Original Research Paper

Blockchain Based Framework for Secure Data Sharing of Medicine Supply Chain in Health Care System

Sahana[1], Thejashwini[1], Vagdevi Kamath[1], Yaparla Lahari[1], Kusuma Mohanchandra[1]

[1] *Department of Information Science and Management, Dayananda Sagar Academy of Technology and Management Bangalore. Karnataka, India.*

Abstract: The potential for blockchain technology in the healthcare sector is summarize in this study. It covers a wide range of technology themes, including storing medical information in blockchains, patient personal data ownership, and patient outreach via mobile apps. Blockchain was created to safeguard digital money transactions, but it has since gained popularity in a variety of other industries, including tourism, real estate, voting, the stock market, and supply chain management. In the healthcare industry, blockchain technology is rapidly gaining traction. Threats to integrity as well as threats to threats to threats to threats to threats to threats to Data management and medicine traceability are two of the most well-known blockchain uses in healthcare. We've explored the problems with standard data processing and drug tracing approaches in this paper.

1. Introduction

Blockchain could be classified as a DDT (decentralized distributed technology). A distributed system of computing nodes within the peer-to-peer network means and manages a set of records that close share or transfer crucial and digital assets like transactions, goods, and services in blockchain. This report summaries the possibilities of blockchain technology in the healthcare industry. It covers a wide range of technological topics, such as storing medical data on blockchains, patient data ownership, and patient outreach using mobile apps. Blockchain was originally designed to protect digital currency transactions, but it has since grown in popularity in a range of other areas, including tourism, real estate, voting, the stock market, and supply chain management. Blockchain technology is quickly gaining acceptance in the healthcare industry. In this study, we've looked at the issues with traditional data processing and drug tracing methods. Blockchain is a system that evolved from bitcoin and is a distributed database with continuously expanding records called blocks that cannot be edited or altered. The most basic concept behind blockchain is to keep shared data's integrity, traceability, and accountability in check. Methods such as preservation and authentication are constrained by Distributed Ledger, which are carried out in a network of interconnected nodes. These nodes install and audit software that harmonises the shared Ledger images among a peer-to-peer network of shareholders, presenting all accountable acts through digital fingerprints or hash codes. Ledger is regarded as widespread and reliable when it comes to data collection. Each node member of the blockchain has Blockchain ensures that data isn't altered with and verifies many aspects of data provenance. Because this technology uses cryptographic techniques, the blockchain network's distributed environment assures that all information is distributed in a transparent, trustworthy, and auditable manner [1]. Because of its irreversibility and immutability properties, blockchain technology is the most trusted all-in-one cryptosystem for protecting transactions over networks [1]. As a decentralized architecture, the blockchain network has piqued the interest of a wide range of entrepreneurs, administrators, and developers. The technology protects transactions from modification and includes a tool for tracing previous network operations [1]. A blockchain is frequently described as a database of definitions and styles. In Kumari et al [2] the Blockchain technology was introduced.

Table 1. Blockchain Companies for Healthcare Data Management

	Blockchain company		
	Name	Country	Website
EMR data management	PokitDoc	USA	http://pokitdoc.com
	Gem	USA	http://enterprise.gem.co/health
	YouBase	USA	http://www.youbase.io
EHR data management	Medicalchain	USA	http://www.medicalchain.com
	HealthWizz	USA	http://www.healthwizz.com
	Curisium	USA	http://www.curisium.com
	Hearthy	Spain	http://hearthy.co
	Iryo	Slovenia	http://iryo.io
	Robomed	Russia	http://www.robomed.io
PHR data management	Medcredits	USA	https://medcredits.io
	MyClinic	UK	https://myclinic.com
Point-of-care genomics	Nebula Genomics	USA	http://www.nebula.org
	Genomes.io	USA	http://www.genomes.io
	TimiCoin	USA	http://www.timicoin.io
	Shivom	Switzerland	http://shivom.io
Oncology patients network	OncoPower	USA	http://oncopower.org
Pharma & drug development	Embleema	France	http://www.embleema.com
	BlockPharma	France	http://www.blockpharma.com
	Chronicled MediLedger	USA	http://www.mediledger.com

EMR: Electronic Medical Record
EHR: Electronic Health Record
PHR: Personal Health Record

In developing nations, counterfeit tablet production and distribution may be a severe and continuous problem [3] [4]. The annual worth of counterfeiting to the industry has reached billions of dollars [5]. One explanation for this is that pharmaceutical companies' supply chains have weaknesses that allow medications to change hands before reaching the customer. Data isn't usually shared between systems in present supply chain systems. Producers are unaware of what happens to their products, and the administrative unit is unaware of the system as well. Recalls are time-consuming and costly, and firms are unable to track down patients [6]. The biggest concerns with drug safety in the counterfeit medicine supply chain have to do with how the drugs are packaged.

