VIDYAA VIKAS COLLEGE OF ENGINEERING AND TECHNOLOGY

TIRUCHENGODE – 637 214

Approved by AICTE - New Delhi, Affiliated to Anna University - Chennai

COURSE NAME : BLOCK CHAIN DEVELOPMENT

TEAM ID: NM2023TMID08856 - VACCINE TRACKING TRANSPARENT

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MENTOR NAME: Mr. K.PRASANTH, AP/ECE

1. INTRODUCTION

1.1 Project Overview

The primary objective of a vaccine tracking project is to facilitate the distribution, administration, and monitoring of vaccines to ensure public health and safety. This includes tracking various vaccines, such as those for infectious diseases like COVID-19, influenza, measles, polio, and others.

A vaccine tracking project using block chain leverages distributed ledger technology to enhance the efficiency, security, and transparency of vaccine distribution and administration. This innovative system ensures accurate recording of vaccination data, secure data sharing, and real-time tracking. It facilitates appointment scheduling, inventory management, and adverse event reporting, providing a user-friendly interface for both patients and healthcare providers. The block chain's immutability and transparency instill trust in the vaccination process, while data analytics enable informed decision-making. By seamlessly integrating various stakeholders and processes, this project optimizes vaccination programs, reduces errors, and safeguards public health during critical times.

A vaccine tracking project plays a crucial role in public health, particularly during pandemics and large-scale vaccination efforts, by ensuring the efficient and safe distribution of vaccines to the population. It requires collaboration between healthcare providers, government agencies, and technology experts to implement and maintain successfully.

1.2 Purpose

Vaccine tracking using block chain technology serves a multi-faceted purpose, revolutionizing the management of vaccines from distribution to administration and monitoring. First and foremost, it ensures the security and integrity of vaccination data. The block chain's decentralized and tamper-resistant ledger makes it nearly impossible for unauthorized alterations to occur, fostering accuracy and reliability in vaccine records. This integrity is paramount for maintaining public trust and meeting regulatory compliance standards. Block chain's real-time tracking capability in vaccine supply chains is another crucial purpose. By recording each transaction on the block chain, it creates an immutable record of vaccine movement. This transparency is vital for guaranteeing that vaccines are stored and transported within the required temperature range, safeguarding their effectiveness and preventing spoilage. Efficient inventory management is also a key benefit. By allowing automated, real-time updates to vaccine inventories, block chain streamlines their management. This ensures that healthcare providers have the vaccines they require when needed, thus reducing shortages and wastage. User-friendly interfaces and mobile applications are often included in block chain-based vaccine tracking projects, enhancing convenience for patients. This approach simplifies appointment scheduling and provides secure access to vaccination records, thus encouraging patient participation in vaccination programs. Furthermore, block chain facilitates the reporting of adverse events related to vaccines. The secure and transparent nature of the block chain simplifies the process and enables the swift identification of safety concerns, facilitating timely responses. Data

analytics integrated with block chain systems offer valuable insights for public health officials and policymakers. These insights empower informed decision-making, helping allocate resources efficiently, plan vaccination campaigns, and identify areas with low vaccine coverage. Block chain's interoperability capabilities ensure that patients' vaccine records are accessible and up-to-date across various healthcare providers. It also empowers individuals to own and control their vaccine-related data, granting or revoking access as needed, thus ensuring data privacy and autonomy. Finally, the security and transparency of block chain foster trust among all stakeholders in the vaccination process, including patients, healthcare providers, regulators, and the public. This increased trust is essential for achieving high vaccination coverage and the overall success of vaccination programs.

2. LITERATURE SURVEY

2.1 Existing Problem

One existing problem in vaccine tracking is the lack of a standardized and centralized system for recording and monitoring vaccine distribution and administration. This can lead to challenges in ensuring vaccines reach their intended recipients and managing inventory effectively. Additionally, issues related to data accuracy, privacy, and security can complicate vaccine tracking efforts.

2.2 References

- ✓ Fighting Counterfeit Pharmaceuticals: New Defenses for an Underestimated-and Growing-Menace.
- ✓ Sgueglia, K. 15 People Face Charges in Connection to a Conspiracy with Fake COVID-19 Vaccine Cards, DA Says.
- ✓ Shuster, S. 'Tip Of the Iceberg': Interpol Says Fake COVID-19 Vaccines Were Smuggled Across Continents.
- ✓ Nakamoto, S. Bitcoin: A peer-to-peer electronic cash system. Decentralized Bus. Rev. 2008, 21260. [Google Scholar]
- ✓ Porat, A.; Pratap, A.; Shah, P.; Adkar, V. Blockchain Consensus: An Analysis of Proof-of-Work and Its Applications; Stanford University: Stanford, CA, USA, 2017;

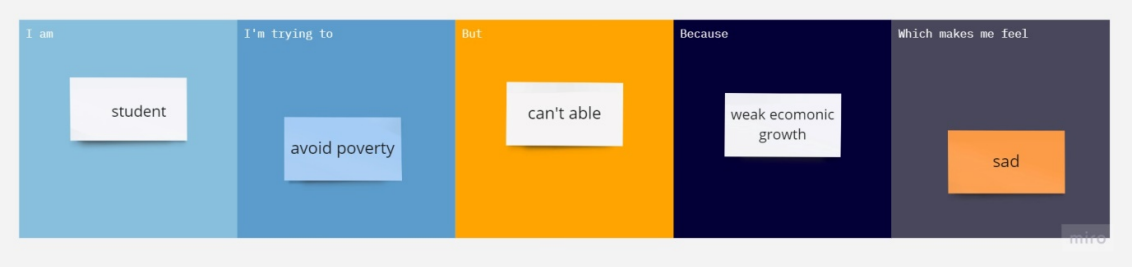
2.3 Problem Statement Definition

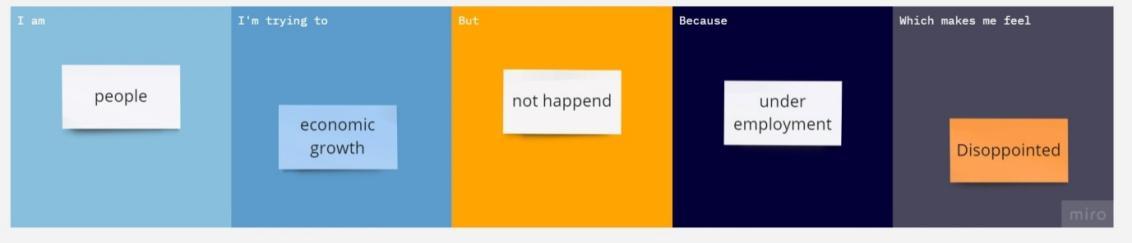
The existing vaccine distribution systems face several critical issues that hinder their effectiveness. To address these challenges, the development of a block chain-based vaccine tracking system is imperative. This system aims to tackle problems such as supply chain transparency, counterfeiting, data integrity, inventory management, and public trust.

The current vaccine supply chain lacks end-to-end visibility, making it challenging to monitor the origins, storage, and transportation of vaccines. Counterfeit vaccines are a serious concern, risking public health. Data integrity issues may lead to inaccuracies in vaccine distribution records, causing inefficiencies and security risks. Poor inventory management can result in vaccine shortages or wastage. Restoring public trust in vaccine distribution is crucial, and block chain technology can play a pivotal role in achieving this by providing tamper-proof and transparent records.

