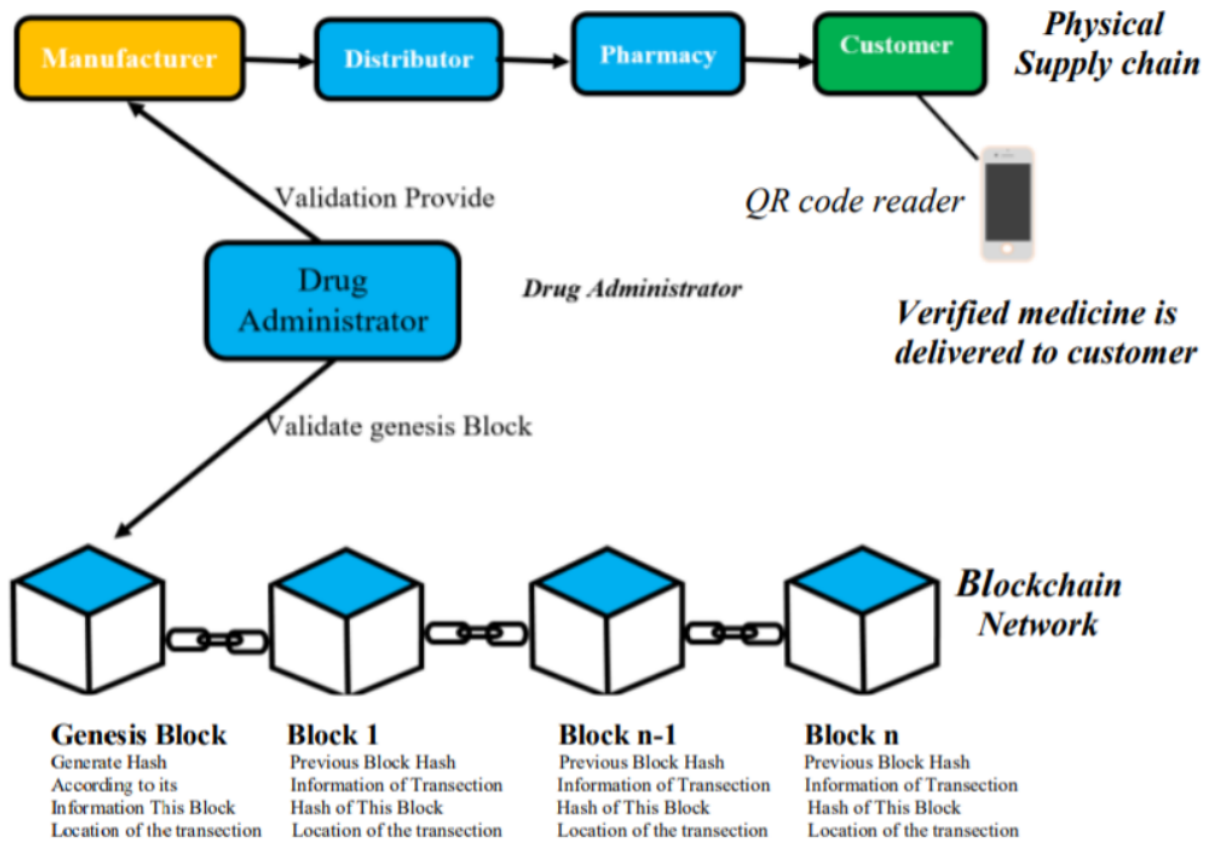
Figure 3.1: Work flow of prototype

know who gave counterfeit medicine or through whom it came. Given the validity of each phase is called consensus. So the main thing is when the transaction completes between any of them there will create a new block, each block has three hash values. Such as previous, present and next value. And for this hash value we are using SHA256. When it is valid according to present and previous data, it will add to the blockchain. Everyone can see each and every transaction in the blockchain network easily when, where and whom between the transaction will occur. In each phase we are using mobile as a scanner. We can easily use this tracing system in business and organization.

