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Computer Science and Engineering

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SB8024- Blockchain Development

by Naan Mudhalvan Scheme – 2023

TEAM ID: NM2023TMID11722

PROJECT DOMAIN: BLOCKCHAIN TECHNOLOGY

PROJECT TITLE: CLIMATE TRACK SMART USING BLOCKCHAIN

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DRUG TRACEANILITY

1.INTRODUCTION

1.1 Project Overview

The blockchain-based drug traceability project aims to enhance transparency and security in the pharmaceutical supply chain by leveraging blockchain technology. This system will provide end-toend visibility of pharmaceutical products, from manufacturing to distribution, and ultimately to the end consumers. It will ensure the authenticity, quality, and compliance of drugs, thereby improving patient safety and regulatory compliance. Establish End-to-End Traceability: Implement a blockchain system to track pharmaceutical products through every stage of the supply chain, from production to consumption .Enhance Transparency: Create a transparent and immutable ledger that allows all stakeholders in the supply chain to access real-time information regarding the movement and status of drugs. Ensure Authenticity: Verify the authenticity and origin of pharmaceutical products to combat counterfeit drugs and ensure patient safety. Improve Regulatory Compliance: Streamline compliance with various pharmaceutical regulations and standards, such as the Drug Supply Chain Security Act (DSCSA) in the United States or similar international regulations. Reduce Recall Risks: Enable faster and more precise recalls by identifying affected products and their distribution routes in case of safety concerns or product defects Enhance Data Security: Implement robust security measures to protect sensitive pharmaceutical data and ensure only authorized personnel have access. Foster Collaboration: Encourage cooperation among stakeholders, including pharmaceutical manufacturers, distributors, pharmacies, and regulatory authorities Periodically audit the blockchain system to ensure regulatory compliance. Generate reports for regulatory authorities as required. By implementing this blockchain-based drug traceability system, the pharmaceutical industry can increase patient safety, reduce the risk of counterfeit drugs, and streamline supply chain operations while ensuring compliance with stringent regulations. This project will contribute to a more transparent and secure pharmaceutical supply chain.

1.2 Purpose

Drug traceability using blockchain technology serves several important purposes in the pharmaceutical and healthcare industry. These purposes are primarily centered around ensuring the safety and authenticity of pharmaceutical products throughout the supply chain. Here are some of the key purposes: Counterfeit Prevention: Counterfeit drugs pose a significant threat to public health. Blockchain enables the creation of an immutable ledger that records the entire history of a drug, from the manufacturing process to distribution. This ensures that counterfeit drugs can be quickly identified and removed from circulation. Supply Chain Transparency: Blockchain provides transparency in the pharmaceutical supply chain by recording all transactions and movements of drugs. This transparency helps stakeholders (manufacturers, distributors regulators, and consumers) track the movement of drugs and ensure they are genuine .Authentication: With blockchain, each drug can be assigned a unique digital identifier (e.g., a digital serial number or barcode) that is recorded on the blockchain. This enables easy verification of a drug's authenticity at every step of its journey through the supply chain .Improved Recall Management: In the event of a product recall due to safety concerns or quality issues, blockchain enables rapid and precise tracking of affected products. This reduces the risk of harm to patients and minimizes financial losses for pharmaceutical companies. Compliance and Regulatory Reporting: Many regulatory authorities require detailed records of drug manufacturing and distribution. Blockchain simplifies compliance by providing a tamper-resistant and auditable record of all transactions, making it easier to meet regulatory requirements .Data Integrity: Blockchain's decentralized and immutable nature ensures the integrity of the data recorded on the ledger. This makes it highly resistant to data tampering, fraud, or unauthorized changes .Efficiency: The transparency and automation features of blockchain can streamline various processes in the pharmaceutical supply chain, reducing administrative burdens and the potential for errors. This, in turn, can lead to cost savings and increased efficiency .Patient Safety: Ultimately, the primary purpose of drug traceability using blockchain is to protect patient safety. By ensuring the authenticity and quality of pharmaceutical products, blockchain technology helps reduce the risk of patients receiving counterfeit, substandard, or harmful drugs. Product Lifecycle Monitoring: Blockchain allows for comprehensive tracking of a drug's entire lifecycle, including its manufacturing, storage conditions, transportation, and distribution. This data can be invaluable for assessing a drug's quality and safety .Global Integration: Blockchain can facilitate international collaboration by providing a standardized and secure platform for traceability. This is particularly important in the pharmaceutical industry, which often involves complex international supply chains.

2.EXISTING PROBLEM

2.1 Existing Problem

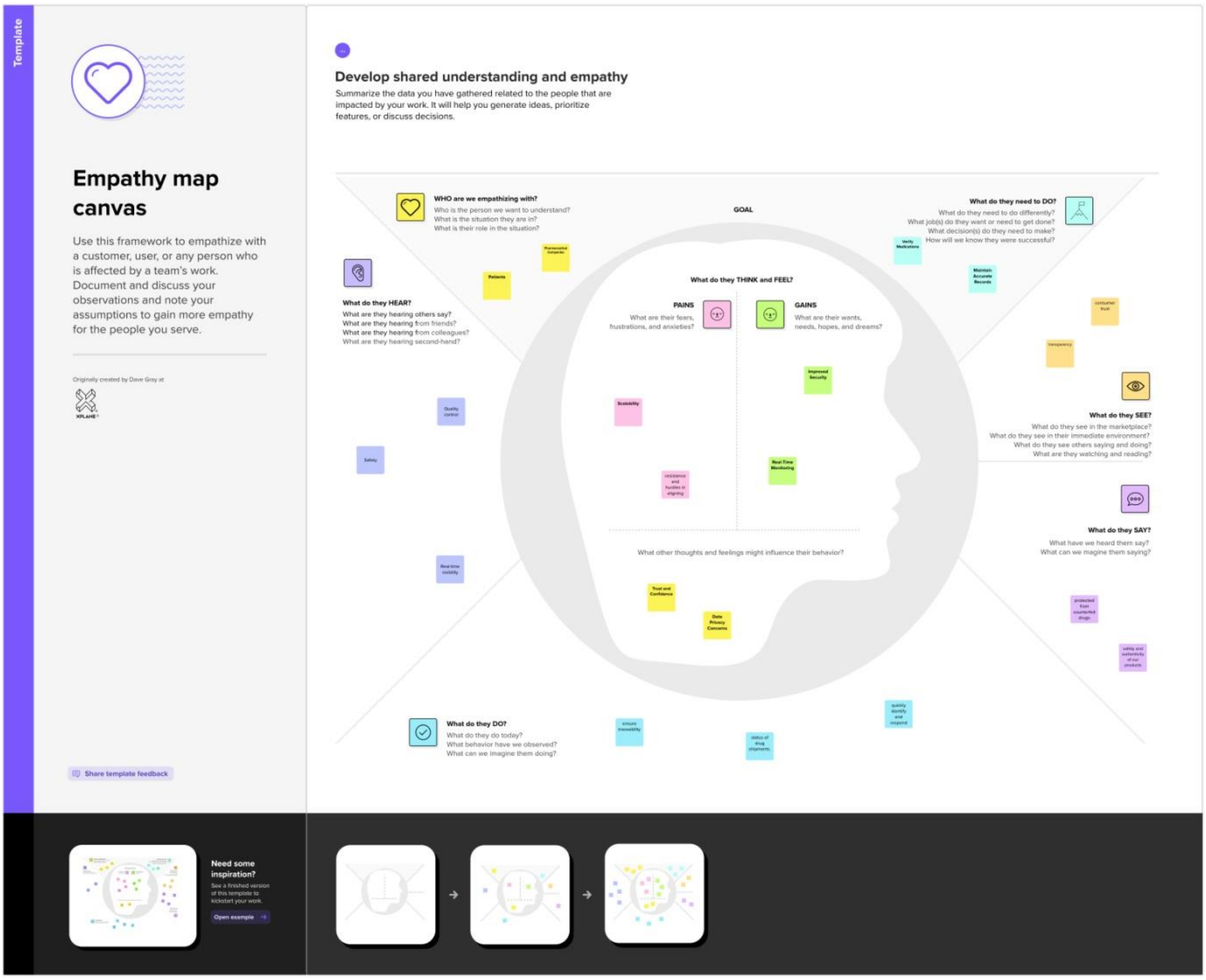
Drug traceability using blockchain technology offers several advantages, such as enhancing transparency and security in the pharmaceutical supply chain. However, there are also some existing challenges and problems associated with implementing blockchain for drug traceability :Interoperability: Different pharmaceutical companies, healthcare providers, and regulatory agencies may use various blockchain platforms or technologies. The lack of standardization and interoperability between these platforms can hinder seamless data sharing and traceability .Adoption and integration: Widespread adoption of blockchain technology in the pharmaceutical industry can be slow due to the need for companies to invest in new systems and integrate them into existing infrastructure. This process can be costly and time consuming. Data privacy and security: While blockchain is generally considered secure, it's not immune to cyberattacks and data breaches. Ensuring the privacy and security of sensitive patient and drug information on a blockchain network is a significant challenge. Scalability: As the pharmaceutical supply chain is vast and complex, blockchain networks may face scalability issues when handling a high volume of transactions and data. Scalability solutions need to be developed to support the growing demands of the industry. Regulatory compliance: The pharmaceutical industry is highly regulated, with strict compliance requirements. Adapting blockchain solutions to meet these regulations, which may vary from one region to another, is a complex and ongoing process .Trust and governance: Trust in the authenticity of data on a blockchain network is essential for drug traceability. Governance structures for blockchain networks must be established to ensure data accuracy and prevent fraudulent activities Data input accuracy: Blockchain's effectiveness in traceability relies on accurate data input at each stage of the supply chain. Human errors or intentional misinformation can compromise the integrity of the system. Cost: Implementing and maintaining a blockchain system can be expensive, especially for smaller pharmaceutical companies and healthcare providers. The cost of infrastructure, training, and ongoing maintenance can be a barrier to adoption .Education and awareness: Stakeholders in the pharmaceutical supply chain may lack the necessary knowledge and awareness of blockchain technology. Education and training are required to ensure that all parties involved understand how to use the system effectively .Blockchain expertise: Developing and managing a blockchain network for drug traceability requires skilled personnel who understand both blockchain technology and the pharmaceutical industry. A shortage of such experts can be a significant challenge .Despite these challenges, the adoption of blockchain for drug traceability continues to progress, as the benefits of improved transparency, security, and accountability are compelling for the pharmaceutical industry and its stakeholders. Solutions to these problems are continually being developed and refined as the technology matures and the industry gains experience in its implementation.