2. Literture Review
2.1. Health of the Public
Disaster and emergency mitigation and management, as well as protective supplies for healthcare workers during public health emergencies and availability to important pharmaceuticals, vaccines, and immunizations, are all supply chain difficulties that affect public health. Blockchain technology solutions overlap with use cases within the pharmaceutical supply chain and combating substandard and falsified (SF) medicines in the context of access to essential and quality medicines, but they also reach maintaining adequate supply at point of distribution (e.g., mitigating stock outs), shortening health systems related corruption in medicines procurement, and catalyzing effective delivery of healthcare services and supplies [7].

The consent management of patients is one of the upcoming trends in healthcare. Stakeholders will be able to access a patient's permission to their treatment history and preferences from anywhere, enhancing the patient experience.

Pharmaceutical businesses have had difficulty tracking their products along the supply chain process for the past decade, allowing counterfeiters to enter the market with their bogus medicines. Counterfeit pharmaceuticals are seen as a major threat to the pharmaceutical sector around the world. According to estimates, US pharmaceutical businesses suffer a yearly commercial loss of roughly $200 billion as a result of counterfeit pharmaceuticals [8] [9]. These treatments may not help patients recover from their illnesses, but they do have a slew of potentially hazardous side effects. According to a survey conducted by the World Health Organization (WHO), every tenth drug used by consumers in developing nations is counterfeit and of low quality. To combat counterfeiting, a system that can trace and track medicine distribution at every stage is required.

2.2. Features of Blockchain
Blockchain provides following features making it an efficient platform for healthcare data handling [2]:
1. Accessibility
   The patients can securely, more easily and effectively access their health records in blockchain enabled applications.
2. Interoperability
   The utilization of centralized data storage in traditional models is obstructing smooth interoperability of patient's data. Blockchain can overcome these issues as there's no need of centralized database in blockchain, instead all the nodes can directly connect with each other.
3. Authentication
   The employment of specific private key together with public key accomplishes the authentication of knowledge stored within the blocks in Blockchain.
4. Decentralized Storage
   One in every of the most important feature of Blockchain technology is decentralized storage. Decentralized storage facilitates improved data quality, faster access to medical data and enhanced security.

2.3. Tracing the Drugs
In the healthcare industry the matter of counterfeit or fake drugs is increasing at a rapid rate. The consumption of those fake drugs might affect the patient's health adversely. These fake drugs will affect the reputation of the firm manufacturing drugs furthermore as other stakeholders involved in it [10] [11] [12]. Therefore, it's essentially important to style a secure system for traceability of

medication so as to beat the matter of counterfeiting. Many steps are taken by the governments worldwide for drug traceability. Patients and other stakeholders can easily trace the situation of the drug within the drug supply chain and verify its legitimacy through a secured drug traceable system [13] [14] [15] [16] [17].

The traditional drug traceability systems are inefficient and lacks major requirements for pharmaceutical supply chain Handling. The dearth of visibility within the current healthcare systems could be a major issue which increases problems like drug shortages, opioids and counterfeits. Also, because of the shortage of transparency the patients and other stakeholders don't seem to be able to track drug movements within the supply chain effectively.

