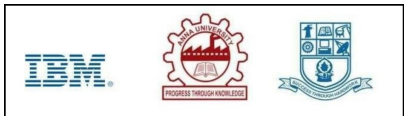

BLOCKCHAIN TECHNOLOGY FOR DRUG TRACEABILITY

PROJECT REPORT

SUBMITTED BY:

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CHAPTER -1

1.INTRODUCTION :

1.1 PROJECT OVERVIEW:

To create a secure and transparent system for tracking the journey of pharmaceutical products from manufacturers to end consumers, ensuring authenticity, quality, and safety.

1.2 PURPOSE :

The purpose of blockchain technology in drug traceability is to address critical issues in the pharmaceutical supply chain by providing transparency, security, and accountability. Here are some key purposes and advantages of using blockchain for drug traceability:

Enhanced Transparency:

Blockchain creates a transparent and tamper-proof ledger that allows all stakeholders in the pharmaceutical supply chain, including manufacturers, distributors, pharmacies, and regulators, to access and verify the history of each drug product. This transparency ensures that all transactions and movements are recorded and visible, reducing the risk of fraud and counterfeit drugs.

Secure Data Management:

Blockchain's decentralized and immutable nature makes it highly secure. Data recorded on the blockchain cannot be easily altered or deleted, ensuring the integrity of the information. This is crucial for maintaining the accuracy and authenticity of drug-related data.

Traceability and Accountability:

Each drug product is assigned a unique identifier (e.g., a QR code or RFID tag) recorded on the blockchain. This allows for precise traceability, making it easier to track the journey of a drug from its point of origin to its final destination. This traceability increases accountability throughout the supply chain.

CHAPTER -2

2.LITERATURE SURVEY

2.1.EXISTING PROBLEM:

There were several challenges and problems associated with implementing blockchain in drug traceability. These issues may still be relevant, but it's essential to consider that the technology and its adoption may have evolved since then. Some of the existing problems include:

1. Data Standardization: Lack of uniform data standards across the pharmaceutical industry can make it challenging to ensure interoperability and seamless data exchange between different stakeholders in the supply chain.

2. Integration with Existing Systems: Integrating blockchain with existing legacy systems can be complex and costly. This process may require a significant overhaul of current infrastructure.

3. Regulatory Compliance: Ensuring that blockchain solutions comply with pharmaceutical regulations and data privacy laws is a significant challenge. Meeting different regulatory requirements across regions can be daunting.

4. Scalability: As the number of pharmaceutical products and supply chain transactions increases, blockchain systems must handle a growing volume of data. Scaling the blockchain network to accommodate this can be a significant challenge.

5. Privacy Concerns: Protecting sensitive patient information and intellectual property while maintaining transparency is a delicate balance. Ensuring data privacy on a public blockchain can be a concern, especially in healthcare.

6. User Adoption: Getting all stakeholders in the pharmaceutical supply chain, from manufacturers to distributors and regulators, to adopt and use the blockchain system can be difficult.

7. Interoperability: Ensuring that different blockchain systems can communicate with each other and with legacy systems is vital for an effective traceability solution.

8. Security Threats: While blockchain is touted as a secure technology, no system is entirely immune to security threats. Smart contracts, wallets, and other components can be vulnerable to hacking.

9. Cost and Complexity: Developing and maintaining a blockchain system can be costly, and the complexity of the technology may be a barrier to adoption for smaller pharmaceutical companies.

10. Counterfeit Drugs: While blockchain can help combat counterfeiting, determined criminals may still find ways to produce counterfeit drugs and falsify blockchain data.

11. Technical Expertise: The need for specialized blockchain development and maintenance expertise can be a challenge for organizations without in-house knowledge.

12. Long-Term Viability: The rapid evolution of blockchain technology means that solutions implemented today must remain relevant and secure in the future.

It's important to keep in mind that the blockchain landscape is dynamic, and ongoing efforts in research and development are addressing these challenges. For the latest information on the problems and solutions in blockchain-based drug traceability, it's advisable to refer to recent reports, industry publications, and updates from organizations involved in the field.