2.2 Problem Statement Definition

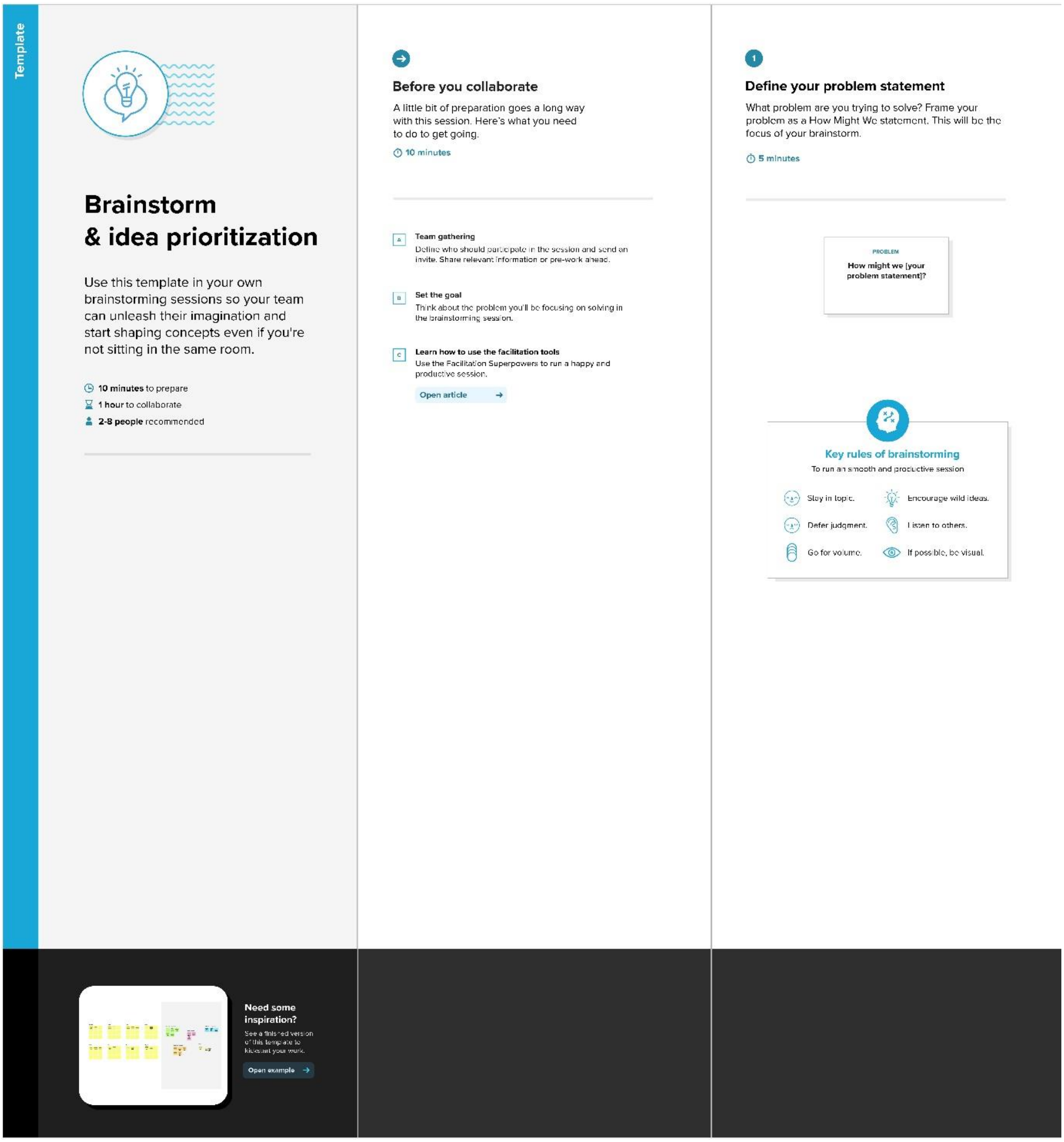
A problem statement for drug traceability using blockchain technology can be defined follows Ensuring the authenticity and transparency of the pharmaceutical supply chain is a critical challenge in the healthcare industry. The current pharmaceutical supply chain faces issues related to counterfeit drugs, substandard quality products, and a lack of transparency. To address these challenges, there is a need for a robust drug traceability system utilizing blockchain technology. This system should enable end-toend tracking and verification of pharmaceutical products throughout the supply chain, from manufacturers to distributors to pharmacies. The objective is to enhance patient safety, reduce the prevalence of counterfeit drugs, improve regulatory compliance, and provide stakeholders with realtime access to accurate and immutable data about the origin, handling, and distribution of pharmaceuticals. Developing and implementing a secure and efficient blockchain-based drug traceability system is crucial for ensuring the integrity of the pharmaceutical supply chain and safeguarding public health."

