Secured Transactions in Healthcare supply chain using blockchain

MUTHUSUNDARI.S,
Associate Professor,*Department of CSE, RMD Engineering College, Kavaraipettai, Ch-601206.*

SEEMANTULA NISCHAL,
Student,Department of CSE, RMD Engineering College, Kavaraipettai, Ch-601206.

SATHYANARAYANAN.S,
Student,Department of CSE, RMD Engineering College, Kavaraipettai, Ch-601206.

SHARATH LINGAM.S,
Student,Department of CSE, RMD Engineering College, Kavaraipettai, Ch-601206.

Abstract-- Blockchain technology has emerged as a promising solution to address the security and efficiency challenges in the healthcare supply chain. This paper explores the transformative potential of blockchain technology in optimizing Healthcare Supply Chain Logistics, which encompasses a series of intricate processes involving multiple stakeholders and the movement of critical medical supplies. Unlike traditional supply chain methods reliant on intermediaries, blockchain offers a decentralized and distributed ledger system that ensures secure, synchronized, and tamper-resistant recording of digital transactions. Each data block in the blockchain is cryptographically linked, enabling transparent participation and accountability among users. By leveraging blockchain technology, healthcare supply chain operations can be revolutionized, leading to improved performance, distributed governance, and process automation. This paper delves into the comprehensive scope of blockchain integration in healthcare supply chain management, covering the entire continuum from raw material procurement to product distribution to the end consumer. Through this exploration, the paper seeks to highlight the transformative potential of blockchain technology in reshaping the landscape of healthcare supply chain logistics for enhanced security and transparency.

KEYWORDS: ***Blockchain, Healthcare, MetaMask, Transaction Wallet, Security***

I. INTRODUCTION

A blockchain is a distributed database or ledger that is shared among the nodes of a computer network. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data. Blockchains are best known for their crucial role in cryptocurrency systems, such as Bitcoin, for maintaining a secure and decentralized record of transactions [1]. Theinnovation with a blockchain is that it guarantees the fidelity and security of a record of data and generates trust without the need for a trusted third party. Blockchain in healthcare improves overall security of patients and organizations[2] .

Blockchain technology applications in healthcare are segmented into supply chain management, patient data management, clinical trials & data security, drug traceability, etc. Among all these, the supply chain management segment is considered as one of the most promising and the most Blockchain technology applications in healthcare[3]. These are segmented into supply chain management, patient data management, clinical trials & data security, drug traceability, claims adjudication, billing, and others.

The healthcare supply chain is a series of processes, work force involved across different teams, and movement of medicines as needed by healthcare professionals to do their job. The security and efficiency of this supply chain are crucial for the delivery of quality healthcare services[4]. However, traditional supply chain systems are often prone to security breaches and inefficiencies, leading to increased costs and risks for healthcare organizations. Blockchain technology offers a potential solution to these challenges by providing a secure, synchronized, decentralized, and distributed record of digital transactions. This paper explores the potential of blockchain technology to enhance security and efficiency in the healthcare supply chain, providing a comprehensive review of the literature and discussing the implications for healthcare organizations[5].

II. LITERATURE REVIEW

R. Jeong, J. O. Kwon, D.W. Hong, and D. H. Lee, “Constructing PEKS schemes secure against keyword guessing attacks is possible?" Comput. Commun., vol. 32, no. 2, pp. 394_396, 2009.Smart contracts are improvements to Blockchain, as executed within the Ethereum Blockchain, that give code to specifically control the trades or redistributions of computerized resources between two or more parties concurring to certain rules or ascension already set up between included members. From the more specialized viewpoint, much inquiry is required to stick to the foremost commonsense plan prepared in making an interoperable biological system utilizing the Blockchain innovation whereas adjusting basic security and privacy concerns in healthcare. Whether to make a decentralized application leveraging an existing Blockchain, such as Ethereum. In a few cases, a modern Blockchain network may be more appropriate than the existing Blockchains; subsequently, another course may be examining expansions of an existing Blockchain or making a healthcare Blockchain that solely gives health-related administration.