2.2. REFERENCES:

Blockchain & IoT based Drugs Traceability for Pharma Industry

2021 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC)

PUBLISHED IN:
https://ieeexplore.ieee.org/document/9570251/

A Comprehensive Drug Management System by Segregating Spurious and Substandard Drugs Using Blockchain Technology

2021 International Conference on Automation, Control and Mechatronics for Industry 4.0 (ACMI)

PUBLISHED IN:
https://ieeexplore.ieee.org/document/9528238/

Monitoring Supply Chain of Pharmaceutical Drugs Using Blockchain

2022 IEEE Delhi Section Conference (DELCON)

PUBLISHED IN:
https://ieeexplore.ieee.org/document/9753598/

2.3.PROBLEM STATEMENT:

Problem statement definition:

Ensuring the authenticity and safety of pharmaceutical products throughout the supply chain is a critical challenge in the industry due to several reasons.They are,

Counterfeit Drugs: Counterfeit pharmaceuticals, often containing ineffective or harmful ingredients, pose a serious threat to public health. These fake drugs can infiltrate the supply chain at any point, putting patients at risk.

Supply Chain Complexity: The pharmaceutical supply chain is extensive and involves various stakeholders, including manufacturers, distributors, wholesalers, pharmacies, and hospitals. This complexity makes it challenging to monitor and secure every step of the process.

Global Distribution: Pharmaceuticals are distributed worldwide, making it challenging to coordinate supply chain security efforts across borders and regions.

Patient Safety: Patients rely on pharmaceutical products to maintain or improve their health. Unsafe or counterfeit drugs can have life-threatening consequences, eroding trust in the healthcare system.

Data Security: Protecting sensitive information within the supply chain, such as patient data and proprietary information, is crucial. Traditional databases are vulnerable to breaches.

CHAPTER -3

3. IDEATION AND PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS:

Creating an empathy map canvas for drug traceability in blockchain technology involves understanding the thoughts, feelings, actions, and needs of various stakeholders. Here's a simplified template:

What do stakeholders say about drug traceability in blockchain technology?

Regulators: "We need a robust system for tracking drugs."
Pharmaceutical companies: "We want to ensure the authenticity of our products."
Consumers: "We want to know the origin of the medicines we use."
Thinks: What might be going on in their minds?

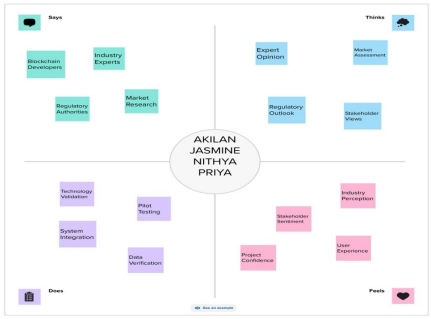
Regulators: Concerns about patient safety and compliance.
Pharmaceutical companies: A desire to protect their brand and reputation.
Consumers: Worries about counterfeit drugs and product quality.
Feels: What emotions are they experiencing?

Regulators: Anxious about ensuring public safety.
Pharmaceutical companies: Pressure to meet regulatory requirements.
Consumers: A need for trust and safety.
Does: What actions do they take related to drug traceability in blockchain technology?

Regulators: Draft regulations and conduct audits.
Pharmaceutical companies: Implement blockchain-based traceability systems.
Consumers: Verify drug authenticity using blockchain apps.
Needs: What are their unmet needs?

Regulators: Reliable data and compliance from pharmaceutical companies.
Pharmaceutical companies: Secure and cost-effective blockchain solutions.
Consumers: Easy access to product information for peace of mind.

This empathy map can help you understand the perspectives and motivations of different stakeholders in the context of drug traceability in blockchain technology, which is essential for designing effective solutions.