3. IDEATION AND PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation and Brainstorming



2

Brainstorm

Write down any ideas that come to mind that address your problem statement.

10 minutes

TIP

You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!

HARIPRASATH S G

NITHIN S

SANJAI R

SUNNY KUMAR JAISWAL

3

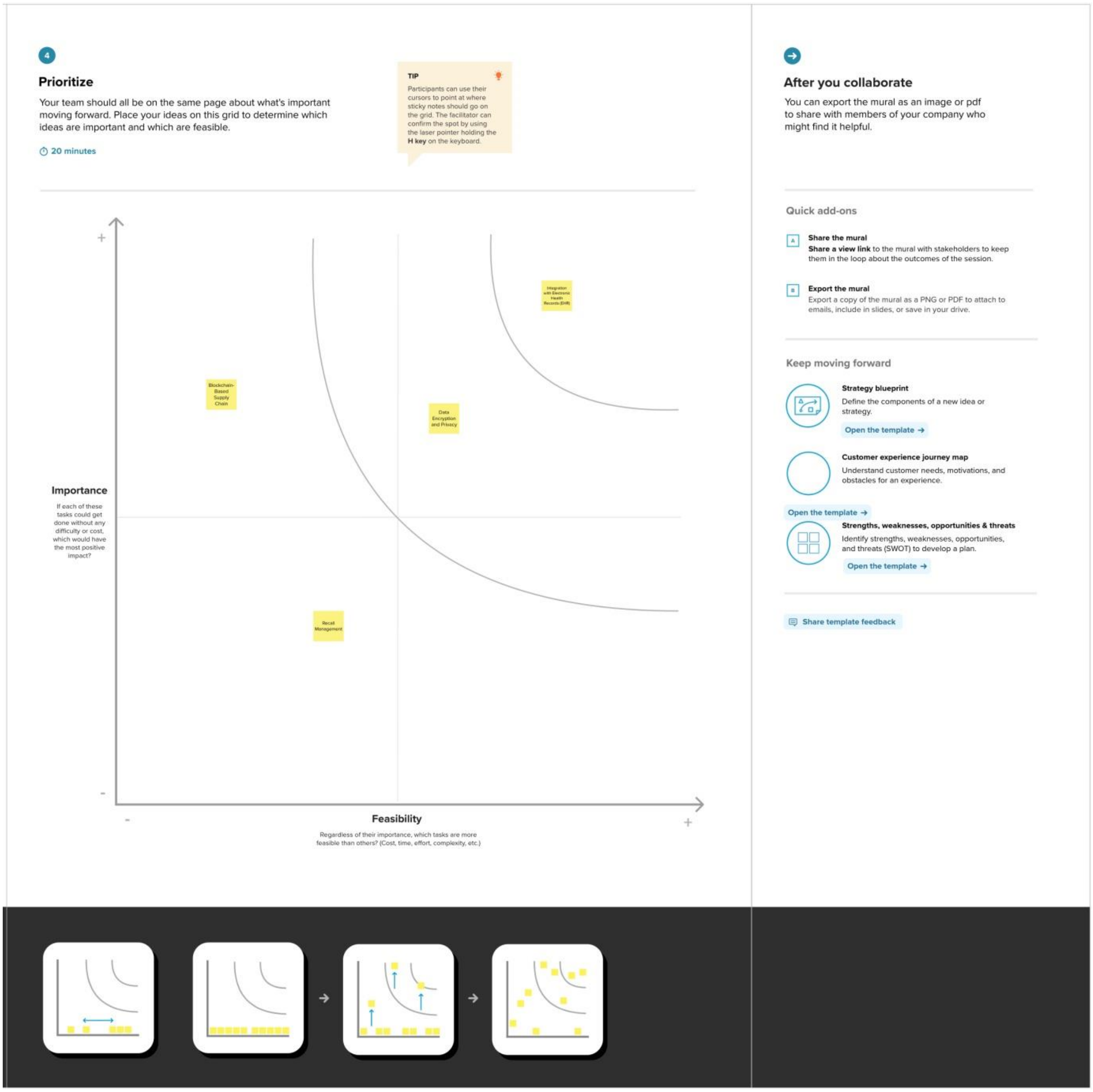
Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.

20 minutes

TIP

Add customizable tags to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your mural.



4.REQUIREMENT ANALYSIS

4.1 Functional Requirement

Identify Stakeholders:Identify all relevant stakeholders, including pharmaceutical manufacturers, distributors, regulators, healthcare providers, and patients. Understand their roles and needs in the drug supply chain. Regulatory Compliance:Identify the specific regulations and compliance requirements relevant to the pharmaceutical industry in the target region. Ensure the blockchain solution aligns with these regulations. Data Requirements:Define the types of data that need to be tracked and recorded, including batch/lot numbers, expiration dates, manufacturing and shipping data, and any other relevant information. Data Sources:Identify the sources of data, such as manufacturing facilities, distribution centers, and partners, and determine how this data will be integrated into the blockchain. Traceability Requirements:Specify the level of traceability required, whether it's at the product, batch, or unit level. This will impact the granularity of data stored on the blockchain. Privacy and Security:Define the security and privacy measures required to protect sensitive information, including personally identifiable information (PII) and proprietary data. Consider encryption, access controls, and consensus mechanisms. Interoperability:Ensure the blockchain system can interoperate with existing systems, such as ERP systems, supply chain management platforms, and regulatory databases. Scalability:Consider the scalability requirements, as the system must handle a growing volume of transactions and data over time. User Access and Roles:Determine who can access the blockchain and define roles and permissions for different stakeholders. User Experience:Focus on user-friendliness to encourage adoption. Both technical and nontechnical users should find the system easy to use. Technology Stack:Choose the appropriate blockchain platform (e.g., Ethereum, Hyperledger, or a custom solution) and relevant technologies (smart contracts, consensus algorithms) based on the project's specific requirements. Data Storage and Retrieval:Decide on the data storage mechanism and how data will be retrieved from the blockchain, considering performance and accessibility. Integration with IoT and Other Technologies:Explore how the blockchain system can integrate with IoT devices and sensors for real-time monitoring and data collection. Auditability and Reporting:Plan for audit trails and reporting capabilities to ensure transparency and accountability. Testing and Validation:Establish requirements for testing, quality assurance, and validation processes to ensure the system's reliability. Cost and ROI Analysis:Assess the costs of implementation and maintenance against the expected return on investment, taking into account the reduction in counterfeit drugs, improved supply chain efficiency, and compliance benefits. Change Management:Develop a change management plan to guide the adoption of the blockchain system within the organization and among stakeholders. Timeline and Milestones:Create a project timeline with specific milestones to track progress. Risk Assessment:Identify potential risks and mitigation strategies associated with blockchain implementation.