Table 2. Selected Companies Exploring Blockchain for Health Supply Chain Management

Company	Features	Website
Block Verify	Extending anti-counterfeit solutions from luxury valuables to medications	http://www.blockverify.io
Chronicled	Partnered with The LinkLab for a blockchain-supported DSCSA compliance platform	https://www.chronicled.com
IBM Blockchain	Early work with supply chain management in food products with multiple partners	https://www.ibm.com/blockchain/supply-chain
FarmaTrust	UK org developing blockchain solution for pharmaceutical supply chain, Initial Coin Offering (ICO) primarily for European market	https://www.farmatrust.com
iSolve	Advanced Digital Ledger Technology, BlockRx ICO primarily for U.S. market	http://isolve.io
Modum	Blend of blockchain and sensors, MOD token Initial Token Offering (ITO)	http://modum.io
OriginTrail	Recognized by Walmart Food Safety, partnered with Yimishiji; TRAC token	https://origintrail.io
Provenance	UK org starting with chain-of-custody for food; positioned to extend	https://www.provenance.org
T-Mining	Belgians partnered with NxtPort for container shipping; adaptable tech	http://t-mining.be
The LinkLab	Knowledge resource, development partner, partnered with Chronicled	http://www.thelinklab.com
VeChain	Combining blockchain and IoT; food/drug forays in roadmap; VEN/VET token	https://www.vechain.com
Walton	Early phase to use RFID and IoT; goals to scale to business ecosystem; WTC token	https://www.waltonchain.org

The subsequent problems with general drug traceability approaches describes the requirement of blockchain in drug traceability [2].

1. Problem of Regulatory Consents
   A good amount of pharmaceutical ingredients needed   in manufacturing of medicine are imported from outside the country. Every step from production to drug distribution must follow drug supply chain regulations by law.
2. 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 within the current software's the storage of those cold-chain shipping information are done on the centralized databases which   are highly vulnerable to data hacks and manipulations.

The aims of drug tracebility [5]:
1. To safeguard public fitness and to forestall and combat counterfeit capsules at national, local levels through the measures provided on this convention and protocol.
2. To formulate a commonplace and coordinated technique towards the elimination of the counterfeit tablets, and also the development of common definitions, information resources and tools.
3. To stop counterfeit drugs.
4. To find the consciousness of the fake medication issue which needs an expanding security level for the appropriation of lawful pharmaceutical items.

3. Proposed Method for Blockchain in Personal Health Record

A Personal Health Record (PHR) system allows patients to manage and share data concerning their health conditions by particular individuals, within the event of an emergency, the patient is unable to approve the emergency staff access to the PHR. Furthermore, a history record management system of the patient's PHR is required, which exhibits hugely private personal data. They have suggested a healthcare management framework that employs blockchain technology to provide a tamper protection application by considering safe policies. These policies involve identifying extensible access control, auditing, and tamper resistance in an emergency scenario. Systematically, it works supported the permissioned blockchain Hyperledger Fabric and Hyperledger Composer. During this framework, the authors have utilized the smart contracts in blockchain technology to supply security policies that patients can manage the access rules of other participants within the healthcare system using the consortium strategy.

Further, framework provides the historian records for auditing that stores the history of transactions while patients are in an emergency. Moreover, they will trace the history of the records held by other participants (doctors) after recovery. The Hyperledger Composer playground to judge its performance of our framework. Our experimental results demonstrated that this framework assures the key data sharing of the PHR by considering the immutability, auditing, and emergency access control policies [1].
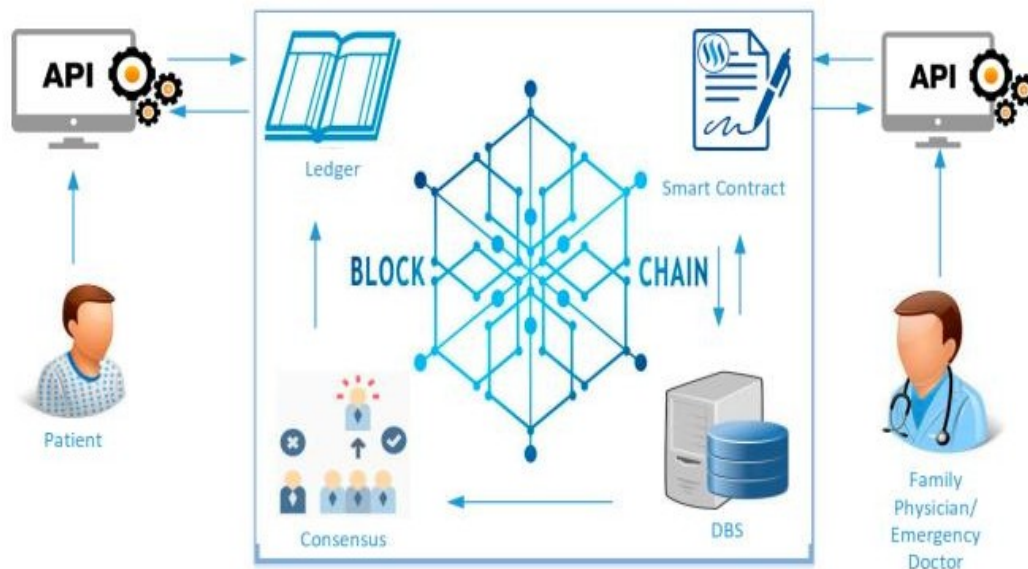