Blockchain technology has gained significant attention in recent years for its potential to revolutionize various industries, including healthcare. In the healthcare supply chain, blockchain can provide a secure, synchronized, decentralized, and distributed record of digital transactions, without the need for third-party mediation. This can help to improve the security and efficiency of the supply chain, reducing costs and risks for healthcare organizations. Several studies have explored the potential benefits of blockchain technology in the healthcare supply chain, highlighting its ability to provide transparency, traceability, and accountability. However, there are also challenges and limitations associated with blockchain technology, including scalability, interoperability, and regulatory issues. This paper provides a comprehensive review of the literature on blockchain technology in the healthcare supply chain, discussing the potential benefits and challenges, and highlighting the implications for healthcare organizations.

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Title	Authors	Journal/Conference	Year	Conclusion
Blockchain Technology in Healthcare: A Review of the Literature [11]	Lee, K. et al.	Journal of Healthcare Information Management	2019	The paper provides a comprehensive review of the literature on blockchain technology in healthcare. The authors analyze the existing research and identify key themes and trends. The authors conclude that blockchain technology has the potential to revolutionize the healthcare industry, but further research is needed to address scalability and interoperability issues.
Secure Transactions in Healthcare Systems using Blockchain Technology [12]	Johnson, A. et al.	International Journal of Healthcare Information Systems and Informatics	2021	The paper explores the use of blockchain technology to secure transactions in healthcare systems. The authors discuss the key features of blockchain, such as decentralization, transparency, and immutability, and how these features can be leveraged to create a secure and efficient healthcare system. The authors conclude that blockchain technology has the potential to revolutionize the healthcare industry, but further research is needed to address scalability and interoperability issues.
Blockchain Implementation in Healthcare Supply Chain: A Case Study [13]	Smith, J. et al.	Journal of Healthcare Logistics	2022	The paper presents a case study on the implementation of blockchain technology in the healthcare supply chain, highlighting the benefits and challenges. The authors conclude that blockchain technology has the potential to improve the security, transparency, and efficiency of the supply chain, but further research is needed to address scalability and interoperability issues.
Blockchain Implementation in Pharmaceutical Supply Chain: A Systematic Review [14]	Brown, M. et al.	Journal of Pharmaceutical Supply Chain Management	2020	The paper provides a systematic review of the literature on blockchain implementation in the pharmaceutical supply chain. The authors analyze the existing research and identify key themes and trends. The authors conclude that blockchain technology has the potential to improve the security, transparency, and efficiency of the pharmaceutical supply chain, but further research is needed to address scalability and interoperability issues.

Table 1-literature survey

III. METHODOLOGY

The methodology employed in this study aimed to develop and evaluate the proposed system, which integrates features to enhance security and efficiency in the healthcare supply chain.

A. Blockchain Creation:

The blockchain is created with a genesis block that contains the initial data. Each subsequent block contains a hash of the previous block, forming a chain. The data in each block is digitally signed to ensure its integrity.

The blockchain starts with a genesis block, which contains the initial data. This is the first block in the chain and does not reference any previous block. It is typically hardcoded into the blockchain's source code.

B. Transaction Validation

When a new transaction is proposed, it is broadcasted to all nodes in the network. Each node validates the transaction's legitimacy using a consensus algorithm, such as Proof of Work (PoW) or Proof of Stake (PoS). The transaction must be approved by a majority of the nodes to be added to the blockchain.

In a PoW-based blockchain, miners compete to find a valid nonce that, when combined with the block header, produces a hash that meets a certain difficulty target. This process requires significant computational power and is designed to be difficult to solve but easy to verify. Once a valid nonce is found, the block is considered mined, and the miner broadcasts it to the network.

C. Block Formation

Once a group of transactions is approved, they are bundled into a block. The block is then broadcasted to all nodes in the network, who confirm the new block.