Pain:

- Stakeholders might experience frustration due to the costs and complexities associated

3.2 IDEATION AND BRAINSTORMING:

Certainly! When brainstorming blockchain's application in drug traceability, consider these ideas:

1. Immutable Drug Records: Use blockchain to create a tamper-proof ledger of drug manufacturing, distribution, and sales. Every transaction is recorded, making it nearly impossible to counterfeit or alter data.

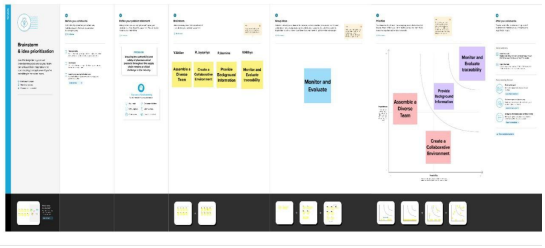
2. Supply Chain Transparency: Implement blockchain to provide end-to-end visibility in the pharmaceutical supply chain. This helps ensure the authenticity and safety of drugs by tracking their journey from manufacturer to consumer.

3. Smart Contracts: Utilize smart contracts for automatic verification and approval of drug shipments. This can help in verifying compliance with regulations and ensuring the quality of drugs.

4. Public vs. Private Blockchain: Decide whether to use a public or private blockchain. Public blockchains offer transparency but might raise privacy concerns. Private blockchains provide control but may lack transparency.

5. Data Standardization: Establish common data standards to ensure interoperability across the supply chain, enabling seamless data sharing and verification.

Remember that successful implementation of blockchain in drug traceability requires collaboration between pharmaceutical companies, regulators, technology providers, and other stakeholders to create a robust, secure, and efficient system.



CHAPTER -4

4.1 FUNCTIONAL REQUIREMENTS :

In a drug traceability project using blockchain technology, there are both functional and non-functional requirements that need to be considered:

Functional Requirements:
1. Identity Verification: Ensure that only authorized individuals or entities can access and update the blockchain data related to drug traceability.

2. Product Registration: Allow pharmaceutical companies to register each drug product on the blockchain, including essential details such as batch number, manufacturing date, and expiration date.

3. Traceability: Enable the tracking of drugs at each stage of the supply chain, from manufacturing to distribution to dispensing. This includes recording changes in ownership and location.

4. Verification: Implement a mechanism for verifying the authenticity and integrity of drugs by scanning a unique identifier (e.g., QR code) on the packaging.

5. Transaction Logging: Record all transactions related to drug movements on the blockchain, ensuring a complete audit trail.

6. Alerts and Notifications: Send alerts or notifications to relevant parties in the supply chain when issues such as recalls, expired products, or suspicious activities are detected.

7. Integration: Integrate with existing systems used by pharmaceutical companies, distributors, and regulatory authorities to ensure smooth data flow.

8. Compliance Reporting: Generate reports and data required for compliance with regulatory authorities' drug traceability requirements.

4.2. NON- FUNCTIONAL REQUIREMENTS:

1. Security: Implement robust security measures to protect the blockchain from unauthorized access and ensure the integrity of drug traceability data.

2. Scalability: The system should be able to handle a growing volume of drug traceability data as more products are added to the blockchain.

3. Performance: Ensure that the system can process transactions quickly and efficiently, especially during peak periods.

4. Privacy: Protect sensitive data while ensuring transparency in the supply chain. Use appropriate encryption techniques.

5. Reliability: Ensure that the blockchain is highly available and reliable to prevent downtime that could disrupt the drug supply chain.

6. Regulatory Compliance: Adhere to regulatory requirements related to data retention, security, and traceability in the pharmaceutical industry.

7. Interoperability: Ensure that the blockchain system can interoperate with other blockchain networks or systems used by different stakeholders in the drug supply chain.

8. User Experience: Design a user-friendly interface for easy interaction with the blockchain system, making it accessible to both technical and non-technical users.

9. Data Retention: Define data retention policies to manage the blockchain's historical data while complying with legal and regulatory requirements.

10. Auditability: The system should support auditing and reporting capabilities to provide visibility into the history of drug traceability events.