3. IDEATION & PROPOSED SOLUTION

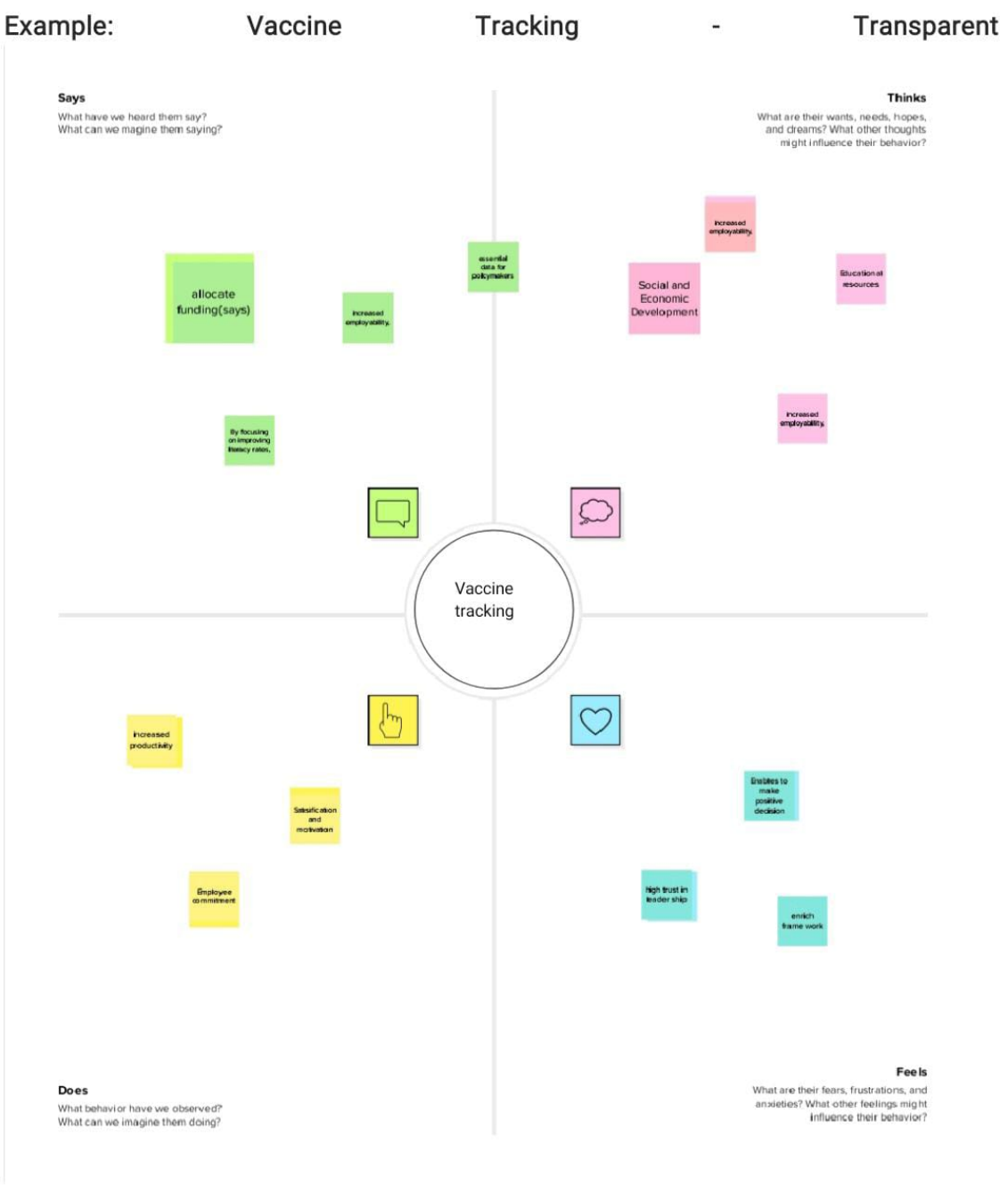
3.1 Empathy Map Canvas





I am (Customer)	I am trying to	But	Because	Which makes me feel
Healthcare Provider	Streamline vaccine distribution	Often fragmented with limited visibility into vaccine availability	Lack of integration and coordination	Frustrated and concerned about the potential negative impact on public health
Vaccine Recipient	Provide an user centric platform for individuals to schedule vaccine appointments	Existing system often lacks user friendliness	Frustration and confusion among vaccine recipients	Overwhelmed and anxious about the vaccination process
Healthcare Administrator	Streamline vaccine inventory management	Current inventory process are often manual and prone to errors	Inefficiency leads to vaccine shortages and overstocking	Stressed and overwhelmed by the unpredictable vaccine supply

Empathy Map Canvas :



3.2 Ideation & Brainstorming

Step: 1 Team gathering, Collaboration and Select the problem statement

Problem:

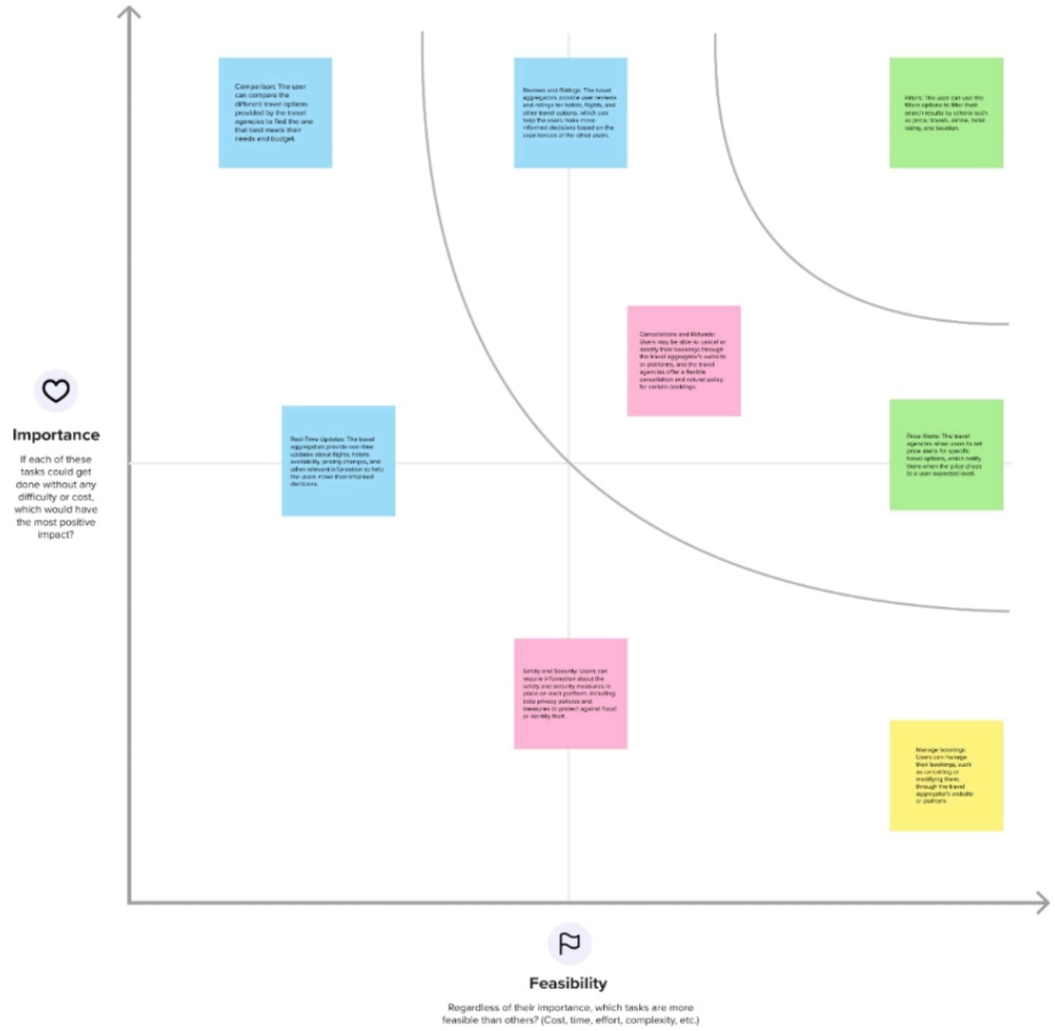
Inefficient vaccine tracking and administration processes hinder the timely and safe distribution of vaccines, causing delays, errors, and vaccine wastage. The absence of a streamlined system for scheduling appointments, managing vaccine inventory, and monitoring adverse events complicates the vaccination process. Healthcare providers and recipients face challenges accessing vaccination records and scheduling appointments, while public health officials lack real-time data to make informed decisions. These inefficiencies undermine the overall vaccination effort, jeopardizing public health goals, and eroding confidence in vaccination programs. A comprehensive vaccine tracking project is needed to address these issues and ensure the efficient and accountable management of vaccines.