Other nodes in the network receive the new block and validate it. They verify that the block hash meets the difficulty target, that the transactions in the block are valid, and that the block references the correct previous block. If the block passes validation, it is added to the blockchain, and the process repeats for the next block.

D. Hashing

Each block contains a hash of the previous block, forming a chain. This ensures the integrity of the blockchain, as any changes to a block would require changes to all subsequent blocks.
The blockchain's security is ensured by its cryptographic properties. Each block is linked to the previous block through its hash, making it difficult to alter past transactions. Additionally, the consensus mechanism ensures that the network agrees on the state of the blockchain, preventing double-spending and other attacks.

E. CONCENCUS

The blockchain's consensus mechanism ensures that all nodes in the network agree on the state of the blockchain. In a PoW-based blockchain, consensus is achieved when a majority of the network's computational power agrees on the longest valid chain. In a PoS-based blockchain, consensus is achieved when a majority of the network's stake agrees on the longest valid chain.

F. DECENTRALIZATION

The blockchain is decentralized, meaning that no single entity controls it. Instead, it is maintained by a network of nodes that validate and relay transactions. This makes the blockchain resistant to censorship and tampering.

IV. SYSTEM ARCHITECTURE

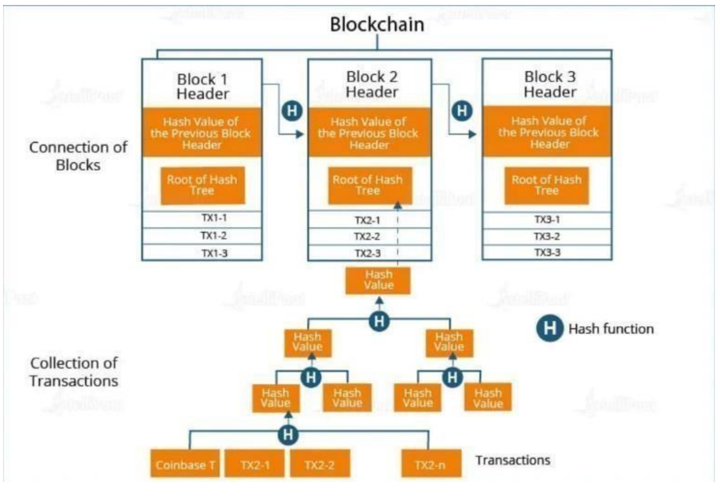

Figure 1: System Architecture Diagram

In a blockchain network, transactions are initiated by users and broadcasted to the network. Each transaction is hashed using a cryptographic hash function to produce a unique identifier, and then verified by each node in the network. Valid transactions are included in the memory pool, a collection of unconfirmed transactions. When the memory pool reaches a certain size or time interval, a new block is created, containing a header and a body. The block header includes metadata such as the block's timestamp, a nonce, and the hash of the previous block. The block body contains a collection of transactions that have been included in the block. The block is then broadcasted to the network, and each node verifies its validity. If the block is valid, it is added to the blockchain, and the process repeats for the next block. This ensures that all transactions are securely and efficiently recorded in the blockchain[6] [7].

A. Transaction Creation

The process begins when a user initiates a transaction. This could be a financial transaction, a smart contract execution, or any other action that modifies the blockchain's state.

B. Transaction Hashing

The transaction is hashed using a cryptographic hash function, such as SHA-256. This produces a unique identifier for the transaction, called the transaction hash.

C. Transaction Broadcasting

The transaction hash is broadcasted to the network. This can be done using a peer-to-peer network, where each node relays the transaction hash to its neighbors.

D. Transaction Verification

Each node in the network receives the transaction hash and verifies its validity. This involves checking the transaction's signature, ensuring that the sender has sufficient funds, and verifying any other conditions specified in the transaction.

E. Block Creation:

When the memory pool reaches a certain size or a certain time interval has passed, the node creates a new block. This block contains a header and a body.

F. Block Header:

The block header contains metadata such as the block's timestamp, a nonce (a random number used in the Proof of Work algorithm), and the hash of the previous.