CHAPTER-5

PROJECT DESIGN

5.1 Data flow diagrams & User stories:

User stories can help define the requirements and functionality of a blockchain-based drug traceability system. Here are some user stories that represent the needs and perspectives of various stakeholders in the pharmaceutical supply chain:

1. As a Pharmaceutical Manufacturer:
   - I want to record the production details of each batch of drugs on the blockchain to ensure their authenticity and quality.
   - I need to create digital certificates of authenticity for each batch and share them with distributors and regulators.

2. As a Drug Distributor:
   - I want to verify the authenticity of drugs I receive from manufacturers by scanning blockchain-enabled QR codes.
   - I need to log each drug shipment and transaction on the blockchain for transparency and traceability.

3. As a Pharmacist:
   - I want to confirm the source and authenticity of the drugs I receive from distributors to provide my patients with safe medications.
   - I need to access a user-friendly interface to quickly verify product information using blockchain technology.

4. As a Regulatory Authority:

- I need real-time access to the blockchain ledger to monitor the movement of drugs, ensuring compliance with regulations.
- I want the ability to audit and track down the history of a specific drug batch in case of recalls or safety concerns.

5. As a Patient:
   - I want to use a mobile app to scan QR codes on drug packaging and receive instant confirmation of the drug's authenticity and origin.
   - I need assurance that the medications I receive are genuine and have been through a secure supply chain.

6. As a Healthcare Provider:
   - I need a reliable and efficient system to access drug information, verify authenticity, and ensure patient safety.
   - I want to be able to report suspected counterfeit drugs to the authorities using the blockchain system.

7. As a Blockchain Developer:
   - I want to ensure the security of the blockchain network to prevent unauthorized access or tampering of drug records.
   - I need to implement smart contracts that automatically trigger verification processes and maintain the integrity of the supply chain.

8. As a Quality Control Analyst:
   - I want access to detailed data on the environmental conditions and handling of drugs during transportation to ensure product quality.
   - I need the ability to flag or reject drug shipments that don't meet quality standards.

9. As an Auditor:
   - I need to perform audits of the blockchain ledger to verify the accuracy of the data and the compliance of all supply chain participants with established standards.

10. As a Consumer Advocate Group:

- I want to collaborate with regulatory authorities to ensure that the blockchain-based traceability system is transparent, secure, and in the best interests of patient safety.

These user stories help outline the specific requirements and expectations of each stakeholder group in a blockchain-based drug traceability system, which can guide the development and implementation of such a solution.

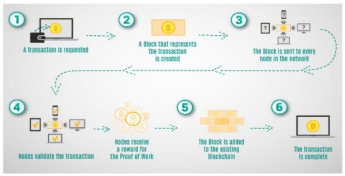
CHAPTER -6

6. PROJECT PLANNING AND SCHEDULING

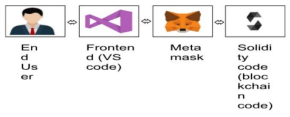
6.1 TECHNICAL ARCHITECTURE:

Solution Architecture Diagram:

Technical Architecture:



Technical Stack:



CHAPTER -7

7. CODING AND SOLUTIONS:

// SPDX-License-Identifier: MIT

```
pragma solidity ^0.8.0;

contract Drug{
    address public owner;

    constructor() {
        owner = msg.sender;
    }

    modifier onlyOwner() {
        require(msg.sender == owner, "Only the owner can perform this action");
        _;
    }

    struct Drug {
        string drugName;
        string manufacturer;
        uint256 manufacturingDate;
        address trackingHistory;
    }

    mapping(uint256 => Drug) public drugs;
    uint256 public drugCount;

    event DrugManufactured(uint256 indexed drugId, string drugName, string
manufacturer, uint256 manufacturingDate);
    event DrugTransferred(uint256 indexed drugId, address indexed from, address
indexed to, uint256 transferDate);

    function manufactureDrug(uint256 drugId, string memory _drugName, string
memory _manufacturer, uint256 _manufacturingDate) external onlyOwner {

        address initialHistory;
        initialHistory = owner;

        drugs[drugId] = Drug(_drugName, _manufacturer, _manufacturingDate,
initialHistory);
```

```
        drugCount++;

        emit DrugManufactured(drugId, _drugName, _manufacturer,
_manufacturingDate);
    }

    function transferDrugOwnership(uint256 _drugId, address _to) external {
        require(_to != address(0), "Invalid address");
        require(_to != drugs[_drugId].trackingHistory, "Already owned by the new
address");

        address from = drugs[_drugId].trackingHistory;
        drugs[_drugId].trackingHistory = _to;

        emit DrugTransferred(_drugId, from, _to, block.timestamp);
    }

    function getDrugDetails(uint256 _drugId) external view returns (string memory,
string memory, uint256, address) {

        Drug memory drug = drugs[_drugId];
        return (drug.drugName, drug.manufacturer, drug.manufacturingDate,
drug.trackingHistory);
    }
}
```

CHAPTER -8

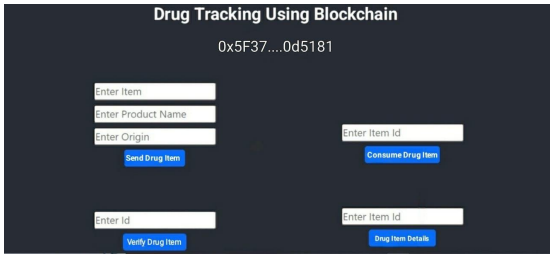
8. PERFORMANCE TESTING

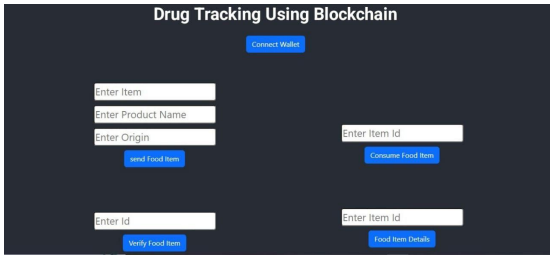
8.1. PERFORMANCE MATRICES

CHAPTER -9

9. RESULTS:

9.1. OUTPUT:





CHAPTER -10
10. ADVANTAGES AND DISADVANTAGES

ADVANTAGES:

Implementing a drug traceability project using blockchain technology offers several advantages and disadvantages:

Advantages:

1. Enhanced Traceability: Blockchain provides an immutable and transparent ledger, making it easy to trace the origin and movement of pharmaceuticals through the supply chain. This improves accountability and helps prevent counterfeit drugs from entering the market.

2. Improved Safety: With real-time monitoring and verification, drug traceability on the blockchain helps ensure the safety and quality of medications. This can reduce the risk of counterfeit or substandard drugs reaching consumers.

3. Reduced Fraud: Blockchain's tamper-proof nature and smart contract capabilities can reduce the risk of fraud in the pharmaceutical supply chain, helping to maintain the integrity of the industry.

4. Efficient Recalls: In the event of a defective or unsafe drug, blockchain can expedite the recall process by quickly identifying affected batches, reducing potential harm to consumers.

5. Compliance and Accountability: Blockchain helps pharmaceutical companies comply with regulations and standards by providing an auditable record of actions, improving transparency and accountability.

6. Data Security: The decentralized nature of blockchain enhances data security, protecting sensitive information about drug formulations, manufacturing processes, and patient records.

DISADVANTAGES:

1. Complex Implementation: Setting up a blockchain-based drug traceability system can be technically complex and require significant resources. It may also take time for all stakeholders to adapt to the new technology.

2. Cost: Developing and maintaining a blockchain network can be expensive, especially for smaller pharmaceutical companies or healthcare providers.

3. Interoperability: Ensuring that various stakeholders, including pharmaceutical companies, distributors, healthcare providers, and regulators, can access and use the blockchain system may be challenging due to interoperability issues.