3.5 Design, Implementation and Simulation

The proposed framework represents blockchain based secure infrastructure to detect counterfeit medicine. Javascript is used to implement the steps of the proposed model. Mainly the project is built on nodeJS. Node.js is a cross-platform, an open-source, back-end JavaScript runtime environment that runs on the V8 engine and executes JavaScript program outside a web browser. Anguler web application framework is used for the frontend development.
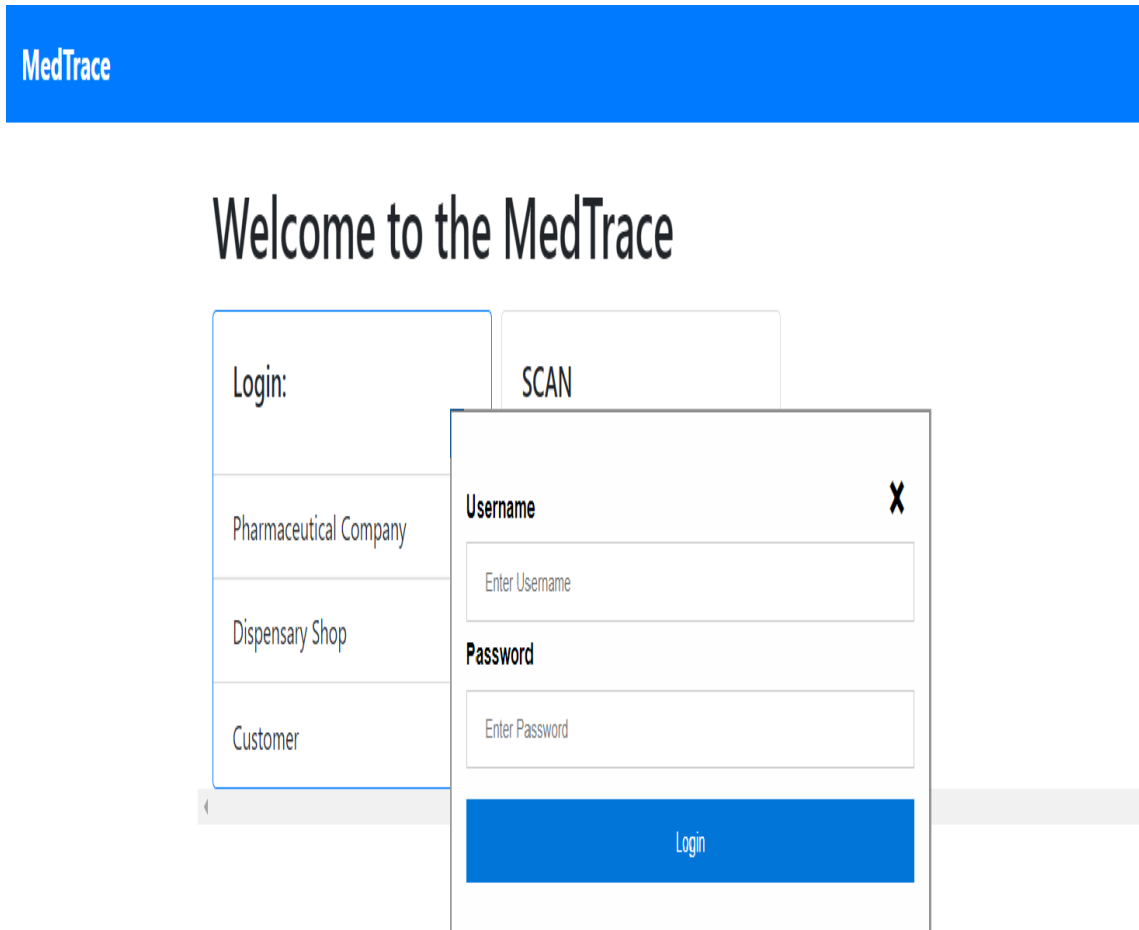
Home Page

Figure 3.2: Home page

User Login Page

Figure 3.3: User login page

Scan With Number

Figure 3.4: Scan with number

3.6   Summary

This chapter discusses the architecture of the blockchain based medicine tracing system. The estimation and analysing part is represented here to build the system.

Chapter 4

Implementation, Testing, and Result Analysis

4.1 Introduction

In this chapter, we discuss the model testing and analyzing the performance. Also, discuss the prototype set up and evaluation of the developed model. This section summaries the overall performance and show the result of efficiency about the medicine authentication system,

4.2 System Setup

To develop a prototype we mainly used Javascript and Angular web application framework. The key modules of this prototype include the validation module, blockchain module, key generator module, and transaction logic module. There are some most popular open-source libraries used in the present worked prototype, as SHA256 [33], elliptic [34], qrious [35], etc. The key generator module uses elliptic to generate a public and private key for the participants. The validation module gets the pending request of the participant validation and gives them the public and private keys using the key generation module. The validation process is maintained by the drug administrator.