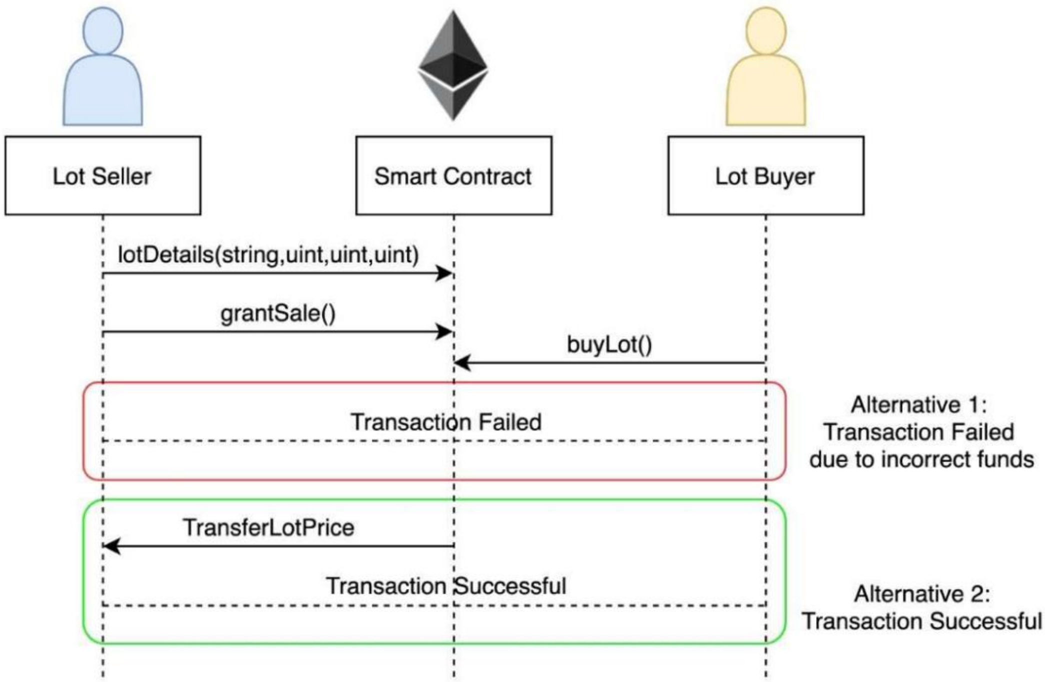
4.1 Non Functional Requirements

Security: Data Encryption: Ensure that all drug-related data stored on the blockchain is encrypted to protect against unauthorized access. Identity Management: Implement strong authentication and authorization mechanisms to control access to the blockchain. Audit Trail:

Maintain a detailed and immutable audit trail of all transactions and changes on the blockchain to track any unauthorized or malicious activities. Performance: Scalability: The system should be able to handle a growing number of transactions and participants as more drugs are added to the system. Response Time: Specify acceptable response times for various actions like querying drug information, adding new drugs, or verifying authenticity. Throughput: Define the number of transactions the system should be able to process per second or per minute. Reliability: High Availability: Ensure that the blockchain network is available and accessible 24/7 with minimal downtime. Fault Tolerance: The system should be able to continue functioning even in the presence of network failures or other issues. Regulatory Compliance: Data Retention: Compliance with data retention regulations, specifying how long data needs to be stored on the blockchain. Auditability: Ensure that the system allows for easy auditing and reporting for regulatory purposes. Interoperability: Compatibility: The blockchain system should be able to integrate with existing systems used by pharmaceutical companies, regulatory bodies, and other stakeholders. Standard Compliance: Ensure compliance with industry standards for drug traceability. Privacy: Data Minimization: Collect and store only the necessary data to ensure the privacy of individuals and businesses involved in the supply chain. Consent Management: Implement mechanisms to manage and record user consent for data sharing on the blockchain. Usability: User Interface: Provide an intuitive and user-friendly interface for stakeholders to interact with the blockchain system. Training and Support: Offer training and support for users to understand and navigate the system effectively. Scalability: Load Testing: Perform load testing to ensure the system can handle an increasing number of transactions without degradation in performance. Resource Allocation: Define how resources like storage and computing power will be allocated and scaled as needed. Data Integrity: Immutable Records: Ensure that once data is recorded on the blockchain, it cannot be altered or deleted. Data Verification: Implement mechanisms for verifying the integrity of the data stored on the blockchain. Cost: Cost Optimization: Define strategies for cost optimization, as blockchain operations can be resource-intensive. Transaction Fees: Specify how transaction fees are managed and distributed among participants.

5.PROJECT DESIGN

5.1 Data Flow Daigram and User Stories



Story 1

As a user, I want to create a decentralized identity on the Ethereum blockchain so that I can have full control over my personal information and digital assets. want to link my Ethereum wallet address to my decentralized identity so that I can use it for authentication and authorization purposes. I want to store my personal information (such as name, email, and other relevant details) securely within my decentralized identity smart contract.

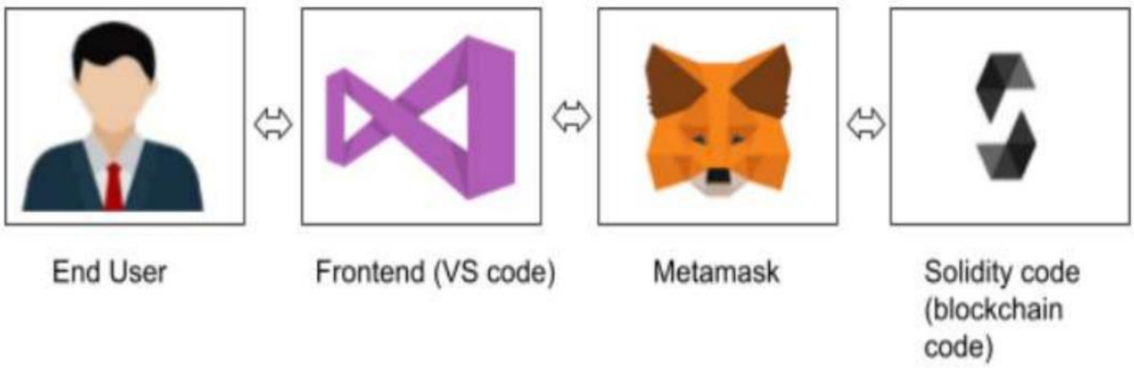
Story 2

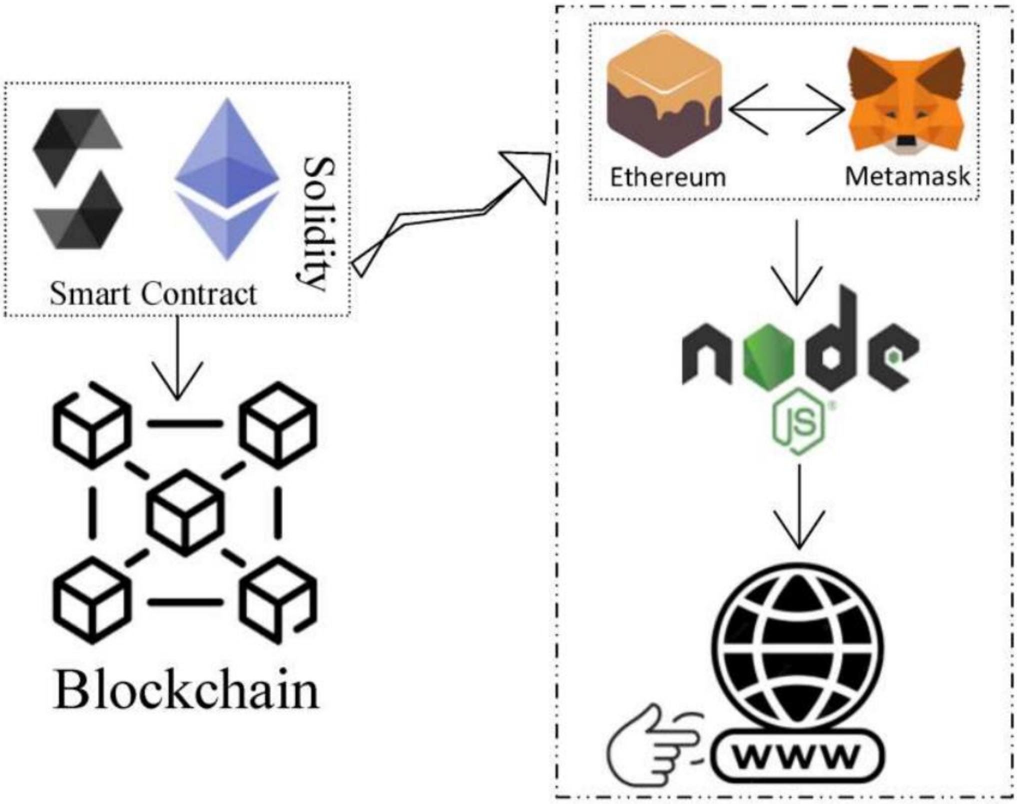
As a user, I want to share specific elements of my decentralized identity, such as my email address, with a third party in a secure and privacy-preserving manner.As a user, I want to have the ability to update and revoke access to my personal information from third parties I've shared it with through the decentralized identity smart contract.As a service provider, I want to verify the authenticity of a user's decentralized identity to ensure the user is who they claim to be.