4. Privacy Concerns: While blockchain provides data security, there can be concerns about patient privacy and the potential exposure of sensitive health information when integrated into a public blockchain.

5. Scalability: As the volume of drug transactions grows, scaling the blockchain to handle the increased load can be a technical challenge.

6. Adoption Hurdles: Getting all stakeholders in the pharmaceutical supply chain to adopt blockchain technology can be a major hurdle, as it requires a collective effort to realize the full benefits of traceability.

In summary, while blockchain technology offers significant advantages in drug traceability, such as improved safety and enhanced traceability, its implementation can be complex and costly. Overcoming privacy concerns, ensuring interoperability, and achieving broad adoption are key challenges to address in such projects.

CHAPTER -11
11. CONCLUSION:

In conclusion, a drug traceability project implemented using blockchain technology offers several benefits and outcomes,

The use of blockchain in drug traceability ensures a transparent and immutable ledger of pharmaceutical supply chain data, enabling all stakeholders, from manufacturers to consumers, to track the journey of drugs with high precision. Blockchain creates a tamper-resistant record of each step in the drug supply chain, making it easier to identify and hold parties accountable in case of counterfeit drugs, quality issues, or regulatory non-compliance. By verifying the authenticity and provenance of pharmaceuticals, blockchain helps combat the proliferation of counterfeit drugs in the market, enhancing patient safety. The system provides a secure and auditable record, simplifying compliance with stringent pharmaceutical regulations and standards, which vary by region and are critical for patient safety. In the event of a drug recall or contamination, blockchain enables faster and more precise identification of affected batches, reducing the scope and potential harm of such incidents. Ultimately, the project prioritizes patient safety by ensuring that they receive genuine and high-quality medications, enhancing trust in the healthcare system. Blockchain technology ensures data integrity and minimizes the risk of data manipulation or fraud in the pharmaceutical supply chain. Streamlined processes and reduced paperwork result in operational efficiency and cost savings for pharmaceutical companies. The project optimizes supply chain logistics, reducing waste and inefficiencies, and potentially lowering the cost of healthcare for patients.Patients and healthcare professionals can have greater confidence in the pharmaceuticals they use, knowing that the drugs' history is securely recorded on a blockchain.

In summary, a drug traceability project leveraging blockchain technology is instrumental in enhancing drug safety, security, and trust in the pharmaceutical industry. It addresses issues related to counterfeit drugs, regulatory compliance, and supply chain inefficiencies while prioritizing patient safety and data integrity.

CHAPTER -12
12. FUTURE SCOPE:

The future scope of a drug traceability project using blockchain technology includes:

★Enhanced Drug Safety: Blockchain can ensure the authenticity and safety of pharmaceuticals, reducing the risk of counterfeit or substandard drugs entering the market

★Regulatory Compliance: It can facilitate compliance with stringent pharmaceutical regulations by providing an immutable ledger of drug manufacturing, distribution, and prescription data
★Real-time Monitoring: Blockchain enables real-time monitoring of drug supply chains, allowing rapid response to recalls or quality issues.

★Supply Chain Efficiency: Improved traceability can lead to more efficient drug distribution, reducing costs and wastage.

★Patient Empowerment: Patients can verify the authenticity and source of their medications, enhancing trust and safety.

★Data Analytics: Blockchain data can be leveraged for insights into drug utilization, patient adherence, and supply chain optimization.

★Pharmaceutical Research: It can support research by securely sharing data while maintaining privacy.

★ Global Adoption: As blockchain drug traceability gains acceptance, it can become a global standard, harmonizing pharmaceutical supply chains.

Finally, the future of blockchain-based drug traceability promises increased safety, efficiency, transparency, and compliance in the pharmaceutical industry, benefiting both patients and stakeholders.

CHAPTER -13

☐ SOURCE CODE GITHUB

https://github.com/RJPRIYA/NM

☐ PROJECT DEMO LINK

https://drive.google.com/file/d/1FEj9_TTzwkGXT6OWzWh_oqgGmXVaR1Jv/view?usp=drivesdk