

Data Handling & Drug Traceability: Blockchain Meets Healthcare To Combat Counterfeit Drugs.

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Abstract: Blockchain was initially invented for achieving secured digital money transactions but the technology has now started accommodating popularity in various other fields also such as tourism, real-estate, voting, stock-market, supply chain Handling etc. Blockchain technology is garnering ultimate buildup in the healthcare sector. Healthcare industry consists of rapidly growing sensitive data which need to be preserved from confidentiality threats and integrity threats. Out of the numerous applications of blockchain in healthcare, the two extremely prominent applications are– data handling and drug traceability. In this paper, we have discussed the problems with traditional methods of data handling and drug traceability and how blockchain overcomes those problems. Moreover, we have proposed a system which is capable of tracing drugs in the supply chain and reduce counterfeiting of drugs. Some projects and applications working in the direction of drug traceability and data handling such as Blockverify, Mediledger, MedRec, MedicalChain etc. are also discussed.

Index Terms: Blockchain, Data Handling, Drug Traceability, Healthcare, Supply Chain, Counterfeit drugs.

1 INTRODUCTION

A blockchain can be said to be a type of database on the basis of definition and design. The Blockchain technology was initiated in 2009 [1]. Since the data is stored in blocks and is distributed therefore, there is no central or single point of failure in blockchain. Moreover, blockchain uses hash chains, consensus mechanisms and digital signature [2]. The use of these progressive features makes blockchain capable of providing various services such as security, integrity, traceability etc. Major applications of Blockchain can be seen in many sectors including real estate, banking, government and finance [3]- [5]. Healthcare industry is another sector which is garnering utmost hype in blockchain use-cases [6], [7]. Two leading applications of Blockchain in healthcare industry- drug traceability and data handling are discussed in this paper. In section II of this paper, we explore the need for data handling in healthcare along with problems with current healthcare data handling. It represents how blockchain copes with the existing problems and some real time projects based on blockchain for data handling are also discussed. In section III, we look at need for drug traceability using blockchain in healthcare along with some related projects for drug traceability.

Proposed system:

We have proposed a blockchain based system which is capable of tracing the movement of drugs throughout the supply chain – beginning from manufacturer to the end patients. This system will help in fighting the counterfeiting of drugs and reduce them to great extent. In section IV we present the methodology for proposed system to detect counterfeit drugs. In section V we have discussed the results of the proposed system and conclusion and future work in this field are provided in section VI.

2 DATA HANDLING

Healthcare industry is a sector which involves great amount of sensitive data. Since the number of diseases and patients are continuously increasing, the data which needs to be handled and managed in this sector is also tremendously at increase. Data handling in healthcare involves access control, sharing and storage of data. The data is stored in the form of electronic health records (EHRs). An EHR basically contains the medical history of a patient which can be shared among

and used by various organizations. Two major threats posed in sharing of EHRs are privacy [8] and integrity threats [9].

2.1 Problems with current Healthcare Data Handling

Currently there are many problems associated with the healthcare data handling, particularly with the access control, sharing and storage of data. Two major challenges that have annoyed the stakeholders are varying data standards and interoperability [10]. Some other threats which blocks smooth storage of data in healthcare are scalability, performance and data availability.

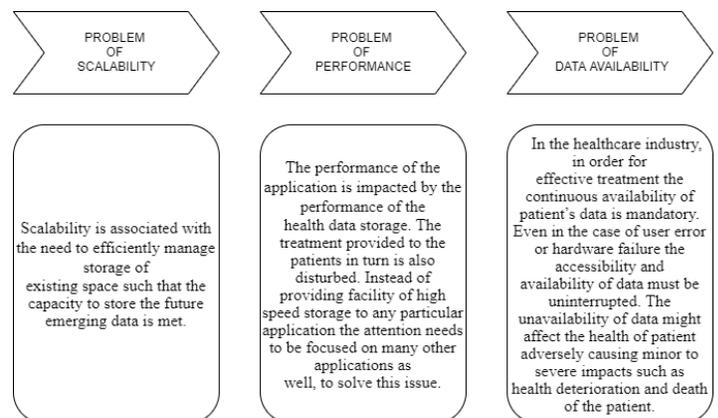


Fig1: Problems with data handling in healthcare.

2.2 How Blockchain copes with these data handling problems

All the challenges and problems with the current healthcare records handling can be overcome by incorporating Blockchain. Blockchain provides a platform where sharing of health data can be achieved with the assurance of patient privacy and data integrity. Blockchain provides a patient-centric model where the patients can manage their health records. Today, in terms of data security, Blockchain is the most efficient technology [11].