Transaction creation

Figure 4.1: Create transaction

Transaction validity request

Figure 4.2: Pending transaction

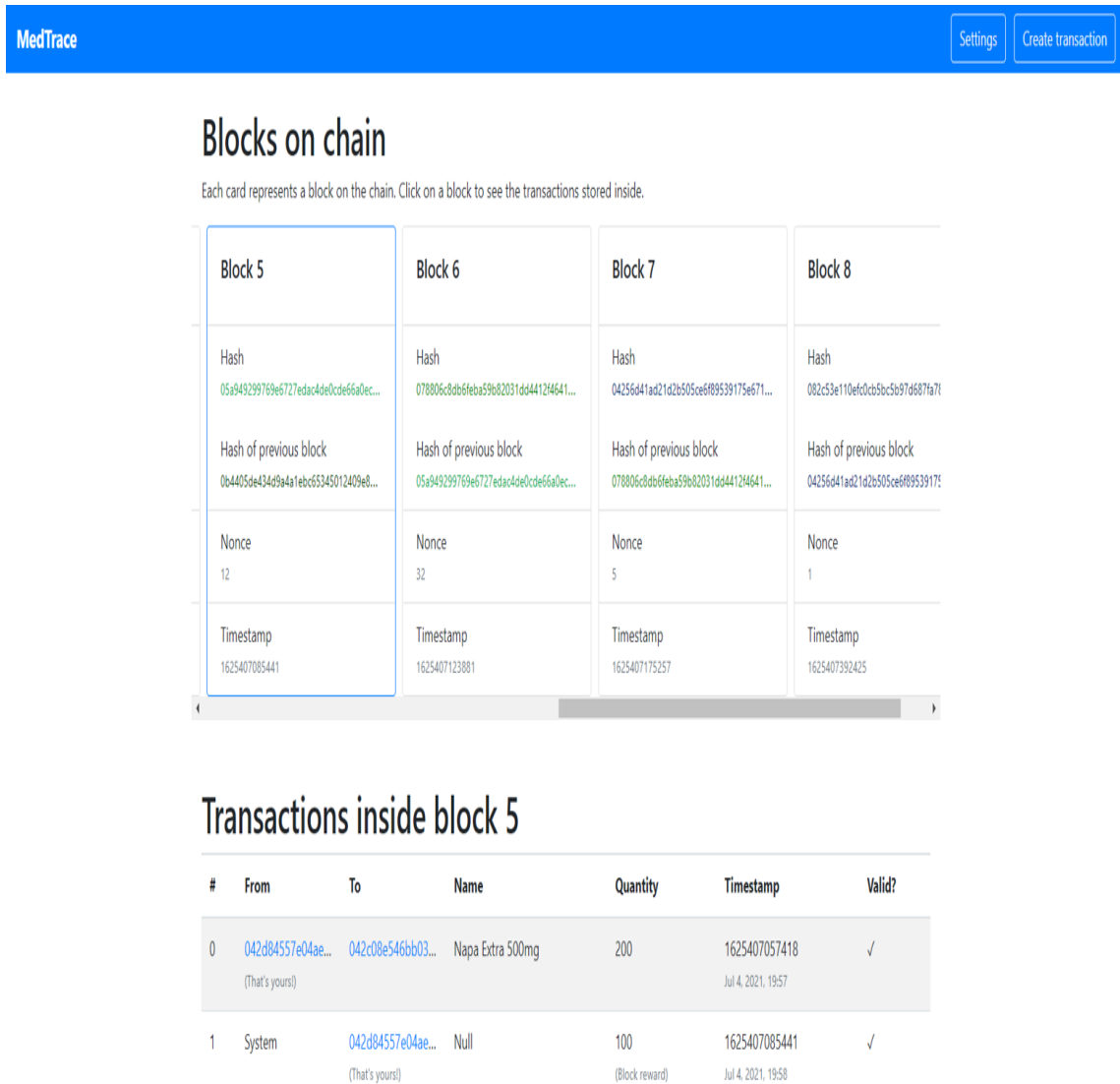**Transaction inside block**

Figure 4.3: Transaction inside block

The transaction module makes the transaction between participants, when the transaction gets valid the blockchain module adds the transaction on a block to the chain. Currently, we run the prototype on localhost. We use windows 10 operating system to build and run the prototype. Mainly the project is built on nodeJS. Node.js is a cross-platform, an open-source, back-end JavaScript runtime environment that runs on the V8 engine and executes JavaScript program outside a web browser. Anguler web application framework is used for the frontend development. AngularJS is also a JavaScript-based open-source front-end web framework mainly maintained by google and by a community of individuals and corporations to address many of the challenges encountered in developing single-page applications.

