

Block Chain in Prescription Management

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Abstract: Blockchain technology has the potential to revolutionize the prescription management system by ensuring secure, transparent, and tamper-proof record-keeping. With blockchain, prescriptions can be stored in a decentralized network, accessible to authorized parties only. Blockchain-enabled prescription management can provide doctors, patients, and pharmacists with a secure and transparent platform to manage prescriptions, reducing the risk of errors and fraud. Blockchain can also ensure the accuracy and completeness of prescription data, reducing the potential for mistakes and improving patient safety. By implementing blockchain in prescription management, healthcare providers can streamline the prescription process, improve patient outcomes, and enhance the overall quality of care. This article provides an overview of the benefits of blockchain in prescription management and its potential impact on the healthcare industry.

I. INTRODUCTION

Prescription management is a critical aspect of healthcare delivery that involves various stakeholders, including physicians, patients, pharmacists, and insurance providers. However, the traditional paper-based prescription management system is often associated with errors, inefficiencies, and security risks. With the emergence of blockchain technology, there is an opportunity to transform the prescription management system by leveraging its features of decentralization, immutability, and transparency. By using blockchain, prescriptions can be stored in a decentralized network, accessible to authorized parties only, ensuring secure and transparent record-keeping. Moreover, blockchain can ensure the accuracy and completeness of prescription data, reducing the potential for mistakes and improving patient safety. In this article, we will explore the benefits of blockchain in prescription management and its potential impact on the healthcare industry. The use of blockchain technology in prescription management can streamline the prescription process, reduce the risk of errors, and improve patient outcomes. By using blockchain, physicians can create and share prescriptions securely and transparently, reducing the risk of unauthorized access or manipulation. Patients can access their prescription information and share it with their pharmacists or insurance providers, ensuring smooth communication and collaboration among all stakeholders.

A. Background

We discuss the basic concepts of blockchain technology in this portion. It was introduced simultaneously with Bitcoin and overcame the double-spend problem, a long-standing vulnerability. In the case of Bitcoin, this is executed by coming to an agreement with the greater part of the so-called mining nodes and adding genuine transactions to the blockchain. Blockchain technology was first used for cryptocurrencies. However, introducing cryptocurrency is not necessary to use the system and create decentralized networks. The fundamental traits and constituent parts of the blockchain will be discussed in the following subsections.

B. Need for Blockchain in Prescription Management

The traditional paper-based prescription management system has been associated with several challenges, including errors, inefficiencies, and security risks. For instance, paper prescriptions can be lost or misplaced, resulting in delays in patient care. Additionally, the paper-based system is vulnerable to errors and fraud, such as prescription forgery or unauthorized access to patient information. These issues can have serious consequences, including patient harm, financial losses, and legal liabilities.

Blockchain technology offers a potential solution to these challenges by providing a secure, transparent, and tamper-proof record-keeping system. By using blockchain, prescriptions can be stored in a decentralized network, accessible to authorized parties only, ensuring secure and transparent record-keeping. This eliminates the risk of unauthorized access or manipulation, reducing the potential for errors and fraud.

Moreover, blockchain can ensure the accuracy and completeness of prescription data, reducing the potential for mistakes and improving patient safety. The decentralized nature of blockchain also ensures that prescription data is available in real-time, enabling healthcare providers to make informed decisions quickly.

In addition to these benefits, blockchain can also enable the tracking and monitoring of medication supply chains, reducing the risk of counterfeit or substandard medications. By using blockchain, stakeholders can track the movement of medications from the manufacturer to the patient, ensuring that medications are authentic and safe.

Overall, the need for blockchain in prescription management arises from the limitations of the traditional paper-based system. By using blockchain, healthcare providers can streamline the prescription process, reduce the risk of errors and fraud, and improve patient outcomes.

II. LITERATURE REVIEW

A. Blockchain—Distributed Ledger Technology

A series of blocks with timestamps connected by cryptographic hashes is referred to as a blockchain. These blocks are securely and irreversibly sealed [1]. Each subsequent block has a hash value reference to the information in the one before it, and as the chain lengthens, fresh blocks are regularly added to the end. The shareholders of the blockchain are also known as the nodes. Every node possesses two keys: a public key for message encryption delivered to it and a private key for decrypting communications and enabling a node to read them. Thus, a blockchain's consistency, irreversibility, and non-reputability are ensured via the public key encryption process. The messages encoded using the matching public key can only be decrypted with the correct private key. The term "asymmetric cryptography" refers to this idea [2]. A more thorough explanation can be obtained in, as it is beyond the scope of this study to provide one.