Story 3

As a developer, I want to easily integrate the Ethereum DID smart contract into my applications and services for secure user authentication and data access.

5.2 Solution Architecture

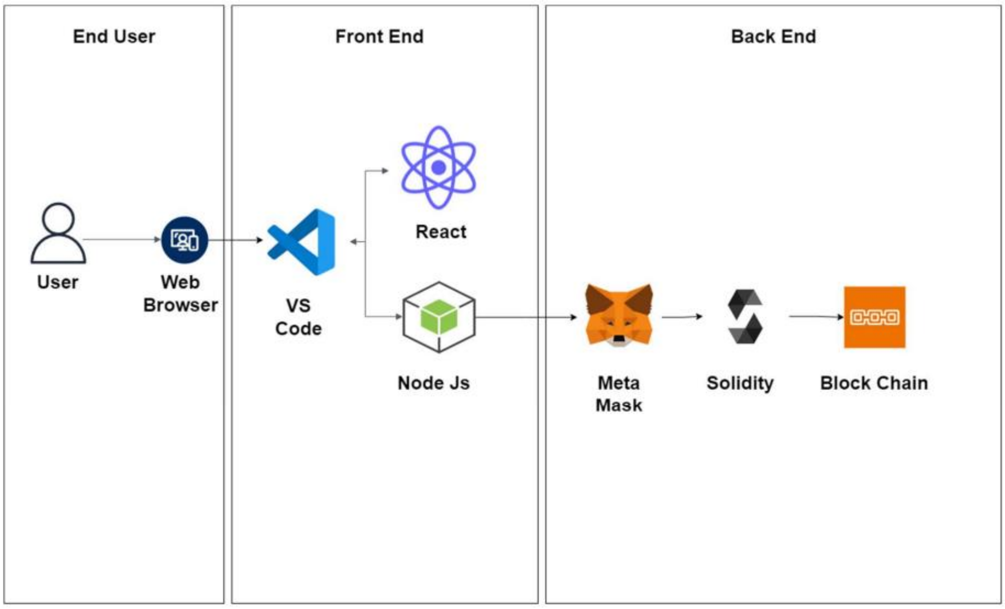




INTRACTION BETWEEN WEB AND THE CONTRACT

6.PROJECT PLANNING & SCHEDULING

6.1 Technical Architecture



GENERAL ARCHITECTURE

6.2 Sprint Planning and Estimation

6.3 Sprint Delivering Schedule:

Week 1:Project Initiation and Planning

 Define project objectives and scope.

 Gather project requirements and conduct initial research.

 Set up the development environment.

 Create a high-level project plan.

Week 2:Smart Contract Architecture

 Design the architecture of the Decentralized Identity Smart Contract.

 Define the data structures and functions.

 Establish the contract's ownership and access control mechanisms.

Week 3:Decentralized Identifier and User Interface Development

 Integrate a DID resolver for Ethereum.

 Test DID resolution to fetch user information.

 Handle DID document updates and revocation.

 Develop a user-friendly frontend for interacting with the smart contract.

 Enable users to create, manage, and verify their decentralized identities.

 Ensure a seamless user experience

7.CODING AND SOLUTING

7.1 Feature1

Smart Contract(Solidity)

```
// 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;
string email,

 uint256 registrationTimestamp );
 constructor()
 { owner = msg.sender;
}

 modifier onlyOwner()

 { require(msg.sender == owner,

 "Only contract owner can call this");
 _;
}
 modifier notRegistered()
 {
 require( bytes(identities[msg.sender]
.identityId).length == 0,
"Identity already registered" );

 _; }
```

```
 function registerIdentity
( string memory identityId,
 string memory name,
string memory email,
 string memory _address )

 external notRegistered
 {



require(bytes(identityId).length > 0,
 "Invalid identity ID");
require(bytes(name).length > 0,

 "Invalid name");
require(bytes(email).length > 0,
"Invalid email");
 identities[msg.sender] = Identity

({ identityId: identityId, name:

name, email: email, contactAddress :
 _address, registrationTimestamp:
```

```
 block.timestamp });

 emit IdentityRegistered( msg.sender,
identityId, name, email, block.timestamp );
 } function getIdentityDetails( address userAddress )

external view returns

 (string memory, string memory,
string memory, string memory,uint256)

{
Identity memory identity
= identities[userAddress];
 return ( identity.identityId,

 identity.name, identity.email,

identity.contactAddress,

 identity.registrationTimestamp
 );

}
```

```
}
```

This Solidity smart contract, named "Identification," seems to be a basic identity registration system on the Ethereum blockchain. Here are some features you can consider adding or enhancing to make this contract more functional and secure.Introduce role-based access control to allow for different levels of permissions (e.g., admin, manager, user).Create a mechanism for administrators to manage and modify user identities.Add functions to allow users to update their identity details or delete their identity when needed.Implement a Know Your Customer (KYC) process for identity verification.Integrate with an oracle or external service for identity verification, such as government-issued IDs or documents.Enhance data privacy by encrypting sensitive information, such as email addresses or contact addresses.Implement encryption and decryption mechanisms for stored data, allowing only authorized parties to access it.Additionally, security should always be a top priority when dealing with identity data and user information on the blockchain.

7.2Feature 2

Frond end(Java Script)

```
import React, { useState } from "react";
import { Button, Container, Row, Col } from 'react-bootstrap';
import '../../node_modules/bootstrap/dist/css/bootstrap.min.css';
import { contract } from "./connector";
 DRUG TRACEABILITY

function Home() {
 const [Id, setId] = useState("");
 const [name, setName] = useState("");
 const [email, setEmail] = useState("");
 const [addr, setAddr] = useState("");
 const [mAddr, setmAddr] = useState("");
 const [data, setdata] = useState("");
```

```
const [Wallet, setWallet] = useState("");
const handleId = (e) => {
setId(e.target.value)
}
const handleName = (e) => {
setName(e.target.value)
}
const handleEmail = (e) => {
setEmail(e.target.value)
}

const handleAddr = (e) => {
setAddr(e.target.value)
}



const handleRegisterIdentity = async () => {
try {
let tx = await contract.registerIdentity(Id.toString(), name, email, addr)
let wait = await tx.wait()
alert(wait.transactionHash)
console.log(wait);
} catch (error) {
alert(error)
}
}
const handleMetamaskAddr = (e) => {
setmAddr(e.target.value)
}
const handleAddrDetails = async () => {
```

```
try {
let tx = await contract.getIdentityDetails(mAddr)
let arr = []
tx.map(e => arr.push(e))
setdata(arr)
// alert(tx)
console.log(tx);
} catch (error) {
alert(error)


}
}
const handleWallet = async () => {
if (!window.ethereum) {
return alert('please install metamask');
}
const addr = await window.ethereum.request({
method: 'eth_requestAccounts',
});
setWallet(addr[0])
}
return (
<div>
<h1 style={{ marginTop: "30px", marginBottom: "80px" }}>Identity On Blockchain</h1>
{!Wallet ?
<Button onClick={handleWallet} style={{ marginTop: "30px", marginBottom: "50px"
}}>Connect
Wallet </Button>
:
```

```
 <p style={{ width: "250px", height: "50px", margin: "auto", marginBottom: "50px", border:
'2px
solid #2096f3' }}>{Wallet.slice(0, 6)}....{Wallet.slice(-6)}</p>
 }
 <Container>



 <Row>
 <Col style={{marginRight:"100px"}}>
 <div>

 <input style={{ marginTop: "10px", borderRadius: "5px" }} onChange={handleId}
type="number"
placeholder="Enter Identity ID" value={Id} /> <br />

 <input style={{ marginTop: "10px", borderRadius: "5px" }} onChange={handleName}
type="string"
placeholder="Enter Name" value={name} /> <br />

 <input style={{ marginTop: "10px", borderRadius: "5px" }} onChange={handleEmail}
type="string"
placeholder="Enter Email" value={email} /><br />

 <input style={{ marginTop: "10px", borderRadius: "5px" }} onChange={handleAddr}
type="string"
placeholder="Enter Address" value={addr} /><br />

 <Button onClick={handleRegisterIdentity} style={{ marginTop: "10px" }}
variant="primary">Register
Identity</Button>
 </div>
 </Col>
 <Col>
```

```
<div>
<input style={{ marginTop: "10px", borderRadius: "5px" }}
onChange={handleMetamaskAddr}
type="string" placeholder="User Metamask address" value={mAddr} /><br />
<Button onClick={handleAddrDetails} style={{ marginTop: "10px" }}
variant="primary">Get Identity
Details</Button>
{data ? data?.map(e => {
return <p>{e.toString()}</p>


}) : <p></p>}
</div>
</Col>
</Row>


</Container>
</div>
)
}
export default Home;
```

