DRUG TRACEABILITY USING BLOCKCHAIN

A PROJECT REPORT

Submitted by

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1.INTRODUCTION:

Counterfeit medications contribute to major public health concern that severely impact human lives and treatment outcomes. The World Health Organization (WHO) defines counterfeit medications as products that are deliberately and fraudulently mislabeled with respect to source and/or identity. Counterfeit drugs can contain insufficient, incorrect, erroneous ingredients, falsified information such as wrong labeling, and packaged incorrectly.1 WHO estimates that one out of ten medicines circulating in developing countries are either substandard or falsified, and approximately 1%–2% of all the drugs consumed are counterfeit in the developed nations.
1,2 The global counterfeit drug trade impacts all pharmaceutical stakeholders including hospitals, pharmacies, wholesale distributors, global health programs, and regulatory authorities.3 The Illegal drug market contributes immensely toward producing fake and fraudulent medicines as its actors add contaminated, improperly stored, and falsified ingredients. This is enabled because there is a lack of technical and business solutions that offer adequate traceability and provenance solution.4,5 For example, a substandard version of the anti-cancer drug Avastin® was purchased and delivered to thousands of cancer patients in the U.S causing potential treatment complications for patients.6,7 The Asia Pacific, African, and Latin American regions are most vulnerable to counterfeit drugs with almost 30% of the drugs produced and consumed are counterfeit leading to almost 1.5 million deaths per year.8 In the European region the number of reported cases of counterfeit drugs have doubled compared to previous years.9 A recent report by a prominent European research project highlights that the counterfeit medication industry is considered more lucrative and profitable business than selling legal medicines and it estimates a revenue loss equals almost 4.5% in drug sales amounting to €10 billion every year.
10–12 The increased access to medications via online pharmacies and unauthorized distribution channels makes it difficult to ensure product safety in the supply chain.13 In addition, limited data visibility about inventory and stock levels across the supply chain presents greater opportunities for counterfeits to enter the market.3,4 Drug traceability is the process of identifying the originality and legitimacy of the product that enables all stakeholders to track and trace the transactions at every stage in the supply chain.14,15 Regulations such as the US drug supply chain security act (DSCSA) requires all supply chain stakeholders to implement reliable measures that improve product traceability, the actual implementation of DSCSA will be in a phased manner by the year 2023. Blockchain technology is a decentralized, distributed ledger system that provides an efficient and trusted solution for product traceability. Blockchain technology powers the crypto currencies and has been applied to variety of industries such as banking, supply chain, energy, commodities trading, healthcare and many businesses involving transaction processing. To deal with the issue of counterfeit drugs, blockchain technology has the potential to provide pragmatic solution for drug traceability and provenance in a secure and immutable manner. Blockchain technology enables the creation of a distributed shared data platform for storing and sharing the transaction data among various supply chain stakeholders ensuring the information remains accessible, immutable, transparent and secure via cryptographic techniques and accessible only to authorized parties. Thus, provides a proactive approach to track, detect, and manage counterfeits in pharmaceutical supply chains.
In this paper, we reflect on the potential and the limitations of blockchain technology for drug traceability. We describe the current blockchain enabled trends and describe two state of the art architectures, provide explanations on how these architectures are robust, secure, and scalable to

provide better transaction privacy compared to existing solutions, and discuss potential opportunities for securing the pharmaceutical supply chain. The major contributions of our work are as follows:

• We discuss the reasons how the pharmaceutical supply chain benefits from a blockchainenabled drug traceability solution.

• We highlight the key benefits of using blockchain solution for drug supply chain compared to existing solutions.

• We present two suitable blockchain architectures for drug traceability, Hyperledger Fabric and Besu private blockchains.

• We identify, enumerate, and discuss several future research challenges that may hinder the successful deployment of blockchain solutions in the drug supply chain.