The purported hash links each block in the chain by a unilateral cryptographic hash function (e.g., SHA256). A node signs each transaction it does before broadcasting it to the network for confirmation [3]. Authentication and transaction integrity is provided via the digital signature of an exchange using the secret key. The second is caused by a data transmission issue that prohibits decryption from happening since only users with a certain private key may sign the transaction (i.e., verifying a specific digital mark).

When the chain uses a particular consensus process, such as proof of work or stake, specific nodes, which are referred to as miners, organize and bundle the transactions that have been distributed and are deemed acceptable by the network into time-stamped blocks. The consensus method controls the choice of miners and the data that is included in the block. The validation nodes use the related hash to validate the blocks as they are broadcast to the chain to ensure that the additional block contains valid transactions and correctly refers to the previous block in the network.

The purpose of network nodes is now at our fingertips. When a node begins to link and communicate with other nodes in the network, the proper word would be a peer node because of its similar type of network structure. We shall now refer to it as a "node" for the sake of clarity. A machine running a complete replica of the blockchain ledger and with the primary blockchain client installed is referred to as a full node.

A node is how a user connects to the blockchain network to interact with it. Since every miner must run a fully operating node, the miners stated earlier[13] are a subset of nodes. As a result, every node is a miner, but not every miner is also a node. This scenario has been observed in a particular sort of public blockchain that uses the proof-of-work consensus. A different blockchain network, such as a proof-of-stake (PoS) network, which uses different decentralized consensus models, has no need for mining the basic duties of a peer node.

- joining the blockchain network
- Maintaining the latest ledger

- keeping eye on transactions
- transmitting valid transactions
- keeping an ear out for freshly sealed blocks
- verifying newly fresh blocks
- validation of transactions
- Generating and transmitting new blocks

B. Types of Blockchain

According to the controlled data, its accessibility, and the user operations that may be carried out, there are generally three sorts of blockchains. These consist of

1. public
2. private
3. consortium

All of the data in the permissionless blockchain (sometimes known as just public) is visible to and accessible to the whole public. To protect a participant's anonymity, some portions of the blockchain may be encrypted. Anyone can join a public permissionless blockchain and participate as a simple node or a miner without needing to get permission (node). Blockchains of this type are typically provided as a financial incentive, such as in cryptocurrency networks. These blockchains come in the form of Bitcoin, Ethereum, or Litecoin.

Only a limited number of nodes can participate in the distributed consensus process on a blockchain of the consortium type. It may be used in a single industry or in numerous. When a consortium blockchain is created inside a certain sector of the economy (like the financial sector),[1] it is accessible to restricted public usage and is only partially centralized. Contrary to what is a consortium amongst industries (such as insurance firms, Investment banks, and governmental organizations) is made available for usage by the general public while yet maintaining a somewhat centralized trust.

On a private blockchain, networks may only be joined by chosen nodes. As a result, the network is both scattered and centralized. Private blockchains are permissioned networks that limit which nodes can process transactions, carry out smart contracts, or take part in mining[14]. They are all controlled by the same reliable organization. It is utilized for individual needs. Blockchain technologies that solely enable private blockchain networks are Ripple and Hyperledger Fabric. Be aware that these divisions are still up for debate and that various definitions may be found in the literature.

Depending on their use, blockchains can be divided into two categories: those used to track digital assets (like Bitcoin) and those used to execute specific logic (i.e., smart contracts).

III. PROPOSED SYSTEM

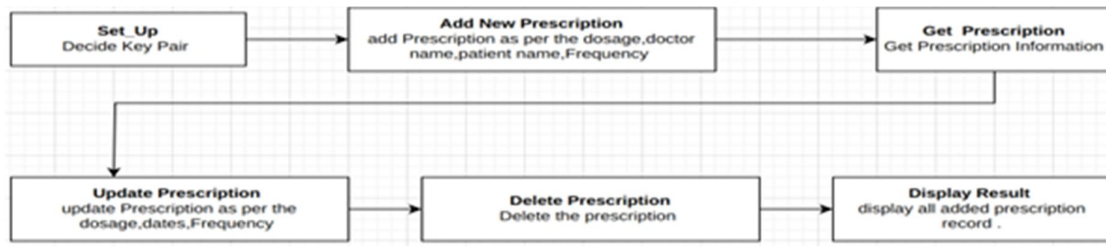


Figure 1. Entities used in the prescription management system

The figure 1 represents the flow of our proposed system. The first block represents that we need to do the setup for running the app. Then the doctor can add the prescription to the system or get and update the previously given prescription. The prescription can be deleted in case the line of treatment or diagnosis is changed.

The distributed ledger's state and the method for putting data into blocks must both be agreed upon by the peers of the blockchain network for it to continue operating. A distributed consensus system, which validates the chronological order of generated transactions, is what is known as such an agreement. It ensures that the shared ledger's precise state and, consequently, the order in which new blocks are added are agreed upon by the majority of peers in the blockchain network.