Contract ABI (Application Binary Interface): The abi variable holds the ABI of an Ethereum smart contract. ABIs are essential for encoding and decoding function calls and data when interacting with the Ethereum blockchain.

MetaMask Check: The code first checks whether the MetaMask wallet extension is installed in the user's browser. If MetaMask is not detected, it displays an alert notifying the user that MetaMask is not found and provides a link to download it**.**

Ethers.js Configuration: It imports the ethers library, which is a popular library for Ethereum development.It creates a provider using Web3Provider, which connects to the user's MetaMask wallet and provides access to Ethereum.

It creates a signer to interact with the Ethereum blockchain on behalf of the user.It defines an Ethereum contract address and sets up the contract object using ethers.Contract, allowing the JavaScript code to interact with the contract's functions.In summary, this code is used for interacting with an Ethereum smart contract through MetaMask and ethers.js. It configures the necessary Ethereum provider and signer for communication with the blockchain and sets up a contract object for executing functions and fetching data from the specified contract address using the provided ABI.

A performance matrix for an Ethereum Decentralized Identity (DID) smart contract would assess various aspects of the contract's functionality and performance. Here is a sample performance matrix for such a smart contract.

8. PERFORMANCE TESTING

8.1 Performance Matrix

Scalability:

- Number of DIDs supported concurrently.
- Transactions per second (TPS) for creating, updating, and resolving DIDs.
- Gas consumption per operation.

Security:

- Smart contract audit results.
- Vulnerability assessments (e.g., OWASP Top Ten).
- Compliance with Ethereum best practices and standards.

Privacy and Confidentiality:

- Protection of user data.
- Encryption and decryption efficiency.
- Privacy-preserving techniques employed (e.g., zero-knowledge proofs).

Interoperability:

- Compatibility with popular identity standards (e.g., W3C DID, Verifiable Credentials).

□ Integration with other Ethereum-based smart contracts and platforms**.**

□ Support for cross-platform compatibility.

Ease of Use:

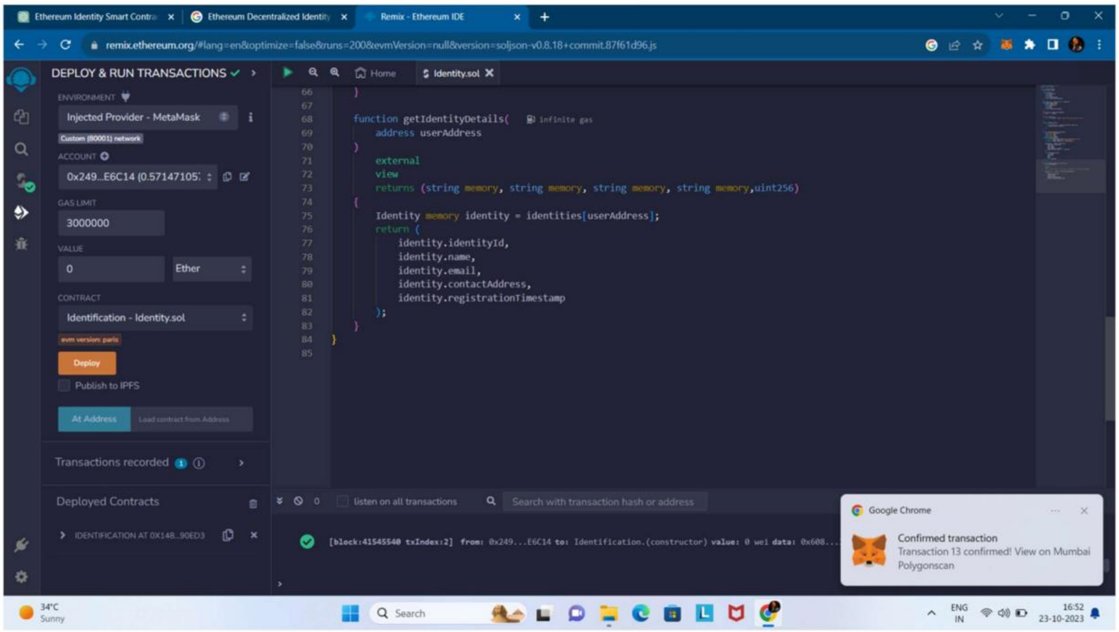
□ User-friendly API and documentation.

□ Accessibility and usability for non-technical users.

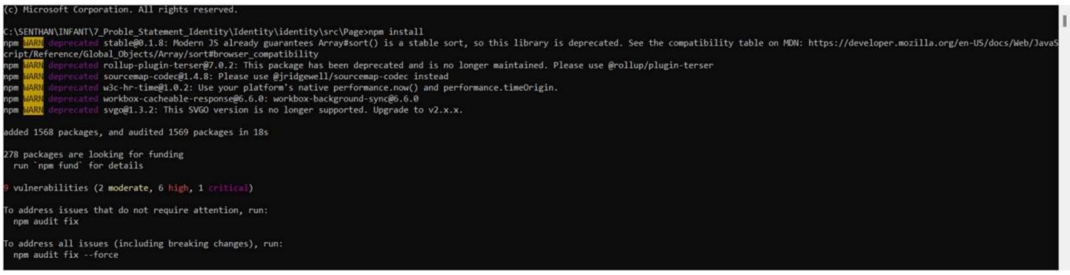
□ Availability of SDKs and developer resources.