Blockchain provides following features making it an effective platform for healthcare data handling:

1. **Accessibility-** The patients can securely, more easily and effectively access their health records in blockchain enabled applications.
2. **Interoperability-** The use of centralized data storage in traditional models is blocking smooth interoperability of patients' data. Blockchain can overcome these issues as there is no need of centralized database in blockchain, instead all the nodes can directly connect with each other.
3. **Authentication-** The use of specific private key along with public key accomplishes the authentication of data stored in the blocks in Blockchain.
4. **Decentralized storage-** One of the major feature of Blockchain technology is decentralized storage. Decentralized storage facilitates improved data quality, faster access to medical data and enhanced security.

3 Healthcare Data Handling Projects based on Blockchain

MedRec- MedRec is a disseminated record handling system which manages electronic health records using blockchain [12]. All the requirements in handling sensitive data are accurately managed by MedRec such as accountability, data sharing, authentication, confidentiality etc.

Medshare- Medshare is an Blockchain based platform which claims that they are adequately capable of tracing behavior of the data and abolish access to breached permissions on data with the utilization of an access control system and smart contracts [13]. Medshare provides trailing, data provenance and auditing on medical data which enables sharing of medical records between untrusted parties.

MedicalChain- The problems of fragmented and multiple health records of patients in organizations are solved by MedicalChain by storing all the medical records on the blockchain as transactions [14]. Time-limited access is provided to patient's health records with the utilization of smart contracts.

Patientory- Patientory is one of the leading and earliest blockchain based startup providing solutions for healthcare [15]. It utilizes blockchain to improve data security by ensuring end-to-end encryption.

Iryo- Iryo [16] provides a platform for patients where they can securely share their medical history by incorporating public blockchain and openEHR archetypes [17]. Some other healthcare data Handling projects based on blockchain includes Hearthy [18], FHIR Chain [19], Gem Health [20], Medico-Health [21] etc.

3 DRUG TRACEABILITY

In the healthcare industry the problem of counterfeit or fake drugs is increasing at a rapid rate. The consumption of these fake drugs might affect the patient's health adversely. These fake drugs will also affect the reputation of the firm

manufacturing drugs as well as other stakeholders involved in it. Therefore, it is essentially important to design a secure system for traceability of drugs in order to overcome the problem of counterfeiting. Many steps have been taken by the governments worldwide for drug traceability [22,23,24]. Patients and other stakeholders can easily trace the location of the drug in the drug supply chain and verify its legitimacy through a secured drug traceable system.

3.1 Why Blockchain for Drug Traceability

The traditional drug traceability systems are inefficient and lacks major requirements for pharmaceutical supply chain Handling. The following problems with general drug traceability approaches describes the need of blockchain in drug traceability –

1. **Problem of Visibility-** The lack of visibility in the current healthcare systems is a major issue which increases problems like drug shortages, opioids and counterfeits. Also, due to the lack of transparency the patients and other stakeholders are not able to track drug movements in the supply chain effectively.
2. **Problem of Regulatory Consents-** A great amount of pharmaceutical ingredients needed in manufacturing of drugs are imported from outside the country. Every step from production to drug distribution must follow drug supply chain regulations by law.
3. **Problem of Cold-Chain Shipping-** There are many medicines which are sensitive in nature and requires to be stored in an environment which is temperature controlled. But in the current software's the storage of these cold-chain shipping information are done on the centralized databases which are highly prone to data hacks and manipulations.

3.2 Related Work

Mediledger Project [25] is a decentralized and open network for the Handling of supply chain in pharmaceutical industry. It uses permissioned blockchain for maintaining records of transaction of the drugs. Mediledger has made the process of certifying authenticity of drugs very easy and it also stops counterfeiting of drugs. BlockVerify is another leading firm working towards the traceability of counterfeit products. BlockVerify [26] uses quick response i.e. QR codes for uniquely identifying different drugs. The drugs packaging are sealed with QR codes and stored on the blockchain. These drugs can be tracked and traced throughout the supply chain. Provenance [27] is another blockchain solution which works for the traceability of products. The products can be traced throughout the supply chain from manufacturer to end-user with the help of unique id assigned to each product. Authentag [28] uses blockchain distributed ledger property for tracking pharma products and verifying authenticity of drugs in the supply chain. Some other blockchain-based solutions for traceability of products and reducing counterfeits includes Skuchain [29], Verisart, VeChain, Ambrosus [30] etc.