Step: 2 Brainstorm Idea, Listing and Grouping

Group Ideas

Creating a comprehensive vaccine tracking project requires a diverse team of professionals and experts. The development team is responsible for building the tracking software, while data analytics experts focus on data collection and analysis. Medical and logistics experts ensure alignment with medical standards and efficient vaccine distribution. Public health officials provide insights into vaccination strategy, while patient advocates prioritize user-friendliness. Legal experts address privacy and compliance, while ethical hackers enhance cybersecurity. Community outreach and support teams engage the public, and project managers oversee coordination. Collaboration with vaccine manufacturers, international health organizations, and community leaders ensures a well-rounded approach.

Step: 3 Idea Prioritization



4. REQUIREMENT ANALYSIS

4.1 Functional Requirement

FR NO.	Functional Requirement (Epic)	Sub Requirement (story/sub-task)
FR-1	User Registration	Registration through from website or Gmail
FR-2	User Confirmation	Confirmation via mail, phone call etc.
FR-3	User Dashboard	Evaluate services and features and views user history and ratings.
FR-4	User Profile and Preferences	Create and manage their profile.
FR-5	Output Generation	Report generation, Content generation Itinerary generation Visual generation

4.2 Non-Functional Requirements

NFR NO.	Non-Functional Requirements	Description
NFR-1	Usability	User-friendly interface to facilitate the user with easy processing. Model provides data gathering. Model provides analyse and compare. Model provides evaluation. Model provides evaluation criteria.
NFR-2	Security	Authentication-user can have his/her own private dashboard to have secured access.
NFR-3	Reliability	The model can run numerous samples simultaneously and handle massive amounts of data.
NFR-4	Performance	As the model is a combination of python programming, the accuracy is high.
NFR-5	Availability	The website is portable and mobile-responsive as well. To run on any device, it simply needs the most minimum requirements.
NFR-6	Scalability	It can be extended further to provide API which can be used by third party organization such as logistics companies ,etc.
NFR-7	Compliance	It makes sure that all legal criteria are met, and this includes travel industry rules as well as payment card industry standards.