9.RESULTS

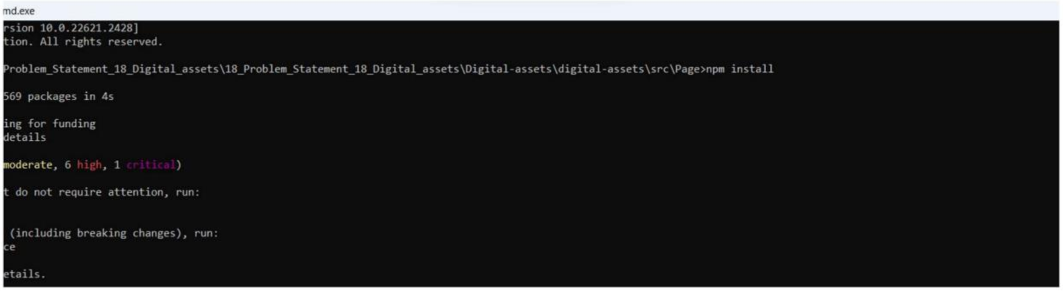
9.1 OUTPUT SCREENSHOTS



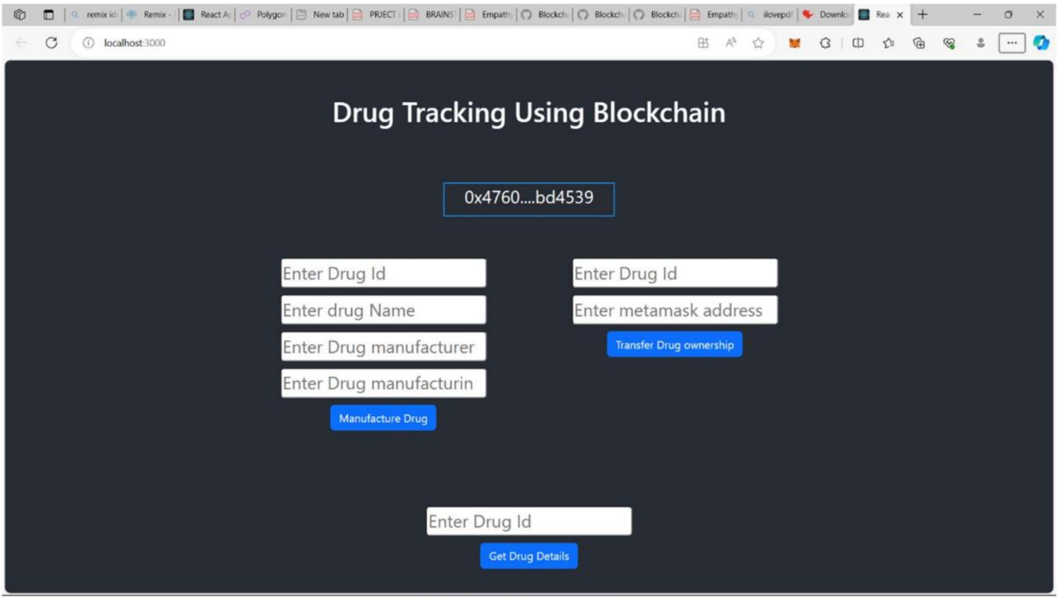
CREATING A SMART CONTACT



INSTALLING DEPENDENCIES 1



INSTALLING DEPENDENCIES 2



WEB PAGE OUTPUT

10.ADVANTAGES AND DISADVANTAGES

10.1 ADVANTAGES

Blockchain technology offers several advantages for drug traceability, which is crucial in ensuring the safety and integrity of pharmaceutical products. Here are some of the key benefits:Transparency and Immutable Records: Blockchain provides a transparent and immutable ledger that records every transaction in the drug supply chain. This transparency helps in tracking the movement of drugs from the manufacturer to the end consumer, reducing the chances of counterfeit or fraudulent products entering the market.Enhanced Security: Blockchain's cryptographic security features make it extremely difficult for unauthorized parties to alter or tamper with the data recorded on the blockchain. This ensures that the drug traceability information remains secure and accurate.Real-time Updates: Information on the blockchain is updated in real-time, allowing stakeh olders in the supply chain to access the most current data about a drug's origin, location, and status. This can help in faster response to issues such as recalls, ensuring patient safety.Streamlined Compliance: Blockchain can automate compliance with regulatory requirements. Smart contracts can be used to execute predefined actions when certain conditions are met, helping to ensure that regulations are consistently followed throughout the supply chain.Reduced Counterfeits: The immutability and transparency of blockchain make it difficult for counterfeit drugs to enter the supply chain. Consumers and regulators can verify the authenticity of drugs by scanning QR codes or utilizing other means of access to the blockchain data.Efficient Recalls: In the event of a product recall, blockchain can rapidly trace the affected products back to their source, allowing for targeted and efficient recalls, reducing waste and protecting public health.Supply Chain Efficiency: Blockchain can streamline the supply chain by reducing paperwork, manual data entry, and intermediaries, which can lead to cost savings and faster, more efficient operations.Increased Trust: By providing a trustworthy and transparent system, blockchain helps build trust among all parties involved in the pharmaceutical supply chain, including manufacturers, distributors, pharmacies, and patients.Data Integrity: Blockchain ensures that data is accurate and consistent across the entire supply chain. This is particularly important for pharmaceuticals, where data integrity can directly impact patient safety.Global Reach: Blockchain is a borderless technology, making it suitable for global supply chains. It can help ensure consistency and traceability in drug distribution across different countries and regions.Public Access: Some blockchain networks are public, meaning that anyone can verify the data on the blockchain. This transparency can further enhance trust and accountability in the pharmaceutical industry.

10.2 DISADVANTAGES

While blockchain technology has the potential to enhance drug traceability and transparency in the pharmaceutical industry, it also has its disadvantages and challenges. Some of the disadvantages of using blockchain for drug traceability include :Implementation Costs: Developing and implementing a blockchain system can be expensive. Pharmaceutical companies, especially smaller ones, may find it costprohibitive to set up and maintain a blockchain network Complexity: Blockchain technology is complex, and it can be challenging to understand and implement, especially for non-technical stakeholders. This complexity may result in slower adoption rates. Interoperability: Ensuring that different blockchain systems used by various stakeholders in the pharmaceutical supply chain can interoperate seamlessly can be difficult. Lack of standardization may hinder the effectiveness of drug traceability .Scalability: As the number of drug transactions and participants in the supply chain increases, blockchain networks can face scalability issues. The larger the network, the more computational resources are needed to maintain it, potentially causing slower transaction processing times .Data Privacy Concerns: While blockchain provides transparency, it can also present privacy concerns. Sensitive information, such as patient data or proprietary information, may be visible to all participants in a public blockchain. Private and permissioned blockchains can mitigate this, but they come with their own challenges.Regulatory Compliance: The regulatory environment around blockchain in the pharmaceutical industry may not be well-defined or consistent across different jurisdictions. Meeting regulatory compliance requirements can be a significant challenge.Human Error: While blockchain can reduce fraud and errors, it's not immune to human error during data entry. Incorrect information entered into the blockchain can lead to inaccuracies in the traceability system.Risk of Centralization: In some cases, the adoption of blockchain technology can lead to a form of centralization, where a few dominant entities control the network, potentially defeating the purpose of decentralization and transparency.Adoption Challenges: Convincing all stakeholders in the pharmaceutical supply chain to adopt blockchain technology can be challenging. Resistance to change, lack of technical expertise, and concerns about costs and data security can impede adoption.Security Risks: While blockchain is touted for its security, it's not immune to attacks. Smart contract vulnerabilities, 51% attacks (in public blockchains), and social engineering attacks can compromise the integrity of the system.Environmental Concerns: Many blockchain networks rely on energy-intensive consensus mechanisms like Proof of Work (PoW), which has raised concerns about their environmental impact due to high energy consumption.Maintenance and Upkeep: Keeping a blockchain network up and running, especially over the long term, requires ongoing maintenance, updates, and potentially expensive hardware. This can be a burden for organizations.