4.3 Evaluation

The most initial demand for a medicine supply chain traceability system must be its practicality, which might have been neglected mentioned in related works in section II. We designed the prototype for practical medicine supply chain traceability and regulation to trace and track the authentic medicine as if fraud manufacturers or suppliers cannot mix any kind of counterfeit medicine in the authentic supply chain. First, our prototype maintains data privacy and authentication of the participants. Additionally, the prototype as a blockchain solution first uses the current location of the transactions to its block, which really makes it easy to detect the fraud distributor and falsify medicine on the supply chain network. As well as the prototype is very simple to use. There also a user friendly interface that makes simple and encouraging to use. Finally, we added the single unit of medicine validation checking on the prototype and also proposed an optimized data decreasing process on the blockchain storage removing the information of expired medicine according to the expired date. This was an important priority concern because researchers are not proposed about data reduction in previous. The prototype achieves ultimately stable and admissible data storage with medicine expiration date.

4.4 Results and Discussion

Our prototype is implemented to be an authorized blockchain system for contrary Cyber-attacks. Drug administrators control the access of participants to the blockchain network. As a result, fraud distributors or retailers are cannot make any transactions in the network. Also participants who are not in the medicine supply chain or retailers with a bad commercial review in the medicine supply chain are therefore prohibited to use the blockchain network.

Scan number

Figure 4.4: Scan with number input

Authentication proved
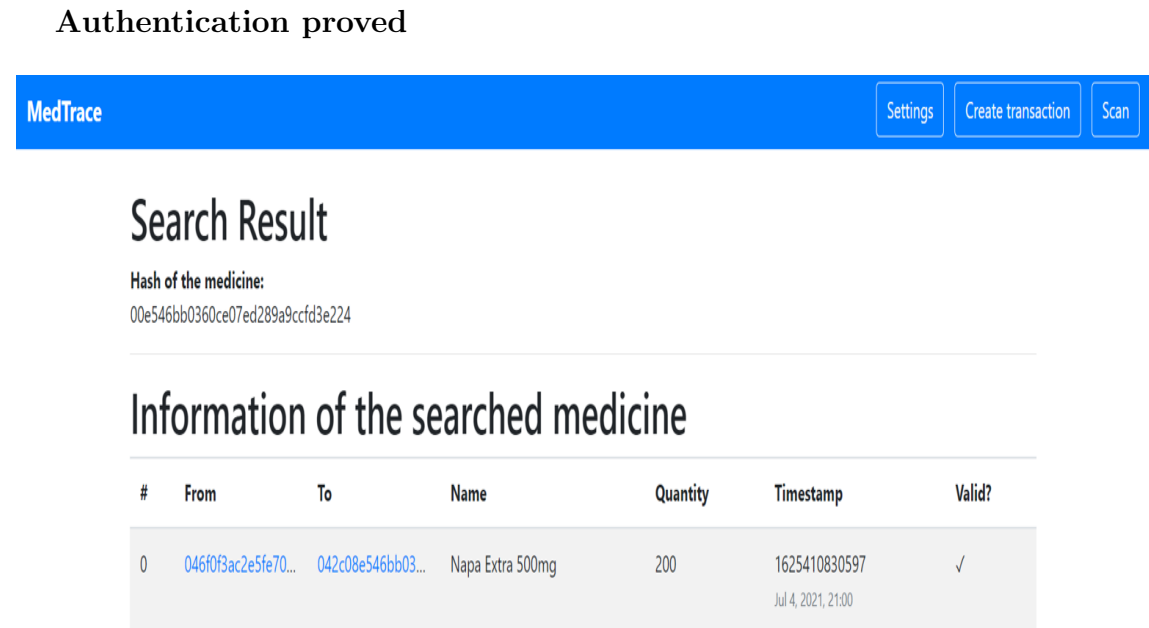
Figure 4.5: Authentication proved after scanned input number

Hence the prototype is secured from those frauds. The prototype is a low possibility of DoS attacks [20] in respect to existing server-client solutions because of the peer to peer architecture. Formal analysis of secure blockchain technology [18, 19] in the prototype may require an extra-large section to describe the basic principal of blockchain, where many of researchers explain in their work and thus be ignored here. Mainly the consensus protocol is the way to determine efficiency of blockchain. The prototype focuses on the practical requirement of medicine supply chain to detect authentic medicine.