Figure 1. Proposed Framework for Personal Health Record (PHR) Access Control in Emergency

4. Discussion

The potential for the employment of blockchain technology in hospitals has begun to be tested in several pilot projects globally. Last year within the Booz Allen Hamilton Consulting developed and

implemented a blockchain-based pilot platform designed to assist the Food and Drug Administration's Office of Translational Sciences explore a way to use the technology for healthcare data management. The trial is currently being implemented at four major hospitals; it's using Ethereum to manage data access via virtual private networks. The project was constructed on the IPFS to utilize encryption and reduce data duplication via off-chain cloud components with cryptographic algorithms to form user sharing.

There are five potential benefits of blockchains compared with traditional healthcare direction systems.

- First, blockchains enable decentralized management; they're suitable for applications where healthcare stakeholders (e.g., hospitals, patients, payers, etc.) wish to collaborate with each other without the control of a central management intermediary.
- Second, blockchains provide immutable audit trails; they're suitable for unchangeable databases to record critical information (e.g., claim records).
- Third, blockchains enable data provenance; they're suitable to be used in managing digital assets (e.g., patient consent in clinical trials).
- The ownership can only be changed by the owner, following cryptographic protocols. Also, the origins of the assets are traceable (i.e., the sources of the info and records are often confirmed), increasing the reusability of verified data.
- Fourth, blockchains make sure the robustness and availability of data; they're suitable for the preservation and continuous availability of records (e.g., the electronic health records of patients).
- Finally, they increase the protection and privacy of data; data is encrypted in blockchains and may only be decrypted with the patient's private key whether or not the network is infiltrated by a   malicious party, there's no practical thanks to read patient data.

Effective supply chain management may be a challenge in every industry, but the healthcare industry presents one more layer of complexity. A compromised supply chain can directly impact patient safety and health outcomes, which is why many are turning to blockchain technology to boost security, integrity, data provenance, and functionality.

The increase in globalization has led to the adoption of data systems and technology, yet as a sector with multiple actors in various jurisdictions. This has led to a posh health supply chain. Numerous efforts are made to guard supply chains within the broader context of all commodities and goods. The US National Strategy for Global Supply Chain Security could be   a White   House initiative to push efficiency and security and foster resilience. While the government-wide strategy is very important, it's especially important in healthcare because a compromised supply chain may result in patient safety problems. Additionally, to the danger of missing critical supplies, there are health risks related to failing to secure and distribute lifesaving commodities.   Security breaches may also result in adverse events that affect patient health. This could include increased morbidity and mortality within the end-user or patient.

However, extending these potential benefits to acute challenges within the health supply chain remains an undelivered promise. Going forward, this can require greater research, investment, and deployment of solutions which will be evaluated rigorously for his or her actual impact on patient safety and population health outcomes. Numerous use cases within the health sector will likely emerge. Two additional pharmaceutical sector examples that illustrate specific benefits that a blockchain-powered supply chain might offer are drug recall management and addressing medicine abuse (e.g., opioids). The capacity to utilize smart contracts to automate processes and reduce costs is additionally an important mechanism by which blockchain technology could help achieve supply chain performance enhancement.

Drug counterfeiting may be a global problem with significant risks to consumers and therefore the general public. Within the Philippines, 30% of inspected drug stores in 2003 were found with substandard/spurious/falsely-labeled/falsified/counterfeit drugs [13]. The economic burden on the population drug expenditures and on governments is high. The Philippine Food and Drug Administration (FDA) encourages the general public to test the certificates of product registration and report any instances of counterfeiting. The National Police of Philippines responds to such reports through a special task force. However, no literature on its impact on the distribution of such drugs

were found. Blockchain technology may be a cryptographic ledger that's allegedly immutable through repeated sequential hashing and fault-tolerant through a consensus algorithm.