11. CONCLUSION

In conclusion, drug traceability in the context of cloud computing offers significant advantages for the pharmaceutical industry and regulatory agencies. By leveraging the capabilities of cloud-based systems, drug manufacturers and stakeholders can achieve enhanced visibility, security, and efficiency in their supply chains. Here are some key points to summarize the benefits of drug traceability through cloud computing:Enhanced Data Management: Cloud computing allows for the centralized storage and management of drug-related data, ensuring that all stakeholders have real-time access to critical information. This leads to more accurate and efficient tracking of drugs throughout the supply chain.Improved Security: Cloud service providers typically invest heavily in cybersecurity measures, making cloud-based drug traceability systems more resilient against data breaches and cyber threats. This is crucial in maintaining the integrity of the pharmaceutical supply chain.Real-time Tracking: Cloud-based solutions enable real-time monitoring of drug shipments, making it easier to identify and address any issues or discrepancies promptly. This enhances overall supply chain transparency.Regulatory Compliance: Cloud-based drug traceability systems can be configured to meet various regulatory requirements, such as those outlined in the Drug Supply Chain Security Act (DSCSA) in the United States. This ensures that pharmaceutical companies remain compliant with industry regulations.Scalability and Cost-Efficiency: Cloud computing provides scalability, allowing organizations to adapt to changing demands without the need for significant infrastructure investments. This can lead to cost savings in the long run.

12.FUTURE SCOPE

The use of blockchain technology for drug traceability holds significant promise for enhancing transparency, security, and efficiency in the pharmaceutical industry. While the technology is already being adopted for this purpose, its future scope is likely to expand in several key ways: Global Adoption: The pharmaceutical industry is global, with the distribution of drugs spanning across countries and regions. Blockchain can provide a standardized and interoperable system for tracking drugs from production to consumption worldwide. As more countries and organizations recognize its benefits, the adoption of blockchain for drug traceability is expected to grow. Regulatory Compliance: Regulatory agencies, such as the U.S. Food and Drug Administration (FDA) and the European Medicines Agency (EMA), are increasingly interested in blockchain solutions to ensure drug safety and compliance. The future will likely see more regulatory guidance and requirements related to blockchain-based drug traceability, encouraging wider adoption. Enhanced Data Quality: Blockchain's immutability and transparency can help improve the quality of data related to drug manufacturing, distribution, and supply chain management. This can lead to better decision-making, reduced errors, and fewer instances of counterfeit drugs entering the market. Interoperability: To achieve a seamless and truly global drug traceability system, different blockchain platforms and systems need to be interoperable. The future of blockchain in drug traceability will likely involve the development of standards and protocols to enable data exchange between various blockchain networks.

Supply Chain Optimization: Beyond traceability, blockchain technology can be used to optimize the entire pharmaceutical supply chain. This includes reducing excess inventory, minimizing waste, and enhancing supply chain efficiency, all of which can lead to cost savings. Patient-Centric Solutions: Patients are becoming more interested in the authenticity and safety of the drugs they consume. Blockchain can empower patients to verify the legitimacy of their medications, view their journey through the supply chain, and make informed decisions about their healthcare. Blockchain Integration with IoT and AI: Combining blockchain with the Internet of Things (IoT) and artificial intelligence (AI) can provide real-time monitoring and data analysis of pharmaceutical products. This can help in proactive issue identification and resolution, reducing the risk of counterfeit or substandard drugs. Smart Contracts: The use of smart contracts in blockchain can automate various processes in the pharmaceutical supply chain, such as payment and verification, reducing administrative overhead and ensuring that all parties adhere to predefined rules and standards. Data Privacy and Security: Ensuring the privacy and security of sensitive pharmaceutical data is of paramount importance. Future developments in blockchain technology will likely include advanced encryption and privacy features to protect sensitive information. Blockchain Consortia: As more pharmaceutical companies, distributors, and regulatory bodies collaborate on blockchain initiatives, we can expect the formation of blockchain consortia that work together to create and maintain shared blockchain networks for drug traceability.

13.APPENDIX

SOURCE CODE

Digitalassest.sol

```
// 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;
DRUG TRACEABILITY
```

```
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);
}
}
```

Home.js

```
import React, { useState } from "react";
import { Button, Container, Row, Col } from 'react-bootstrap';
import '../../node_modules/bootstrap/dist/css/bootstrap.min.css';
DRUG TRACEABILITY
```

```
import { contract } from "./connector";

function Home() {

 const [Id, setId] = useState("");

 const [name, setName] = useState("");

 const [email, setEmail] = useState("");

 const [addr, setAddr] = useState("");

 const [mAddr, setmAddr] = useState("");

 const [data, setdata] = useState("");

 const [Wallet, setWallet] = useState("");

 const handleId = (e) => {

 setId(e.target.value)

 }

 const handleName = (e) => {

 setName(e.target.value)

 }

 const handleEmail = (e) => {

 setEmail(e.target.value)

 }


 const handleAddr = (e) => {

 setAddr(e.target.value)
```



```
 }


 const handleRegisterIdentity = async () => {
```

```
try {
let tx = await contract.registerIdentity(Id.toString(), name, email, addr)
let wait = await tx.wait()
alert(wait.transactionHash)
console.log(wait);
} catch (error) {
alert(error)
}
}
const handleMetamaskAddr = (e) => {
setmAddr(e.target.value)
}
const handleAddrDetails = async () => {
try {
let tx = await contract.getIdentityDetails(mAddr)
let arr = []
tx.map(e => arr.push(e))
setdata(arr)
// alert(tx)
console.log(tx);
```



```
} catch (error) {
alert(error)
}
}
```

```
const handleWallet = async () => {
if (!window.ethereum) {
return alert('please install metamask');
}
const addr = await window.ethereum.request({
method: 'eth_requestAccounts',
});
setWallet(addr[0])
}
return (
<div>
<h1 style={{ marginTop: "30px", marginBottom: "80px" }}>Identity On Blockchain</h1>
{!Wallet ?
<Button onClick={handleWallet} style={{ marginTop: "30px", marginBottom: "50px" }}>Connect
Wallet </Button>
:
<p style={{ width: "250px", height: "50px", margin: "auto", marginBottom: "50px", border: '2px
solid #2096f3' }}>{Wallet.slice(0, 6)}....{Wallet.slice(-6)}</p>
DRUG TRACEABILITY

}
<Container>
<Row>
<Col style={{marginRight:"100px"}}>
```

```
<div>

<input style={{ marginTop: "10px", borderRadius: "5px" }} onChange={handleId}
type="number"
placeholder="Enter Identity ID" value={Id} /> <br />

<input style={{ marginTop: "10px", borderRadius: "5px" }} onChange={handleName}
type="string"
placeholder="Enter Name" value={name} /> <br />

<input style={{ marginTop: "10px", borderRadius: "5px" }} onChange={handleEmail}
type="string"
placeholder="Enter Email" value={email} /><br />

<input style={{ marginTop: "10px", borderRadius: "5px" }} onChange={handleAddr}
type="string"
placeholder="Enter Address" value={addr} /><br />

<Button onClick={handleRegisterIdentity} style={{ marginTop: "10px" }}
variant="primary">Register
Identity</Button>
</div>
</Col>
<Col>
<div>
<input style={{ marginTop: "10px", borderRadius: "5px" }}
onChange={handleMetamaskAddr}
type="string" placeholder="User Metamask address" value={mAddr} /><br />
```

```
<Button onClick={handleAddrDetails} style={{ marginTop: "10px" }}
variant="primary">Get Identity
Details</Button>
 DRUG TRACEABILITY

 {data ? data?.map(e => {
 return <p>{e.toString()}</p>
 }) : <p></p>}
 </div>
 </Col>
 </Row>

 </Container>
 </div>
 )
}
export default Home;
```

App.js

```
import './App.css';
import Home from './Page/Home'
function App() {
 return (
 <div className="App">
 <header className="App-header">
 <Home />
 </header>
```

```
</div>

);

}

DRUG TRACEABILITY


export default App
```

Github link :

https://github.com/hariprasath-3603/NM-DRUG-TRACEABILITY.git

Demo link :

https://drive.google.com/drive/folders/1doQfbunJCMIuuV0CN-3eL0ds6GCHxQog?usp=drive_link