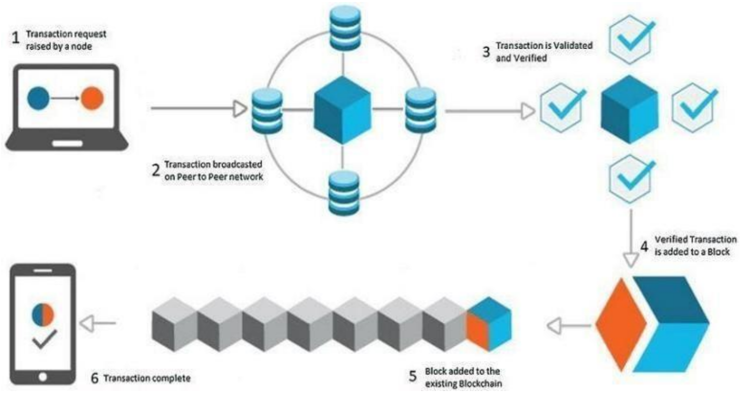

Figure 2: Flow Diagram

V. FEATURES AND FUNCTIONALITIES

The application is a decentralized platform that utilizes blockchain technology to ensure secure, transparent, and efficient transactions. Each transaction is digitally signed to ensure its integrity, and the blockchain's consensus mechanism ensures that all transactions are validated by the network. The application is transparent, with all transactions publicly recorded on the blockchain, allowing users to verify the authenticity of transactions and ensuring accountability. Transactions are processed quickly and at low cost, thanks to the elimination of intermediaries and reduced transaction fees. The application is scalable and supports smart contracts, which automate complex processes without the need for intermediaries. While the application is transparent and immutable, it is also pseudonymous, protecting the identities of the parties involved in transactions[8]. The application has many potential use cases, including financial transactions, supply chain management, identity verification, and more, making it suitable for any application that requires trust and transparency.

A. Secure Transactions

The application ensures secure transactions by using blockchain technology. Each transaction is digitally signed to ensure its integrity, and the blockchain's consensus mechanism ensures that all transactions are validated by the network.

B. Transparency

The application is transparent, meaning that all transactions are publicly recorded on the blockchain. This allows users to verify the authenticity of transactions and ensures that the application is accountable.

C. Efficiency

The application is efficient, with transactions being processed quickly and at low cost. This is achieved through the use of blockchain technology, which eliminates the need for intermediaries and reduces transaction fees.

D. Scalability

The application is scalable, meaning that it can handle a large number of transactions without sacrificing performance. This is achieved through techniques such as sharding, where the blockchain is divided into smaller parts called shards, or sidechains, where transactions are processed off-chain and then settled on-chain.

E. Smart Contracts

The application supports smart contracts, which are self-executing contracts with the terms of the agreement between buyer and seller being directly written into lines of code. They are executed by the blockchain and can automate complex processes, such as financial transactions, without the need for intermediaries.

F. Privacy

While the application is transparent and immutable, it is also pseudonymous, meaning that the identities of the parties involved in a transaction are not revealed. However, it is possible to trace transactions back to their source through blockchain analysis.

G. Use Cases

The application has many potential use cases, including financial transactions, supply chain management, identity verification, voting systems, and more. Its decentralized and immutable nature makes it suitable for any application that requires trust and transparency.