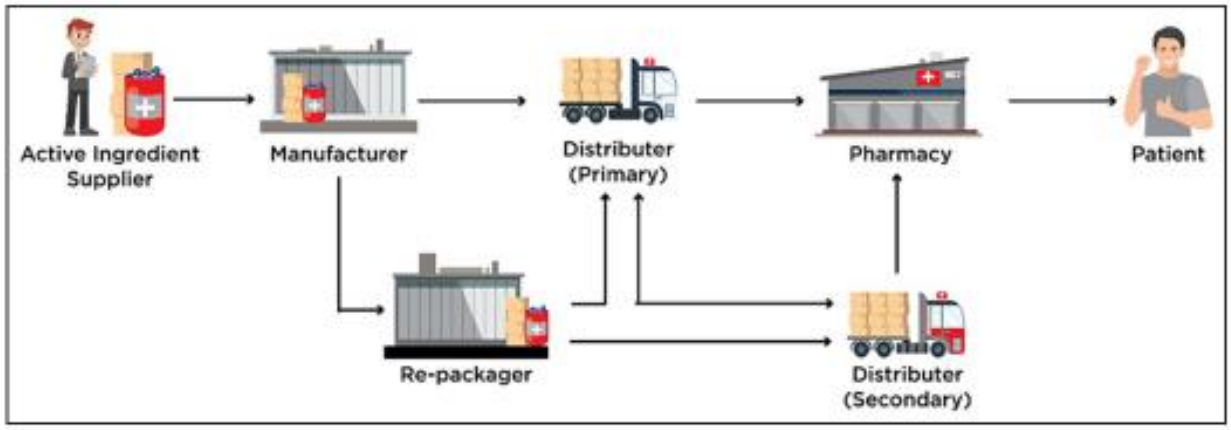
The rest of this paper is organized as follows, in the next section we present an overview of drug traceability in healthcare. In section 3 we present and discuss two blockchain based architectures for drug traceability, in section 4 we discuss several limitations and open challenges pertaining to adoption of blockchain technology that need to be addressed for efficient drug traceability. In section 5, we present the conclusions and future work.

Overview of drug traceability;

In this section, we highlight potential issues related to drug traceability in the pharmaceutical supply chain with an emphasis on counterfeit drugs. A pharmaceutical supply chain follows an end-toend process from sourcing the active medication ingredients (source) to manufacturing the final product (medication) distributed and delivered to patients (end-users). It is the primary responsibility of the supply chain members to distribute authentic and high-quality products at the right time as it directly influences the health and safety of patients. The current drug distribution, and delivery systems have grown immensely in scale and complexity. In addition, limited data visibility, lack clear ownership structure, diversity of stakeholders makes transaction verification difficult. The lack of an integrated view of the entire supply chain often requires centralized third-party solutions to collect and validate information.

Pharmaceutical supply chain comprises of several stakeholders (supplier, manufacturer, distributor, retailer, pharmacy, and patient), and product distribution often requires intricate packing, unpacking and repacking process, which makes drug provenance and traceability very complicated.16 Figure 1 illustrates a high level overview of various stakeholders and their relationship in the pharmaceutical supply chain. There are several factors attributed to the availability of counterfeits in the supply chain, some examples include importing substandard medicines without the approval of regulatory authority, poor manufacturing and storage practices, theft, and infiltration of deficient drugs.17 Different technology driven approaches such as bar codes, RFID tags, IoT, serialization, and e-pedigree have been adopted to enhance trust among stakeholders to improve product visibility in the supply chains.18–22 However, these solutions are centralized and have serious limitations when it comes to security, interoperability, privacy, and scalability toward preventing counterfeits in the supply chains.23,24

Blockchain solutions for supply chain and logistics have recently gained enormous acceptance as they provide an immutable and transparent way to record transactions between non-trusting stakeholders.25 The main feature of blockchain technology is the ability to track and trace transactions of an asset using decentralized distributed ledger with cryptographically secured timestamped records, thus enabling the direct digital transfer and storage of transaction records without the involvement of third-party intermediary service providers. It enables us to create an immutable ledger for transaction processing among untrusted and physically distributed stakeholders across the pharmaceutical supply chain.26 Blockchain technology ensures an efficient and cost-effective solution that underpins different drug traceability functions and procedures to ascertain proper



identification, tracing, tracking, and provenance.27 Blockchain technology has the potential to be integrated with existing anti-counterfeiting solutions including RFID, NFC, QRC, and e-pedigree to provide interoperable and better-integrated solutions.28 The wider acceptance of blockchain based solutions in the pharmaceutical industry is evident based on several recent pilot projects involving major stakeholders is shown in Table 1.