5. PROJECT DESIGN

5.1 Data Flow Diagrams & User Stories

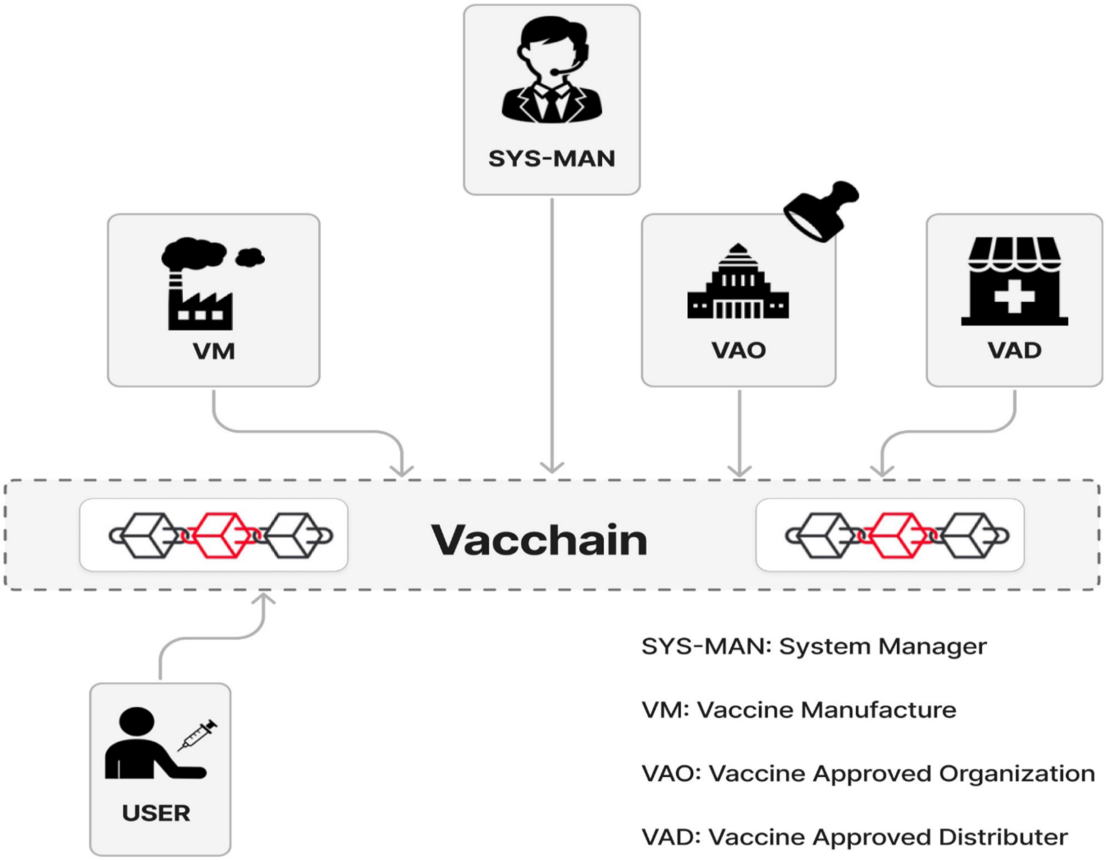


Fig 5.1 Data Flow Diagram of Vaccine Tracking using Block Chain

5.2 Solution Architecture

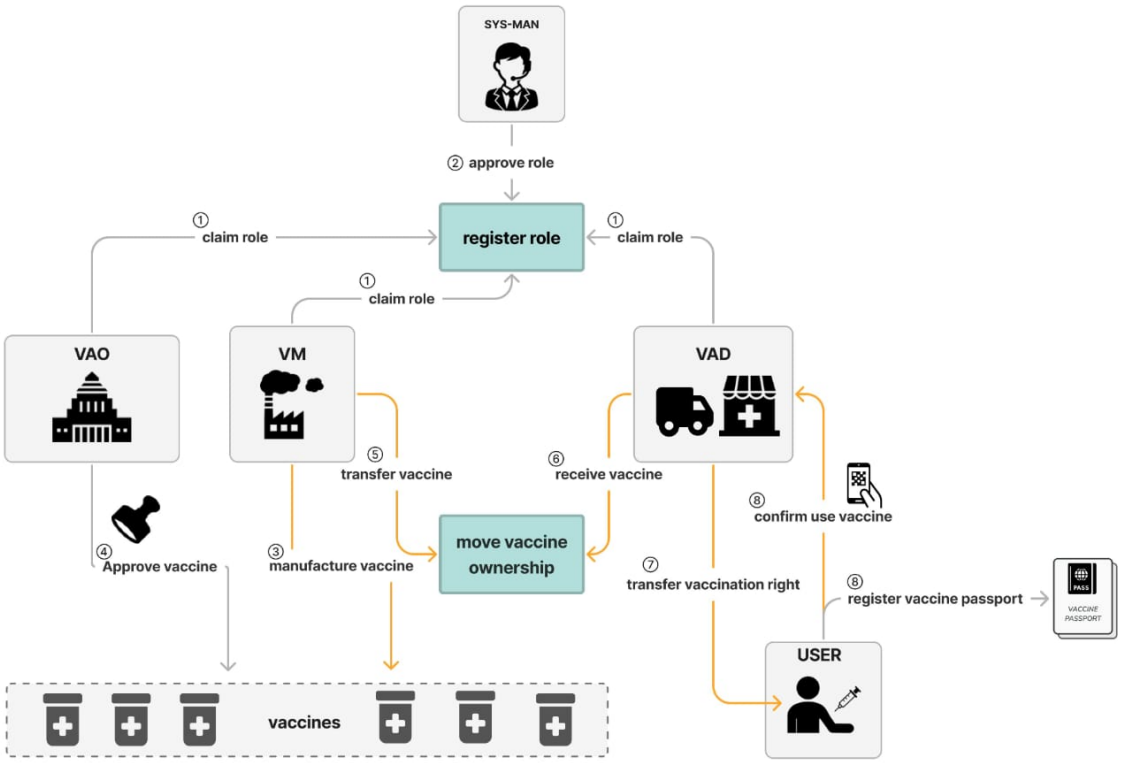
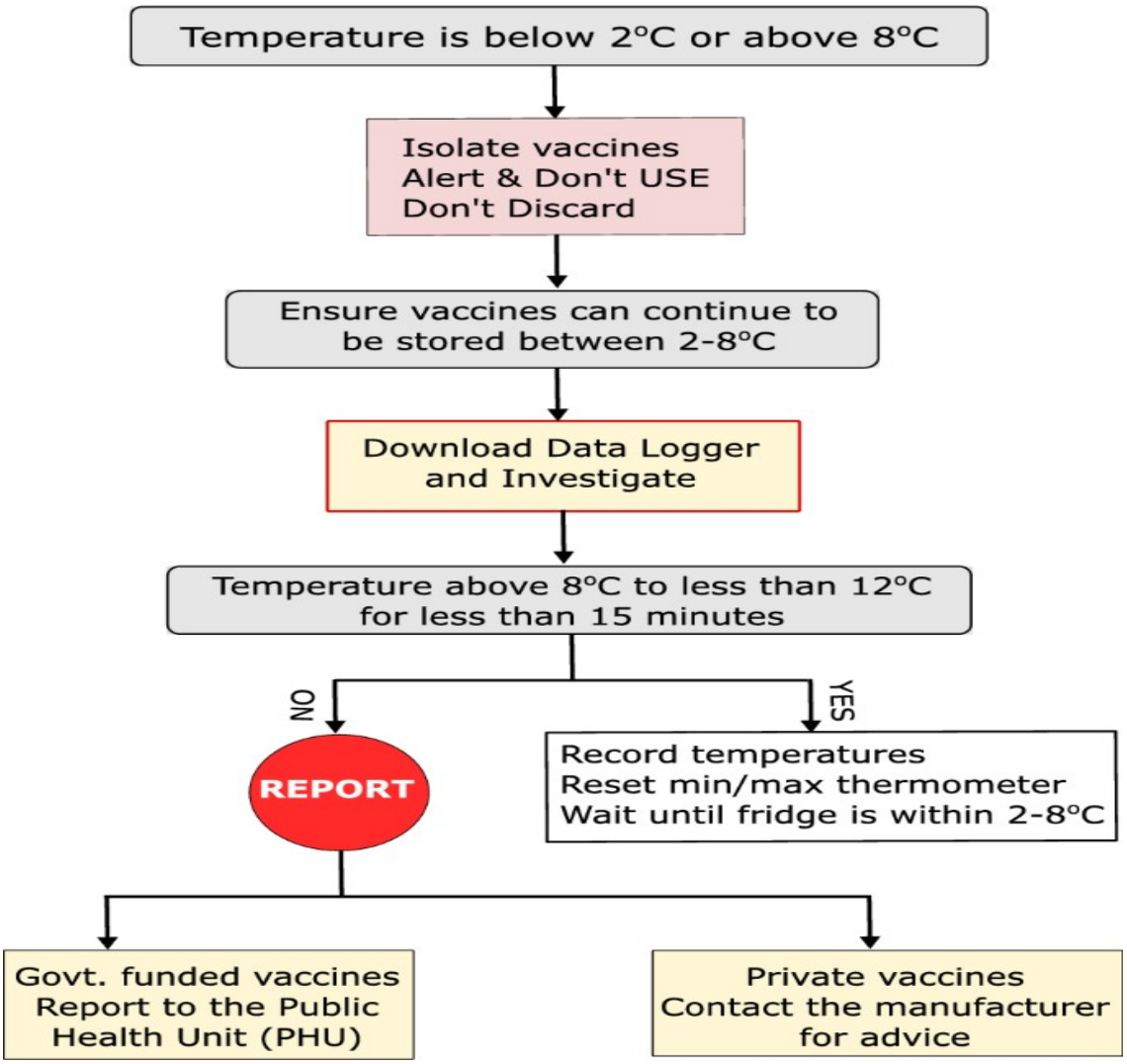


Fig 5.2 Solution Architecture for Vaccine Tracking using Block Chain

6. PROJECT PLANNING & SCHEDULING

6.1 Technical Architecture



6.2 Sprint Planning & Estimation

Sprint planning and estimation for a block chain-based vaccine tracking project is a structured approach to manage the development process effectively. This process involves several key steps:

First, it starts with defining user stories and project requirements, outlining the functionalities needed for vaccine tracking, including recording vaccinations, ensuring authenticity, and managing access for authorized users.

Next, prioritization is crucial. User stories are ranked by importance and impact, ensuring that critical elements like data security and transparency take precedence.

Choosing appropriate sprint duration, typically 2 to 4 weeks, is essential to manage the work efficiently, considering the project's complexity.

Tasks are then broken down into smaller, manageable units, allowing for more accurate estimation of effort. Techniques like story points or hours are used to estimate the time required for each task, and the team reaches a consensus on these estimates.