4 METHODOLOGY

Blockchain provides a secure channel for drug supply chain stakeholders such as manufacturers, patients, wholesalers, pharmacists etc. The movement of drugs at every step in supply chain is stored on the blockchain. The process for drug traceability system using blockchain is represented in Fig. The manufacturer manufactures drugs and binds it with a unique hash code. The manufacturing details of the drugs along with the hash code are stored on the blockchain. Next in the supply chain comes the distributor. Firstly, distributor verifies the drugs origin and check for drug legitimacy and then stores the transaction on blockchain. This process of verifying originality of drugs and storing transactions on blockchain continues throughout the supply chain from manufacturers to end-patients. In this way the problem of counterfeit drugs is reduced and drug traceability is achieved by blockchain.

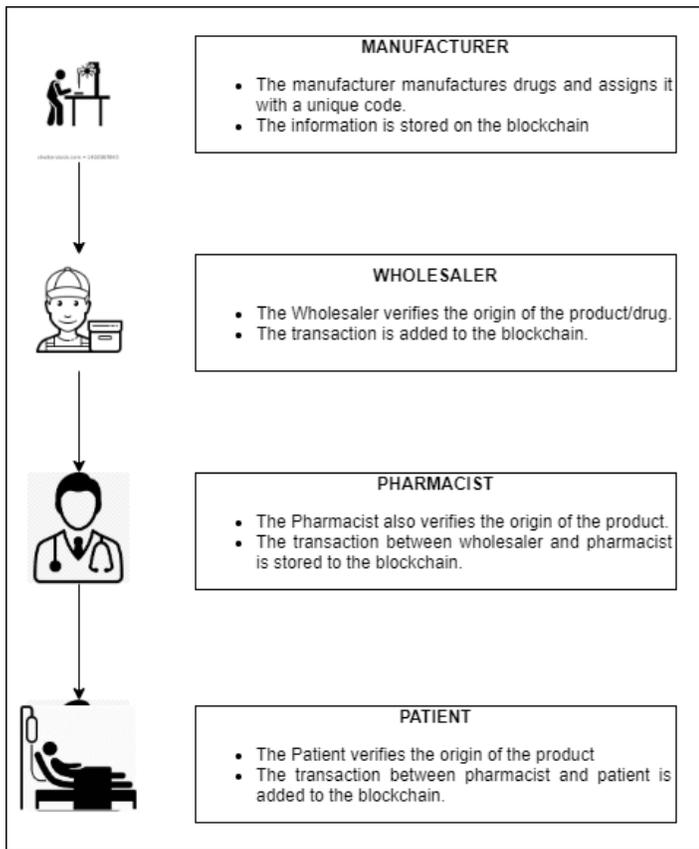


Fig2: Drug Traceability Using Blockchain

5 RESULT

Blockchain has been eventually proved as an aid to healthcare, which improves the process of data handling and drug traceability to great extent. Still there are many shortcomings involved with these tasks. Counterfeiting of drugs can be majorly combated by the proposed system. The proposed system is able to reduce the propagation of fake medicines in healthcare industry to great extent. But, still there are many aspects which increases drugs counterfeiting. The table below describes various aspects increasing counterfeit drugs market and their risk to healthcare sector.

S.NO.	ASPECT	DESCRIPTION	RISK
1	Demand is more than supply.	When supply of drugs is not able to cope with rising demands, then the criminal minds get to work to counterfeit drugs as high major profits can be made by selling counterfeit drugs.	High
2	High prices	High drug prices and major price differentials acts as great incentives for the increase in supply of cheap counterfeit medicines.	Medium
3	Lack of Legislation	An appropriate legislation must be appointed by the country to overcome drug counterfeiting. If the legislation improperly manages the manufacturing and distribution of drugs, the level of counterfeits goes up.	Low
4	Weak Penalty	Weak penalties or absence of penalties for violating drugs legislation increases counterfeiting of drugs.	Low
5	Drug regulatory authority(DRA)	DRA is responsible for keeping quality check on the manufacturing of drugs. Weak DRA or lack of DRA will increase counterfeiting.	Medium

Table 1: Aspects increasing drugs counterfeiting.

6 CONCLUSION AND FUTURE SCOPE

Healthcare is a very sensitive sector which includes tremendous amount of data handling and ways to cope with counterfeiting. With blockchain we can easily and securely achieve drug traceability and data handling in healthcare. In this paper we discussed the problems with traditional methods for drug traceability and data handling and how blockchain overcomes these problems is also discussed. Moreover, a system providing blockchain solutions for data handling and traceability of drugs is also represented and discussed. Blockchain technology is slowly establishing itself in the

healthcare sector. Some future directives can be towards patients consent management. Adding consent of the patient regarding their treatment history and preferences on blockchain will allow stakeholders to access consents from any place and elevate the care provided to the patient. Future research can be done to secure data of clinical trials through blockchain. Blockchain technology is still very new for the users. The potential future work involves making more and more stakeholders aware of the advantages of blockchain.

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