Blockchain technology enables creating a private permissioned network to trace and track events in the pharmaceutical supply chain and provides time stamped records of each transaction performed. Examples of events includes, execution and owner, time, location of transaction, and which stakeholders were involved.29 This confirms the authenticity, integrity, transparency, security, and provenance of each drug or drug ingredient shipped to and from authorized stakeholders at each transfer point. This process minimizes the impediments in the drug supply chain, empowers collaboration between mutually untrusted stakeholders and creates an unassailable and immutable decentralized drug traceability system.30 These benefits help in standardization and regulatory oversight across multiple countries and drug regulatory authorities via shared data exchange, to achieve interoperable solutions based on several regulators such as Food and Drug Administration (FDA) and European Medication Agency (EMA). In the next section, we propose two private blockchain architectures for product traceability in the pharmaceutical supply chain.

II. RELATED WORK ;

We present a critical overview of existing efforts focused at addressing the issue of product traceability in the healthcare supply chain emphasizing solutions proposed for anticounterfeiting. We have included both blockchain and nonblockchain-based approaches and categorized them accordingly.

A. TRADITIONAL EFFORTS FOR DRUG TRACEABILITY;

Traceability is defined as the ability to access any or all information relating to the object under consideration, throughout its life cycle, by means of recorded identifications. The object under consideration is referred to as Traceable Resource Unit (TRU) which is any traceable object within the supply chain. Traceability objectives are twofold; to track the history of transactions, and to track the real-time position of the TRU. In this context, a traceability system requires access to information related to the drug which is the TRU in the supply chain by using different identification techniques to record its identity and distinguish it from other TRUs. The components of a traceability system can be broadly identified by a mechanism for identifying TRUs, a mechanism for documenting the connections between TRUs, and a mechanism for recording the attributes of the TRUs [21].

Existing solutions within supply chain management have traditionally used barcodes and RFID tags as identification techniques, Wireless Sensor Networks (WSN) to capture data, and Electronic Product Code (EPC) to identify, capture, and share product information to facilitate tracking of goods through different stages [22] . In this context, Smart-Track [23] utilizes GS1 standards barcodes containing unique serialized product identifier, Lot production and expiration dates. The information contained in the GS1 barcode is captured across various supply chain processes and used to maintain a continuous log of ownership transfers. As each stakeholder records the possession of the product, an end user (patient) can verify authenticity through central data repository maintained as Global Data Synchronization Network (GDSN) by using a smartphone app. In the downstream supply chain at the warehouse, pharmacy and hospital units can scan the barcode to verify the product and its characteristics. Similarly, Data-Matrix tracking system [24] creates a Data-Matrix for each drug which includes the manufacturer ID, Product ID, Unique ID of the package, the authentication code, and an optional meta-data. This allows the patient to verify the origin of the drug by using the attached Data-Matrix.

More recently Near Field Communication (NFC) tags have been proposed to be used to achieve visibility and authenticity across pharmaceutical supply chain. In this respect, [25] presents an effort to develop a NFC-based system which af fords visibility throughout different stages of pharmaceutical supply chain. Each drug is registered and authenticated by using a key value and an NFC tag is attached to it. Similar to the previous two solutions, the user or the patient can verify the authenticity or the origin of the drug by scanning the attached NFC tag using a mobile application. .Corrado et al. [26], Supriya and Djearamane [27], and Jamal et al. [28] have proposed solutions for traceability but they use a centralized database which makes tampering goods information relatively easy and difficult to detect. In addition to that, the use of different types of centralized databases can result in the proposed solutions to have lack of interoperability and scalability.

B. BLOCKCHAIN-BASED SOLUTIONS FOR DRUG TRACEABILITY

Traditional solutions to achieve traceability within pharmaceutical supply chain are typically centralized and lack transparency across participants of the supply chain, which allows the central authority to modify information without notifying other stakeholders. On the other hand, a blockchain based solution offers data security, transparency, immutability, provenance and authenticated transaction records. Blockchain is a decentralized, immutable shared ledger that can be applied to a variety of business settings involving transaction processes.