Capacity planning helps assess the team's capabilities, considering team size and individual member availability during the sprint.

Setting sprint goals that align with the project's overall objectives, such as completing the Minimum Viable Product (MVP) for vaccine tracking, is critical to keep the team focused.

Creating a realistic sprint backlog by selecting a set of user stories and tasks for the sprint allows for a clear plan of action.

Daily stand-up meetings ensure regular progress tracking, problem-solving, and adjustments to the plan.

At the end of the sprint, a review is held to showcase completed work, and a retrospective is conducted to identify areas for improvement in future sprints.

Continuous refinement of the backlog and planning based on changing requirements and feedback is a key feature of this approach.

In summary, sprint planning and estimation provide a structured framework for efficiently developing a block chain-based vaccine tracking system, ensuring organized progress and adaptation to evolving project needs.

6.3 Sprint Delivery Schedule

Creating a sprint delivery schedule for a block chain-based vaccine tracking project involves structuring the development process into a series of sprints, each with specific goals and tasks. The schedule outlined here covers seven sprints:

Sprint 1: Focuses on setting up the project infrastructure, establishing the block chain network, and creating basic user interfaces for data input.

Sprint 2: Centers on implementing core features related to vaccine data recording, such as smart contract development and data security.

Sprint 3: Aims to enhance data verification and access control, incorporating user roles and conducting security testing.

Sprint 4: Extends functionality and user access by adding support for mobile applications and improving user interfaces.

Sprint 5: Focuses on finalizing the system, conducting testing, and preparing for deployment, ensuring a thoroughly tested and documented vaccine tracking system.

Sprint 6: Dedicated to deployment and initial user training, including system monitoring and issue resolution.

Sprint 7: Follow, focusing on continuous improvement, feature updates, scalability, and maintaining the system as it is in use.

The schedule allows for flexibility and adaptation to changing project needs. Effective communication with stakeholders throughout the process is vital to ensure alignment with their requirements and expectations. This structured approach helps manage the development of a block chain-based vaccine tracking system efficiently and ensures that it evolves to meet evolving demands and challenges.

7. CODING & SOLUTIONING

7.1 Feature 1

The proposed solution outlines the development of a vaccine tracking system using block chain technology, with a focus on "Immutable Record Storage" as a key feature. In this system, smart contracts would play a central role. These contracts would be created on a block chain platform like Ethereum and define the structure of vaccine data while ensuring its immutability.

Authorized parties, such as vaccine manufacturers and healthcare providers, would be responsible for inputting vaccine-related information into the block chain. Once this data is recorded, it becomes unchangeable due to the inherent characteristics of block chain technology, preventing any fraudulent alterations to vaccine records.

Access control measures would be in place to restrict who can add or modify vaccine data, enhancing security. Users would have the ability to verify the authenticity of vaccines by querying the block chain, allowing them to confirm if a vaccine batch matches the records stored in the block chain.

7.2 Feature 2

To make the system user-friendly, a web or mobile application interface would be developed, enabling users to input batch numbers or scan QR codes for quick verification. Additionally, notification features would be integrated, ensuring that stakeholders in the vaccine supply chain receive alerts and updates regarding vaccine movements.

By incorporating these elements, the proposed vaccine tracking system would provide a secure, transparent, and trustworthy means of monitoring vaccine data throughout the supply chain, thereby contributing to the safety and integrity of vaccination efforts.

8. PERFORMANCE TESTING

8.1 Performance Metrics

The use of block chain technology for vaccine tracking offers several key performance metrics to gauge its effectiveness in enhancing transparency, security, and accountability within the vaccine distribution and administration process. These metrics are crucial for evaluating the system's efficiency and reliability.

First and foremost, data integrity is paramount. This metric involves ensuring the accuracy and consistency of vaccine-related data stored on the block chain. By comparing the block chain records with physical vaccine inventory, any discrepancies can be identified and addressed.

Security is another critical aspect. The block chain system must incorporate robust security features such as encryption, access control, and data immutability to safeguard vaccine data from tampering and unauthorized access.

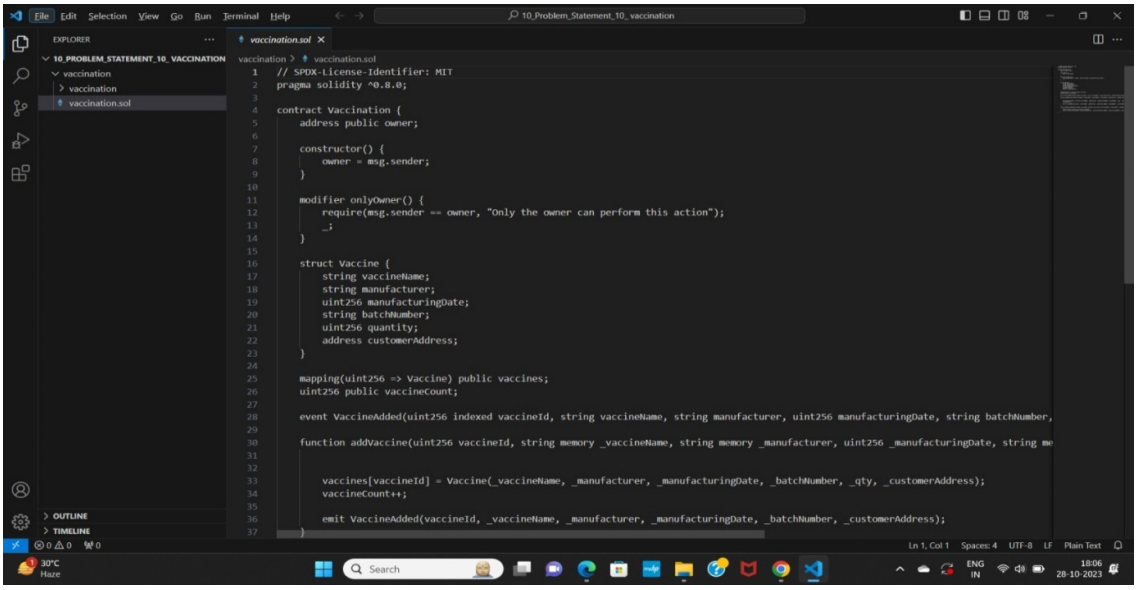
Traceability measures the system's ability to track vaccines at each stage of the supply chain in real-time, providing a comprehensive history of their journey. Smart contracts can enhance efficiency by automating various process, including verification, payments, and alerts.

Compliance with relevant regulations and standards is imperative, as is the system's scalability, error-handling capabilities, public trust, auditability, block chain performance, user training, and adoption. Regular monitoring and assessment of these performance metrics are essential to ensure the effectiveness of a block chain-based vaccine tracking system, ultimately improving vaccine distribution and administration processes.