The method by which a network selects the peer who will prepare and seal the most recent block is described in a distributed consensus protocol, which contains data that has not yet been validated and formatted. The easiest

method is to choose it at random, but this method is ineffective in terms of network durability and may potentially put the network at risk because peers could decide to launch an attack on the entire network [8]. The principle underlying Proof of work, Proof of stake, and other similar protocols are that each miner makes a valuable contribution, and the best miner gets rewarded. The prize encourages rivals to verify each other's work and valuables in a competition that also reduces the likelihood of an attack.

The Bitcoin network employs the PoW consensus protocol. It chooses a peer by using processing power as a mechanism[15]. Hashing unconfirmed transactions is the basis for peer competition. As a result, a peer's probability of selection is proportional to its processing capacity. A reward is given to a peer each time it succeeds and is selected. 12.5 freshly created bitcoins are credited to the chosen miner's account as a current incentive in the Bitcoin network. The output of the hash must match a predetermined state to be valid [7]. A miner broadcasts the freshly created block on the chain if it achieves the necessary value. Then, it is verified by other peers, and if accurate, it is duplicated throughout the network.

The Proof of stake algorithm is built on the resources that each peer has (i.e., a peer's share in the network value that is under their control.). The probability that a peer will be selected to confirm a fresh block is proportional to its stake[11]. In actuality, this is accomplished by requiring a peer to freeze a threshold amount of stake[9]. This grants an entry for the node. The winner is selected from a set of competitors who have tickets in a deterministic pseudo-random manner. Since the competition in this instance is not reliant on the processing capacity of the peers, it uses less energy than PoW[4]. But this strategy resembles a shareholder business, where the wealthy have an edge. This works well because a peer is reluctant to attack the network since it would rather attack its stake. There are various iterations of the proof of stake algorithm, and each one offers a unique method for selecting the peer to guarantee fairness. The Distributed PoS is one of these variations (DPoS).

The nodes build the distributed consensus and afterward concur on specific rules since the system serves as an agreement procedure that keeps the nodes in sync.

In the below example we have deployed our contract on remix online editor. We have added a patient prescription in as shown in the figure 2 and the output is shown. In figure 3, the updation of dosage and the output is visible, and in the figure 4 the get Prescription method is being executed.

status	true Transaction mined and execution succeed
transaction hash	0x195582e2196e1a4171265256cf2de35d654f806bd841a37b6b99d9b838dab3d5
from	0x5B380a6a701c568545dCfc803Fc8875f56beddC4
to	Prescription.deletePrescription(string,string,uint256) 0xd9145CCE520386f254917e481eB44e9943F39138
gas	120171 gas
transaction cost	52877 gas
execution cost	43968 gas
input	0xbf7...00000
decoded input	{ "string_doctorName": "Sanket", "string_patientName": "Ram", "uint256_prescriptionDate": "12" }
decoded output	{}
logs	[]
val	0 wei

Figure 2. Add functionality input/output

IV. CONCLUSION AND FUTURE TRENDS

The field of prescription management is rapidly evolving, with several future trends likely to shape the way prescriptions are managed in the coming years. Here are some potential future trends.

Increased Use of Telemedicine: Telemedicine, or the delivery of healthcare services through remote communication technology, is likely to become more widespread in the future. This trend will likely have

implications for prescription management, with providers increasingly using electronic prescriptions and remote monitoring of medication compliance.

status	true Transaction mined and execution succeed
transaction hash	0x0660e67169d8e5a488d543716a1525b9b6cf9c12a390e3d13c03b3924915336f 🔗
from	0x5B380a6a701c568545dCfc803Fc8875f56beddC4 🔗
to	Prescription.updateDosage(string,string,uint256,uint256) 0xd9145CCE52D386f254917e481eB44e9943F39138 🔗
gas	37542 gas 🔗
transaction cost	32645 gas 🔗
execution cost	10377 gas 🔗
input	0x243...00000 🔗
decoded input	{ "string_doctorName": "Sanket", "string_patientName": "Ram", "uint256_prescriptionDate": "12", "uint256_dosage": "8" }
decoded output	{}
logs	[] 🔗 🔗
val	0 wei 🔗

Figure 3. Update functionality input/output

status	true Transaction mined and execution succeed
transaction hash	0x1ee1e26020894c4b7735215d52eec85b9416fbc8e05870b429116159f1478af1 🔗
from	0x5B380a6a701c568545dCfc803Fc8875f56beddC4 🔗
to	Prescription.addPrescription(string,string,uint256,string,uint256,uint256) 0xd9145CCE52D386f254917e481eB44e9943F39138 🔗
gas	237449 gas 🔗
transaction cost	206477 gas 🔗
execution cost	183449 gas 🔗
input	0x63a...00000 🔗
decoded input	{ "string_doctorName": "Sanket", "string_patientName": "Ram", "uint256_prescriptionDate": "12", "uint256_expirationDate": "22", "string_medication": "Dolo", "uint256_dosage": "6", "uint256_frequency": "2" }
decoded output	{}
logs	[] 🔗 🔗
val	0 wei 🔗

Figure 4. Get functionality output

Adoption of Artificial Intelligence (AI): AI has the potential to transform prescription management by improving diagnosis and treatment decisions and optimizing medication dosing. AI-powered tools can also help providers identify patients who are at high risk for medication-related adverse events, reducing the potential for harm.