Scan QR code
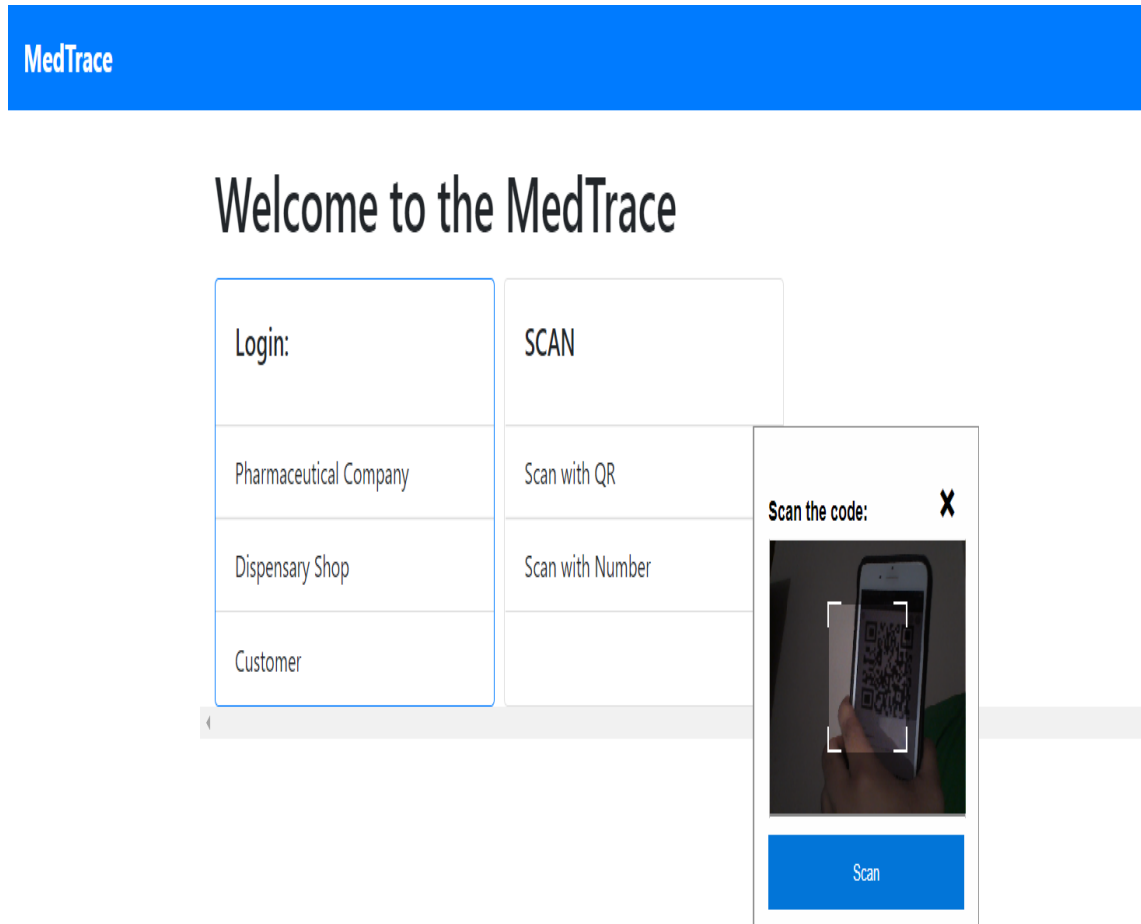
Figure 4.6: Scan QR code to counterfeit medicine trace

Figure 4.7: Authentication proved after scanned QR code

In this prototype, the communication over with the drug administrator, efficiency of consensus algorithm, and the practical throughput requirement of the medicine supply chain together decide whether it could be applied in real medicine supply production system. After the implementation of current prototype, quantitative assessment is presented which will be explained in future work.