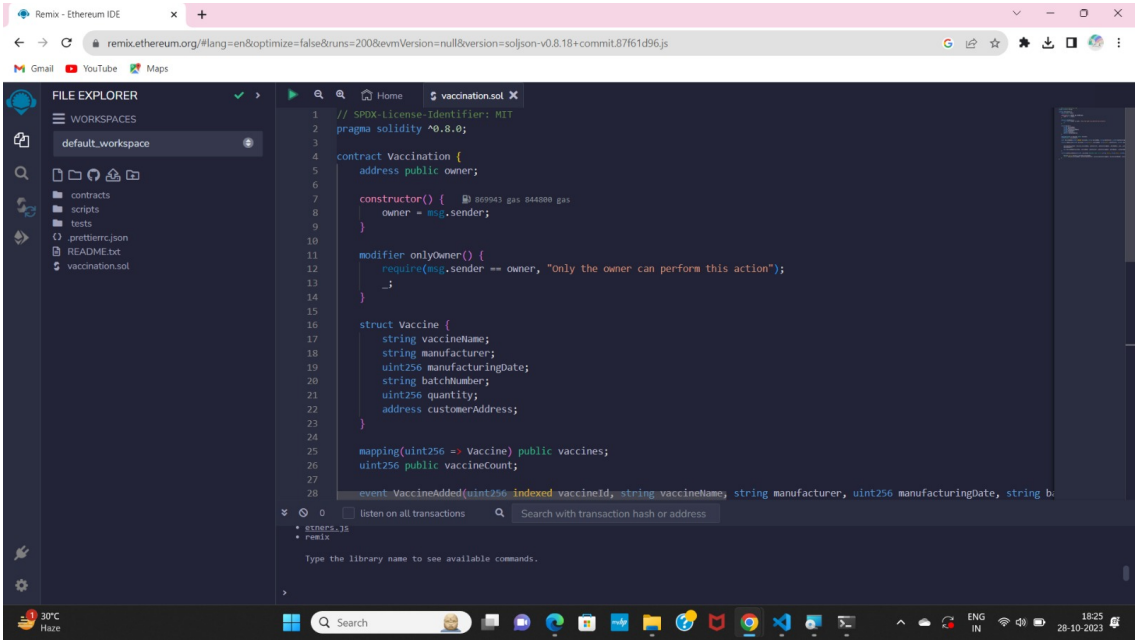
9. RESULTS

9.1 Output Screenshots

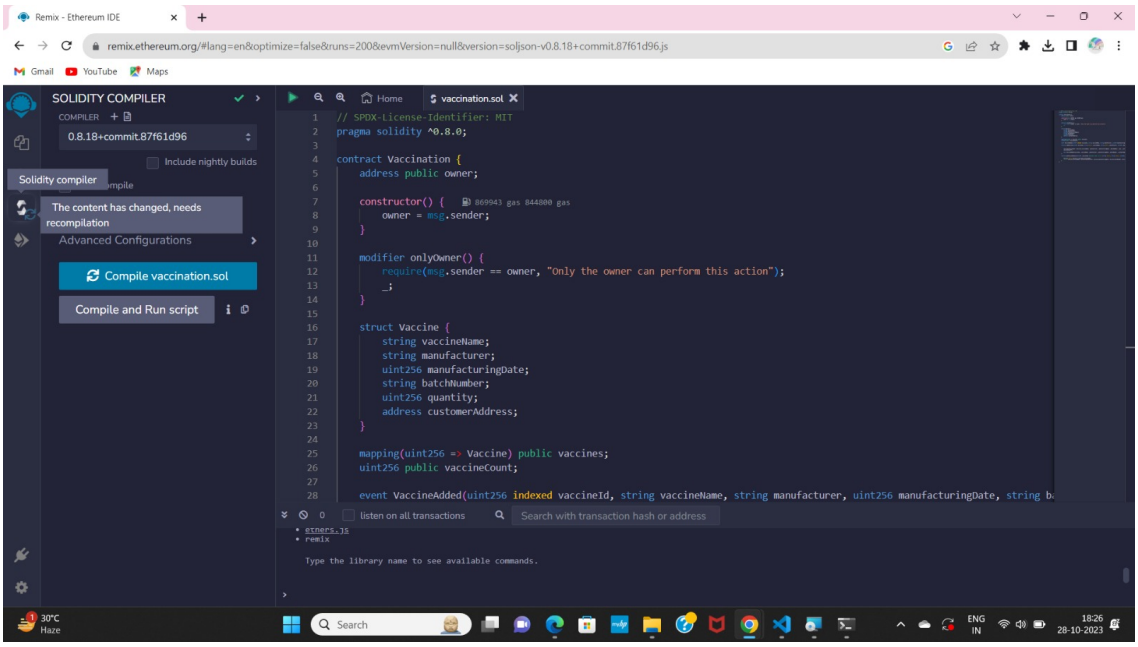
Step 1:



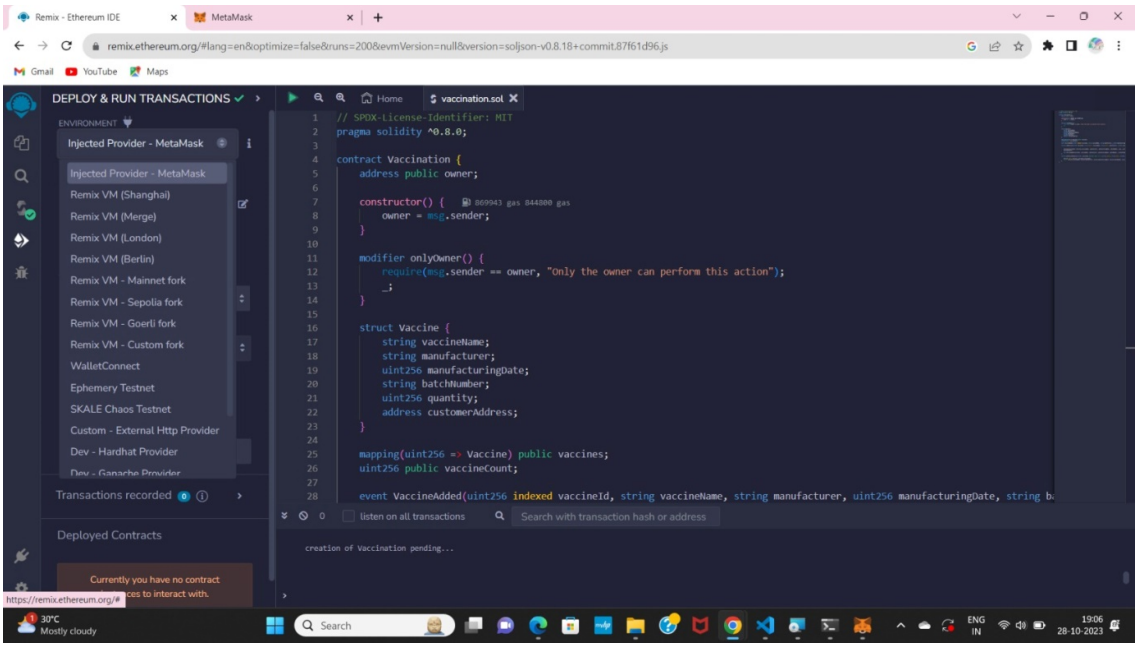
Step 2:



Step 3:


Remix - Ethereum IDE
remix.ethereum.org/#lang=en&optimize=false&runs=200&evmVersion=null&version=soljson-v0.8.18+commit.87f61d96.js
SOLIDITY COMPILER
0.8.18+commit.87f61d96
Include nightly builds
Solidity compiler
The content has changed, needs recompilation
Advanced Configurations
Compile vaccination.sol
Compile and Run script
Home
vaccination.sol
// SPDX-License-Identifier: MIT
pragma solidity ^0.8.0;
contract Vaccination {
address public owner;
constructor() {
owner = msg.sender;
}
modifier onlyOwner() {
require(msg.sender == owner, "Only the owner can perform this action");
_;
}
struct Vaccine {
string vaccineName;
string manufacturer;
uint256 manufacturingDate;
string batchNumber;
uint256 quantity;
address customerAddress;
}
mapping(uint256 => Vaccine) public vaccines;
uint256 public vaccineCount;
event VaccineAdded(uint256 indexed vaccineId, string vaccineName, string manufacturer, uint256 manufacturingDate, string b
listen on all transactions
Search with transaction hash or address
Type the library name to see available commands.
30°C
Haze
Search
ENG
IN
18:26
28-10-2023

Step 4:


Remix - Ethereum IDE
MetaMask
remix.ethereum.org/#lang=en&optimize=false&runs=200&evmVersion=null&version=soljson-v0.8.18+commit.87f61d96.js
DEPLOY & RUN TRANSACTIONS
ENVIRONMENT
Injected Provider - MetaMask
Injected Provider - MetaMask
Remix VM (Shanghai)
Remix VM (Merge)
Remix VM (London)
Remix VM (Berlin)
Remix VM - Mainnet fork
Remix VM - Sepolia fork
Remix VM - Goerli fork
Remix VM - Custom fork
WalletConnect
Ephemery Testnet
SKALE Chaos Testnet
Custom - External Http Provider
Dev - Hardhat Provider
Transactions recorded
Deployed Contracts
Currently you have no contract
Home
vaccination.sol
// SPDX-License-Identifier: MIT
pragma solidity ^0.8.0;
contract Vaccination {
address public owner;
constructor() {
owner = msg.sender;
}
modifier onlyOwner() {
require(msg.sender == owner, "Only the owner can perform this action");
_;
}
struct Vaccine {
string vaccineName;
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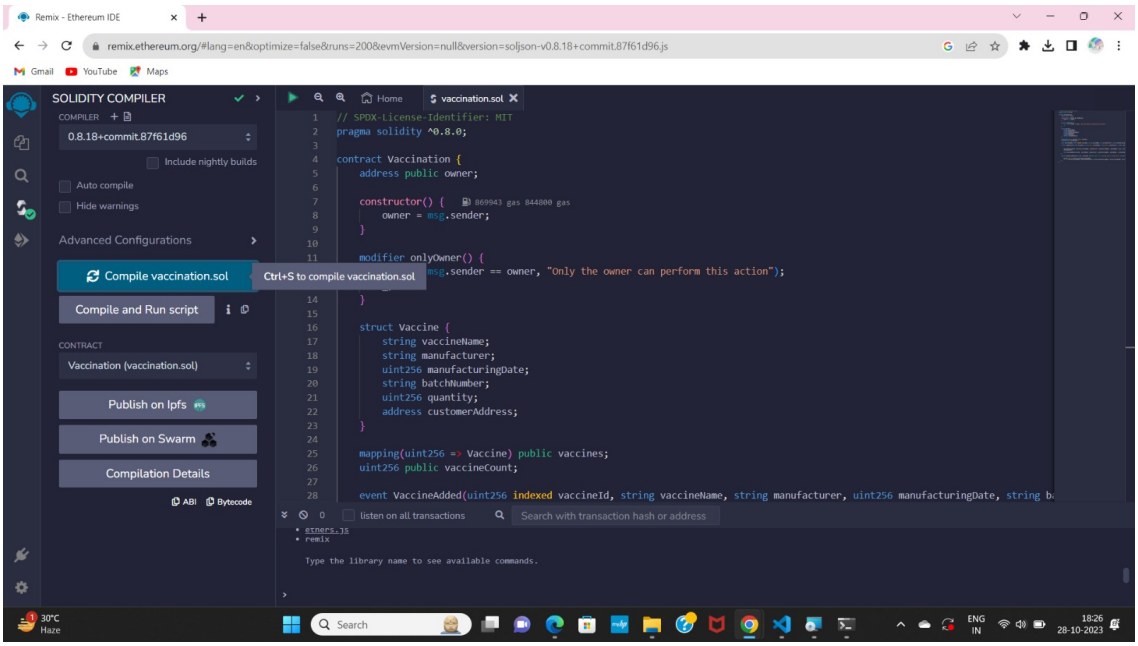
string batchNumber;
uint256 quantity;
address customerAddress;
}
mapping(uint256 => Vaccine) public vaccines;
uint256 public vaccineCount;
event VaccineAdded(uint256 indexed vaccineId, string vaccineName, string manufacturer, uint256 manufacturingDate, string b
listen on all transactions
Search with transaction hash or address
creation of Vaccination pending...
30°C
Mostly cloudy
Search
ENG
IN
19:06
28-10-2023

Step 5:


Remix - Ethereum IDE
remix.ethereum.org/#lang=en&optimize=false&runs=200&evmVersion=null&version=soljson-v0.8.18+commit.87f61d96.js
SOLIDITY COMPILER
0.8.18+commit.87f61d96
Include nightly builds
Auto compile
Hide warnings
Advanced Configurations
Compile vaccination.sol
Ctrl+S to compile vaccination.sol
Compile and Run script
CONTRACT
Vaccination (vaccination.sol)
Publish on Ipfs
Publish on Swarm
Compilation Details
ABI
Bytecode
vaccination.sol
// SPDX-License-Identifier: MIT
pragma solidity ^0.8.0;
contract Vaccination {
address public owner;
constructor() {
owner = msg.sender;
}
modifier onlyOwner() {
msg.sender == owner, "Only the owner can perform this action");
}
struct Vaccine {
string vaccineName;
string manufacturer;
uint256 manufacturingDate;
string batchNumber;
uint256 quantity;
address customerAddress;
}
mapping(uint256 => Vaccine) public vaccines;
uint256 public vaccineCount;
event VaccineAdded(uint256 indexed vaccineId, string vaccineName, string manufacturer, uint256 manufacturingDate, string b
listen on all transactions
Search with transaction hash or address
Type the library name to see available commands.
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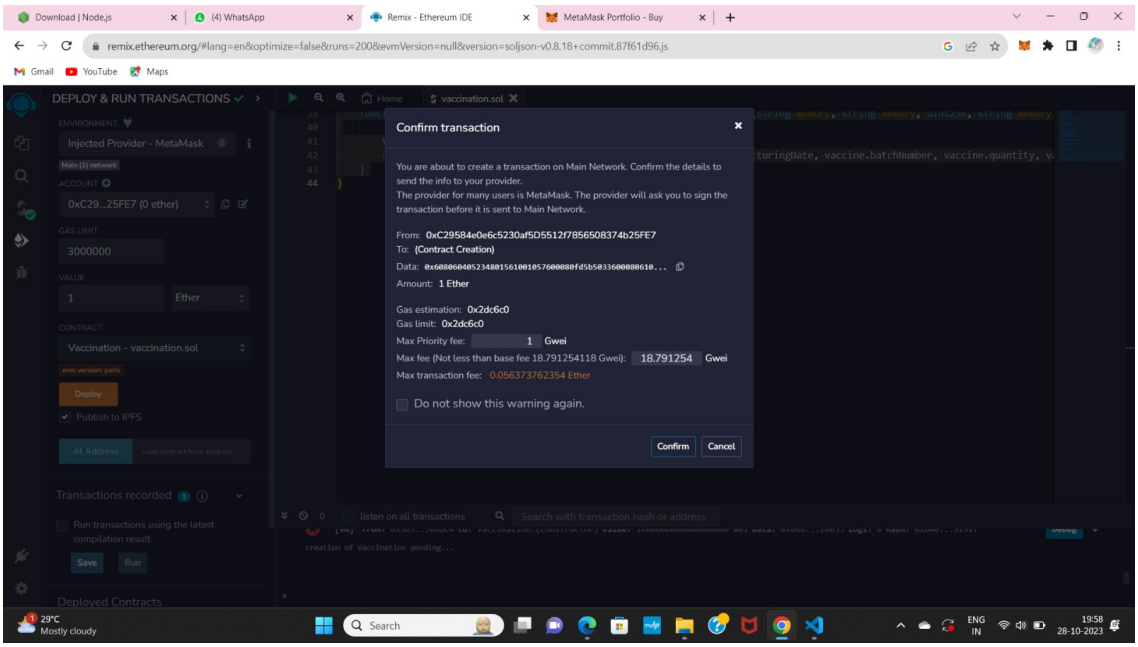
28-10-2023