Blockchain Adoption: The use of blockchain technology in prescription management is likely to increase in the coming years. This will help improve the security and transparency of prescription records, reduce the potential for errors and fraud, and enable secure sharing of patient information.

Personalized Medicine: Personalized medicine, or the tailoring of medical treatments to an individual's unique characteristics, is likely to become more prevalent in the future. This trend will likely have implications for prescription management, with providers increasingly using pharmacogenomics and other personalized medicine approaches to select and optimize medication therapy.

Increased Focus on Medication Safety: Medication safety will continue to be a priority in the future, with providers adopting new strategies to reduce the risk of medication-related harm. This may include the use of medication reconciliation, enhanced patient education, and the integration of medication safety initiatives into clinical workflows.

In conclusion, the traditional paper-based prescription management system has several limitations, including errors, inefficiencies, and security risks. However, the emergence of blockchain technology provides a potential solution to these challenges by enabling secure, transparent, and tamper-proof record-keeping. By using blockchain, healthcare providers can streamline the prescription process, reduce the risk of errors and fraud, and improve patient outcomes.

Moreover, the future of prescription management is likely to be characterized by increased use of technology, enhanced patient engagement, and a focus on optimizing medication therapy to improve patient outcomes. The adoption of AI, telemedicine, and personalized medicine, coupled with the increasing adoption of blockchain technology, will help drive these changes.

Overall, the adoption of blockchain technology in prescription management has the potential to transform the way prescriptions are managed, improve patient outcomes, and reduce costs for healthcare providers. It is therefore important for healthcare providers to consider the potential benefits of blockchain technology in prescription management and work towards its implementation.

REFERENCES

- [1] Gajendra J. Katuwal, "Applications of Blockchain in Healthcare: Current Landscape & Challenges", 6 Dec 2018
- [2] Vincent Schlatt, "Harmonizing Sensitive Data Exchange and Double-spending Prevention Through Blockchain and Digital Wallets", 14 March 2023
- [3] Sachikanta Dash, Pradosh Kumar Gantayat & Rajendra Kumar Das, "Blockchain Technology in Healthcare: Opportunities and Challenges", 01 May 2021
- [4] Maria Prokofieva, Shah J Miah, "BlockPres: A Novel Blockchain-Based Incentive Mechanism to Mitigate Inequalities for Prescription Management System", 25 July 2021
- [5] Antonio Fusco, Grazia Dicuonzo, Vittorio Dell , "Blockchain in Healthcare: Insights on COVID-19", 30 Sep 2020
- [6] Claude Pirtle & Jesse Ehrenfeld, "VigilRx: A Scalable and Interoperable Prescription Management System Using Blockchain", 02 March 2022
- [7] Cornelius C. Agbo, Qusay H. Mahmoud, and J. Mikael Eklund., "Blockchain Technology in Healthcare: A Systematic Review", 4 April 2019
- [8] Hannah S Chen, Juliet T Jarrell, Kristy A Carpenter, David S Cohen, and Xudong Huang, "Blockchain in Healthcare: A Patient-Centered Model", 9 Aug 2019
- [9] Subrata Acharya, "Pharmaceutical uses of Blockchain Technology", 09 May 2019
- [10] Anushree Tandon , Amandeep Dhir, "Blockchain in healthcare: A systematic literature review, synthesizing framework and future research agenda", November 2022
- [11] Waheed Javed; Fatima Aabid, "Role of Blockchain Technology in Healthcare", 31 January 2022
- [12] Seyednima Khezr, Md Moniruzzaman, Abdulsalam Yassine, "Blockchain Technology in Healthcare: A Comprehensive Review and Directions for Future Research", April 2019
- [13] Camden Thatcher M.S, "RxBlock: Towards the design of a distributed immutable electronic prescription system", 10 August 2020
- [14] Valeria Merlo, Gianvito Pio "On the exploitation of the blockchain technology in the healthcare sector: A systematic review", 1 March 2023
- [15] Abid Haleem, Mohd Javaid, Ravi Pratap Singh, "Blockchain technology applications in healthcare: An overview", February 2021