4.5 Summary

Analyzing the testing result and evaluation performance our medicine authentication system has better efficiency and most secure drug tracing system. This prototype can smoothly detect substandard drugs without any complexity by scanning QR code with a mobile phone. Our developed model is a unique and smartest way to secure the medicine that has the best efficiency which is rigidly analyzed in this chapter.

Chapter 5

Standards, Impacts, Ethics, and Challenges

5.1 Impacts on Society

To make sure the availability and easy trace to fraud medicine "Blockchain Based Counterfeit Medicine Authentication System" works accurately. Substandard drug various warning to humankind. To prevent falsified drugs our system helps patient health from a traumatic experience. Also, loss in manufacturing industry to gain revenue. Counterfeit medicine authentication system can detect fraud and protect the patient from health and money risk. Our developed system's success in society is ensuring the quality of drugs and keeping the manufacturer's reputation.

5.2 Ethics

Our system is developed to detect and trace falsified drugs. This system is developed by maintaining the all kind of code of conduct. Also, making sure the data privacy of all customers. The main purpose of the medicine authentication system is removing counterfeit medicine from the market with tracing the fraudulent to keep the drug industry safe and loyal.

5.3 Challenges

Blockchain based medicine authentication system is implemented to trace the substandard drugs to protect the patient's health. To implement this system we faced some difficulties. The QR code scanner can systematically detect including all information of a single unit medicine. The first challenges we faced implement this system at industry level without testing in the real world. So we developed a prototype of a medicine authentication system. After succession in the real world testing we will set it up at industry level.

5.4 Summary

The traditional supply system is easy to duplicate the medicine. Our developed model is better than any other existing system that can clearly trace counterfeit medicine. Medicine authentication system is built using blockchain technology which can not be hacked by hackers. Also, market syndicates or fraudulent can not make any changes in price and can not duplicate the drugs from anywhere.

Chapter 6

Constraints and Alternatives

6.1 Design Constraints

Blockchain based medicine authentication system is implemented as a prototype model. If this system suits the market with benefits then the overall system will be set up at industry level.

6.2 Component Constraints

To implement this project minimum requirement of hardwares are:

- Processor requirement: Intel i3 (7th Gen, 3GHz)

- Memory requirement: 4GB (DDR3, 1600 bus)

- Camera requirement: 2 Mega pixel Digital Camera

The software is used to developed this project:

- Vs Code

- Node.Js

- Anguler

6.3   Budget Constraints

To implement the blockchain based medicine authentication system there is no developed cost to design a prototype. The actual cost will be calculated based on current market price when the project will be set up at industry level.

6.4   Summary

Analyzing the overall architecture blockchain based medicine authentication system is cost efficient.

Chapter 7

Schedules, Tasks, and Milestones

7.1 Timeline

The total time flow of the capstone project is complete in three parts that are segmented on the three semesters. The whole time of the work process was the observation of our supervisor. In the first semester of work flow was the planning about works and selecting titles and, analysis of related works. Also, presented the proposal of the capstone project. The second semester was designing and implementing stage where we developed our prototype. In the last period of time in the third semester, we tested the overall prototype and made a report of the whole work process

7.2 Gantt Chart

Process of the workflow was three semesters long where each semester had 12 weeks. Fig 7.1 illustrates the overall timeline in the Gantt chart