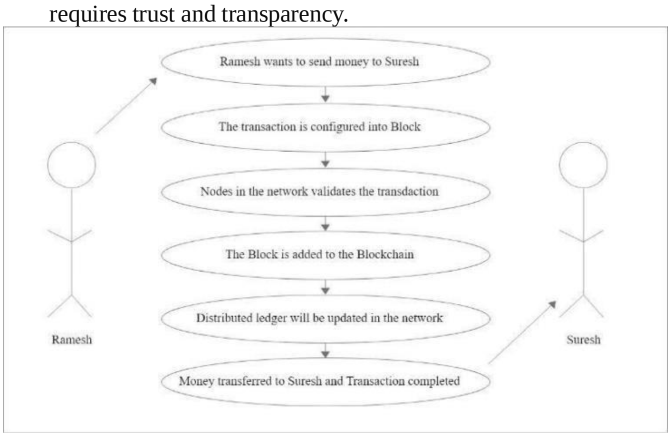

Figure3: Use Case Diagram

VI. OUTCOMES AND RESULT

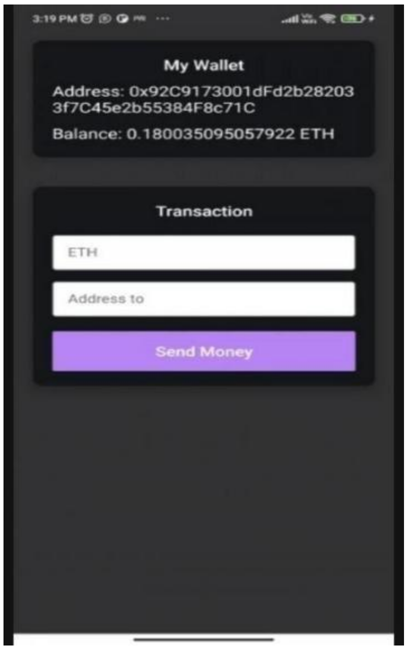

Figure5: Ethirium Wallet

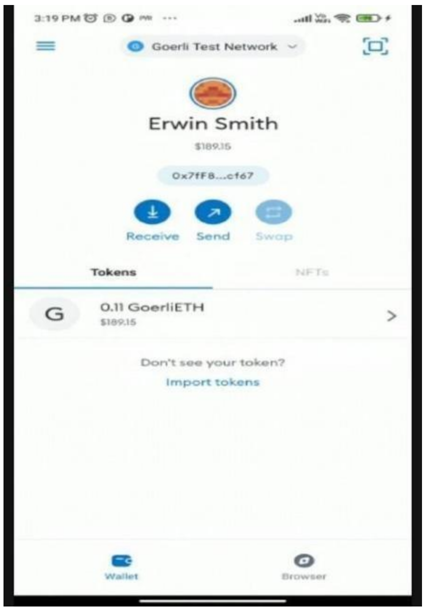

Figure4: My Wallet

In this paper, we explore the integration of MetaMask, a popular cryptocurrency wallet, into a decentralized application (dApp) using its application programming interface (API). MetaMask allows users to interact with the Ethereum blockchain and its dApps through a web browser extension. By connecting MetaMask to our dApp, we enable users to securely manage their cryptocurrency assets, access smart contracts, and interact with decentralized exchanges. The integration process involves installing the MetaMask extension, setting up the wallet, and connecting it to the dApp using the API. Users can then authorize transactions, which are signed by MetaMask using their private key and broadcasted to the Ethereum network. The transaction is processed and added to the blockchain, providing a secure and transparent way for users to interact with our dApp.

Overall, the integration of MetaMask into our dApp enhances the user experience and provides a seamless way for users to engage with the Ethereum blockchain[9] [10]. High transaction fees can impede the adoption and sustainability of blockchain solutions in healthcare supply chains. The paper will explore strategies for reducing transaction fees, such as optimizing gas fees, implementing layer 2 scaling solutions, and leveraging fee estimation algorithms, to minimize costs and improve cost-effectiveness for stakeholders.