Transparency and traceability are used interchangeably however, they represent very different concepts. Transparency is usually used when referring to high-level information of a supply chain. For example, product's components, facilities locations, names of suppliers, etc. with the objective to map the whole supply chain. However, traceability is related to granular information where it envisages choosing a specific component to trace, determines common standards to communicate with partners, implements methods to produce and gather accurate data, selects a platform to store traceability data, and determines how to share data on the platform. Although both terms represent different concepts, they rely on each other because accessing granular information requires full understanding of the supply chain.

In this respect, a number of existing approaches leverage cryptographic properties of blockchain to achieve a decentralized, verifiable track and trace system for pharmaceutical drugs. Mettler et al. [32] have discussed the use of blockchain based approach for various issues in healthcare sector with no technical details or specific application. Kurki [33], presented the advantages of blockchain technology in pharmaceutical supply chain. However, similar to [32] only conceptual discussion was provided. Muniandy and Ong [20] proposed a traceability system using Ethereum for anticounterfeiting. The proposed solution employs smart contract however it lacks implementation or evaluation which limits understanding the contribution.

Huang et al. [34] proposed a drug traceability system, Drugledger, which reflects the practical drug transaction logic in the supply chain, and generates both authenticity and privacy of stakeholders' traceability information without losing the resilience of the system. Drugledger completes its workflow based on the expanded UTXO data structure, especially that of package, repackage, and unpackage. However, recent studies such as [35] have highlighted concerns with the use of UTXO data structure with respect to its weakness in programmability, high storage cost, and low state space utilization.

Faisal et al. [36], proposed a Hyperledger-based solution for drug traceability in the pharmaceutical supply chain. Authors report increase in the performance in terms of throughput and minimizes latency of the proposed system with less utilization of resources, however their solution was not rigorously tested and was implemented in a small-sized network. This effort also highlighted the challenge of achieving scalable solutions with blockchain which has received significant attention in recent literature such as [22]. Similar concerns are valid for the approach adopted by Hulseapple [38] who developed a private blockchain concurrently with the Bitcoin, which is used as a ledger to hash certain data to

secure the transactions in chain. Every product has its own permanent record on their blockchain, making it impossible to manipulate with the private keys. The system was designed to protect every stage of product transfer in the supply chain, creating a trustless system of transparency.

In addition to the above, a number of active projects exist which are focused at exploring use of distributed ledger technologies to achieve traceability within pharmaceutical supply chain. For instance, Arsene [39] involves leading companies including IBM, Cisco, Accenture, Intel, Bloomberg, and Block stream where every drug is issued with a timestamp, making it traceable with its origin and manufacturer details. Similarly, MediLedger [40] investigates use of blockchain to provide a solution compliant with the DSCSA regulation to increase interoperability in the industry. Farmatrust project [41] aims to improve traceability in pharmaceutical industry based on Quorum blockchain with future plans to accommodate other platforms such as Ethereum and Hyperledger. The use of Quorum blockchain presents challenges such as lack of transaction ordering of transactions and policy enforcement which limits it widespread use.