5. Conclusion

Blockchain has been eventually proved as an aid to healthcare, which improves the method of knowledge handling and drug traceability to great extent.Still there are many shortcomings attached these tasks. Counterfeiting of medication are often majorly combated by using Blockchain system.

The findings show that new digital platforms supported blockchains are emerging to enabling fast, simple, and seamless interaction between data providers, including patients themselves.

References

[1] Rajput, A. Raza, Q. Li, and M. T. Ahvanooe, "A Blockchain-Based Secret-Data Sharing Framework for Personal Health Records in Emergency Condition", in *Healthcare Multidisciplinary Digital Publishing Institute*, vol. 9, no. 2, pp. 206, 2021.

[2] Kumari, Kavita, and Kavita Saini, "Data handling & drug traceability: Blockchain meets healthcare to combat counterfeit drugs", *International Journal of Scientific and Technology Research*, vol. 9, no. 3, pp. 728-731, 2020.

[3] D. Kamath, M. F. Fathima, M. K. P., and M. Kusuma, "Survey on Early Detection of Alzheimer's Disease using Different Types of Neural Network Architecture", *International Journal of Artificial Intelligence*, vol. 8, no. 1, pp. 25-32, Jun. 2021.

[6] E.-K. Hachem and M. H. Harouni Alaou, "Improvement of the Intelligent Tutor by Identifying the Face of the E-Learner's ", *International Journal of Artificial Intelligence*, vol. 6, no. 2, pp. 112-119, Dec. 2019.

[7] Saini, Kavita, K. Kumari, and S. Sagar, "Blockchain Securing Drug Supply Chain: Combating unterfeits," in *Blockchain and IoT Integration*, Auerbach Publications, United States, 2021, pp. 77-88.

[8] Absul, K. Bharat, and S. P. Kosbatwar, *a Novel Approach for Traceability & Detection of Counterfeit Medicines through Blockchain* EasyChair: Italy, 2020.

[9] M. M. Hossain, S. Krishna Pillai, S. E. Dansy, and A. A. Bilong, "Mr. Dr. Health-Assistant Chatbot", *International Journal of Artificial Intelligence*, vol. 8, no. 2, pp. 58-73, Dec. 2021.

[10] Clauson, A. Kevin, A. Elizabeth, A. Breeden, C. Davidson and T. K. Mackey, "Leveraging Blockchain Technology to Enhance Supply Chain Management inHealthcare: An exploration of challenges and opportunities in the health supply chain", Blockchain in Healthcare Today, 2018.

[11] M. F. Naen, M. H. Muhamad Adnan, N. A. Yazi, and C. K. Nee, "Development of Attendance Monitoring System with Artificial Intelligence Optimization in Cloud", *International Journal of Artificial Intelligence*, vol. 8, no. 2, pp. 88-98, Dec. 2021.

[12] Sylim, Patrick, F. Liu, A. Marcelo, and P. Fontelo, "Blockchain technology for detecting falsified and substandard drugs in distribution: pharmaceutical supply chain intervention", *JMIR Research Protocols*, vol. 7, no. 9, pp. 63-101, 2018.

[13] Dimitrov, V. Dimiter, "Blockchain Applications for Healthcare Data Management", *Healthcare Informatics Research*, vol. 25, no. 1, pp. 51-56, 2019.

[14] Arpitha, Binduja, Jahnavi, and K. Mohanchandra, "Brain Computer Interface for Emergency Virtual Voice", *International Journal of Artificial Intelligence*, vol. 8, no. 1, pp. 40-47, Jun. 2021.

[15] Harshitha, G. Chamarajan, and C. Y, "Alzheimer's Disease: A Survey", *International Journal of Artificial Intelligence*, vol. 8, no. 1, pp. 33-39, Jun. 2021.

[16] S. Sharunya R, V. Desai, M. Singh, and K. Mohanchandra, "Survey on Early Detection of Alzhiemer's Disease Using Capsule Neural Network", *International Journal of Artificial Intelligence*, vol. 7, no. 1, pp. 7-12, Apr. 2020.

[17] Anisha and Saranya, "A Comprehensive Review on Artificial Intelligence Techniques for Covid-19 Pandemic", *International Journal of Artificial Intelligence*, vol. 8, no. 1, pp. 17-24, Jun. 2021.