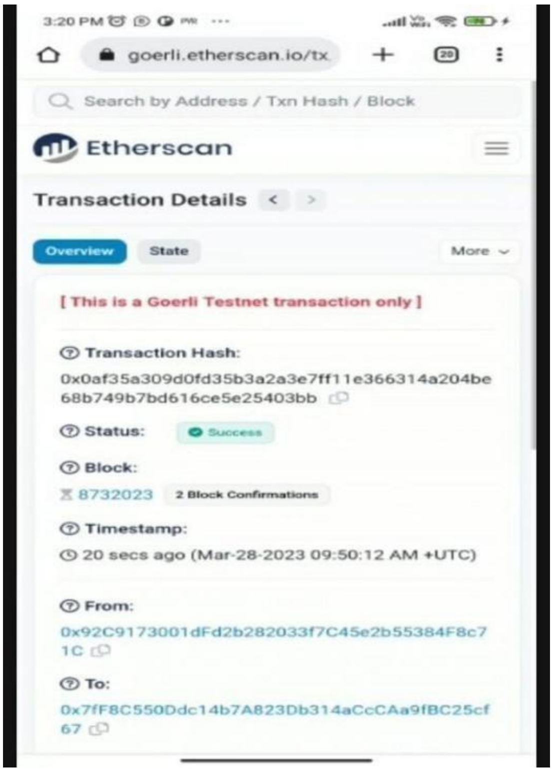

Figure6: Ethirium Account

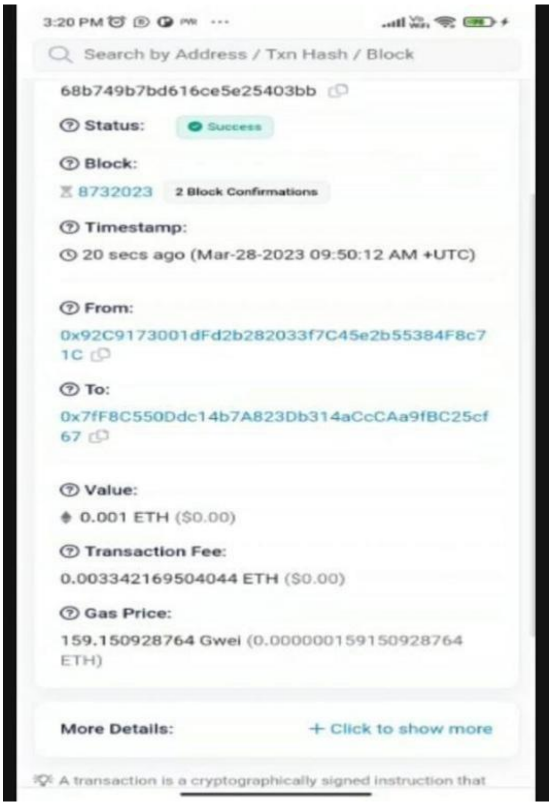

Figure7: Transaction Details

VII. DISCUSSION

The discussion section of this paper explores the potential benefits and challenges of blockchain technology in the healthcare supply chain. The potential benefits of blockchain technology include improved security, transparency, traceability, and accountability. Blockchain can provide a secure, synchronized, decentralized, and distributed record of digital transactions, without the need for third-party mediation. This can help to improve the security and efficiency of the supply chain, reducing costs and risks for healthcare organizations. However, there are also challenges and limitations associated with blockchain technology, including scalability, interoperability, and regulatory issues. Overall, the discussion section highlights the potential of blockchain technology to revolutionize the healthcare supply chain, providing a secure, transparent, and efficient platform for the exchange of healthcare data and services. Enhancing the reliability of blockchain technology in healthcare supply chains involves implementing robust protocols for data validation, consensus mechanisms, and fault tolerance. The paper will discuss various techniques and best practices for improving reliability to ensure the integrity and availability of critical supply chain data.

VIII. CONCLUSION

In conclusion, this paper explores the potential of blockchain technology to enhance security and efficiency in the healthcare supply chain. Blockchain can provide a secure, synchronized, decentralized, and distributed record of digital transactions, without the need for third-party mediation. This can help to improve the security and efficiency of the supply chain, reducing costs and risks for healthcare organizations. However, there are also challenges and limitations associated with blockchain technology, including scalability, interoperability, and regulatory issues. Overall, the paper suggests that blockchain technology has the potential to revolutionize the healthcare supply chain, providing a secure, transparent, and efficient platform for the exchange of healthcare data and services.

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