Step 6: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remix.ethereum.org/#lang=en&optimize=false&runs=200&evmVersion=null&version=soljson-v0.8.18+commit.87f61d96.js
DEPLOY & RUN TRANSACTIONS
Injected Provider - MetaMask
0xC29...25FE7 (0 ether)
3000000
Ether
Vaccination - vaccination.sol
Deploy
Publish to IPFS
At Address
Transactions recorded
Save
Run
Deployed Contracts
Confirm transaction
You are about to create a transaction on Main Network. Confirm the details to send the info to your provider.
The provider for many users is MetaMask. The provider will ask you to sign the transaction before it is sent to Main Network.
From: 0xC29584e0e6c5230af5D5512f7856508374b25FE7
To: (Contract Creation)
Amount: 1 Ether
Gas estimation: 0x2dc6c0
Gas limit: 0x2dc6c0
Max Priority fee: 1 Gwei
Max fee (Not less than base fee 18.791254118 Gwei): 18.791254 Gwei
Max transaction fee: 0.056373762354 Ether
Do not show this warning again.
Confirm
Cancel
29°C
Mostly cloudy
Search
ENG
IN
19:58
28-10-2023

10. ADVANTAGES & DISADVANTAGES

Advantages

Utilizing block chain technology for vaccine tracking offers numerous advantages. It ensures data security and transparency, with immutable records and real-time updates, reducing the risk of fraud and enabling stakeholders to verify information.

Block chain minimizes counterfeit vaccines, automates processes, allows for traceability, and is globally compatible. It also ensures privacy and contributes to the effectiveness of public health initiatives.

In summary, block chain enhances the security, transparency, and efficiency of vaccine tracking, bolstering the safety and effectiveness of vaccination programs.

Disadvantages

Block chain-based vaccine tracking, while offering advantages, has its drawbacks. Implementation complexity, high costs, scalability issues, and energy consumption in some block chain networks can hinder adoption.

Data privacy concerns and potential data loss due to lost access keys are also risks.

Establishing block chain networks takes time, and regulatory challenges may complicate integration with existing healthcare systems.

Moreover, resistance to technological change from stakeholders is a potential obstacle. In conclusion, the benefits of block chain in vaccine tracking must be balanced against these disadvantages, emphasizing the importance of careful planning and consideration before adoption.

11. CONCLUSION

Block chain technology offers a promising solution for vaccine tracking, with its advantages of enhanced security, transparency, and efficiency. It can help combat counterfeit vaccines, automate processes, and improve traceability, all of which are critical for public health. However, the implementation of block chain also comes with challenges, including complexity, cost, scalability, and regulatory issues. To fully realize the benefits, stakeholders must carefully weigh the advantages against these disadvantages and be prepared to invest in the necessary expertise and infrastructure. Block chain has the potential to revolutionize vaccine tracking, but its successful integration requires a thoughtful and strategic approach.

12. FUTURE SCOPE

The future of vaccine tracking through block chain technology holds immense promise for the healthcare industry. Block chain has already proven its worth by enhancing transparency, security, and efficiency in vaccine distribution and administration. Its future scope encompasses a range of crucial developments:

1. **Global Adoption**: More countries and organizations are likely to adopt block chain-based vaccine tracking, establishing a universal standard for secure and transparent vaccine management.
2. **Transparency**: Block chain will continue to provide real-time transparency in vaccine supply chains, fostering trust among stakeholders and the public.
3. **Supply chain optimization**: It will be instrumental in optimizing vaccine supply chains, reducing wastage, and ensuring vaccines reach even the most remote areas efficiently.
4. **Vaccine passport integration**: Block chain will integrate with vaccine passports, offering a secure and private way for individuals to prove their vaccination status for travel and service access.
5. **Improved records**: Block chain will help individuals maintain and access their immunization records, aiding in reminders and booster shots.
6. **Interoperability**: Efforts to make vaccine tracking block chains interoperable with other healthcare systems will create a comprehensive health data ecosystem.
7. **Fraud prevention**: The technology's immutability will deter counterfeit vaccines and ensure the administration of genuine vaccines.
8. **AI and IOT integration**: The integration of AI and IoT with block chain will enhance tracking capabilities and real-time monitoring of vaccine storage conditions.

In summary, the future of vaccine tracking through block chain promises to transform healthcare and vaccination management, but it also necessitates careful consideration of privacy, security, and standardization as it advances.

13. APPENDIX

SOURCE CODE

```
// SPDX-License-Identifier: MIT

pragma solidity ^0.8.0;

contract Vaccination {

    address public owner;

       constructor() {

        owner = msg.sender;

    }

    modifier onlyOwner() {

        require(msg.sender == owner, "Only the owner can perform this action");

        _;

    }

   struct Vaccine {

        string vaccineName;

        string manufacturer;

        uint256 manufacturingDate;

        string batchNumber;

        uint256 quantity;

        address customerAddress;

    }

    mapping(uint256 => Vaccine) public vaccines;

    uint256 public vaccineCount;

    event VaccineAdded(uint256 indexed vaccineId, string vaccineName, string manufacturer,
uint256 manufacturingDate, string batchNumber, address customerAddress);

    function addVaccine(uint256 vaccineId, string memory _vaccineName, string memory
_manufacturer, uint256 _manufacturingDate, string memory _batchNumber,uint256 _qty,
address _customerAddress) external onlyOwner {
```

```
    vaccines[vaccineId] = Vaccine(_vaccineName, _manufacturer, _manufacturingDate,
_batchNumber, _qty, _customerAddress);

        vaccineCount++;



        emit VaccineAdded(vaccineId, _vaccineName, _manufacturer, _manufacturingDate,
_batchNumber, _customerAddress);

    }



    function getVaccineDetails(uint256 _vaccineId) external view returns (string memory,
string memory, uint256, string memory,uint256, address) {

        Vaccine memory vaccine = vaccines[_vaccineId];

        return (vaccine.vaccineName, vaccine.manufacturer, vaccine.manufacturingDate,
vaccine.batchNumber, vaccine.quantity, vaccine.customerAddress);

    }

}
```

GitHub & Project Demo Link