First Semester											
Weeks	1	2	3	4	5	6	7	8	9	10	11	12

Planning

Topic selection & planning

Literature Review

Analysis and Modeling

Evaluation and Feedback

Second Semester											
Weeks	13	14	15	16	17	18	19	20	21	22	23	24

Diagram & Collaboration Tools

Design Submission

Prototype Submission

Analysis and Modeling

Prototype Design

Evaluation and Feedback

Third Semester											
Weeks	25	26	27	28	29	30	31	32	33	34	35	36

Complete Implementation & Testing

Feedback & Improving

Motivation Buildup

Result Analysis

Final Report Writing
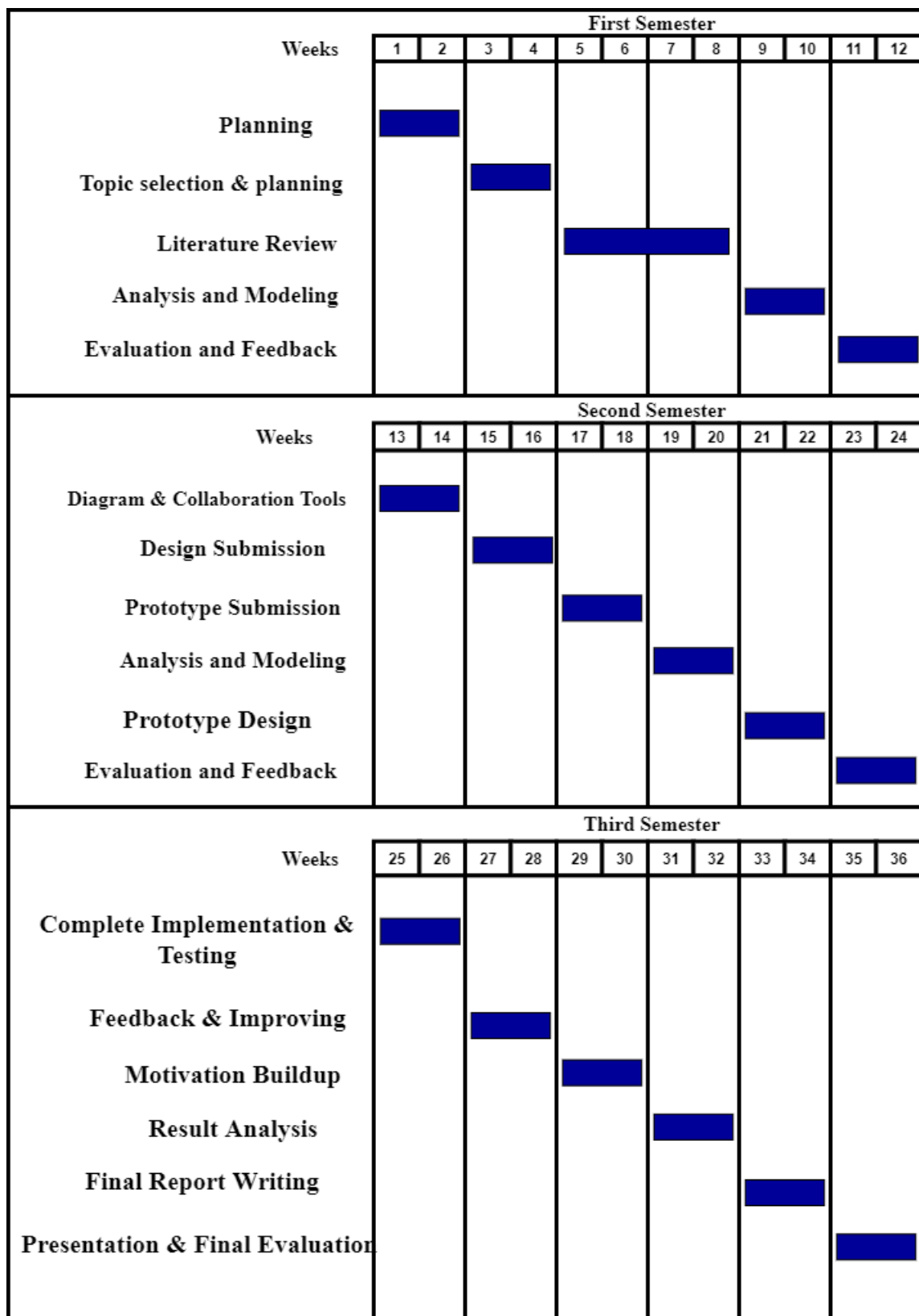
Presentation & Final Evaluation

Figure 7.1: Gantt chart of the workflow of system

Chapter 8

Conclusion

8.1   Introduction

We develop a practical blockchain based secure infrastructure for the medical supply chain among authorized participants on the traditional medicine supply chain. Our application stands on blockchain security to identify the drugs uniquely and individually. therefore, a falsified medicine or fraud distributor can be identified easily without any complexity. The prototype reconstructs the whole traditional medicine supply chain service architecture that can provide medicine security as well as authenticity of the manufacturer. It also introduces the current location of every transaction that makes the system more reliable. Optimization of blockchain data storage by removing expired medicine data makes the chain stable and acceptable.

8.2   Future Works and Limitations

Blockchain based medicine authentication systems detect original medicine scanning QR code using smartphones. The limitation of this system is that a customer/patient can not trace medicine without a smartphone. In the future we will try to make it more simple and feature-able to remove this current limitation. The main upcoming work is we are going to take it at industry level to detect counterfeit medicine.

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