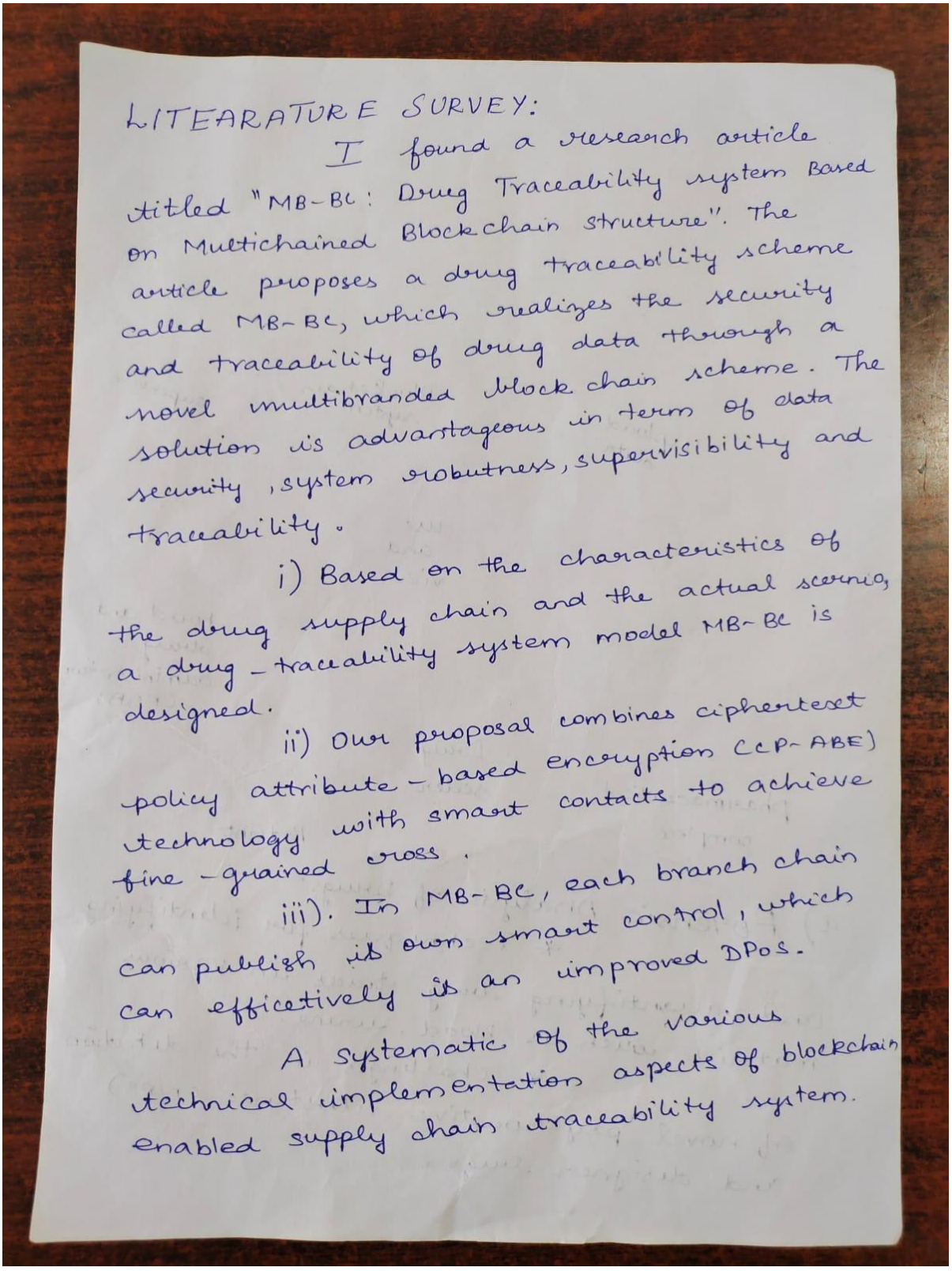
DEFINE PROBLEM/PROBLEM UNDERSTANDING:

The pharmaceutical supply chain (PSC) consists of multiple stakeholders, including raw material suppliers, manufacturers, distributors, regulatory authorities, pharmacies, hospitals, and patients. Thecomplexity of product and transaction flows in PSC requires an effective traceability system to determine the current and all previous product owner ships. In addition, digitizing track and trace process provides significantbenefit for regulatory oversight and ensures product safety. Block chain-based drug traceability offers apotential solution to create a distributed shared data platform for an immutable, trustworthy, accountable andtransparent system in the PSC .

However, there are still several challenges related to the application of block chain technology for drug traceability. Some of these challenges include privacy, trust, transparency, security, authorization and authentication, and scalability .

Two potential block chain-based decentralized architectures were proposed to meet critical requirements for drug traceability . These architectures are Hyper ledger Fabric and Bess. The authors also identified several open research challenges related to the application of block chain technology for drug traceability .

2. LITERATURE SURVEY;



LITEARATURE SURVEY:

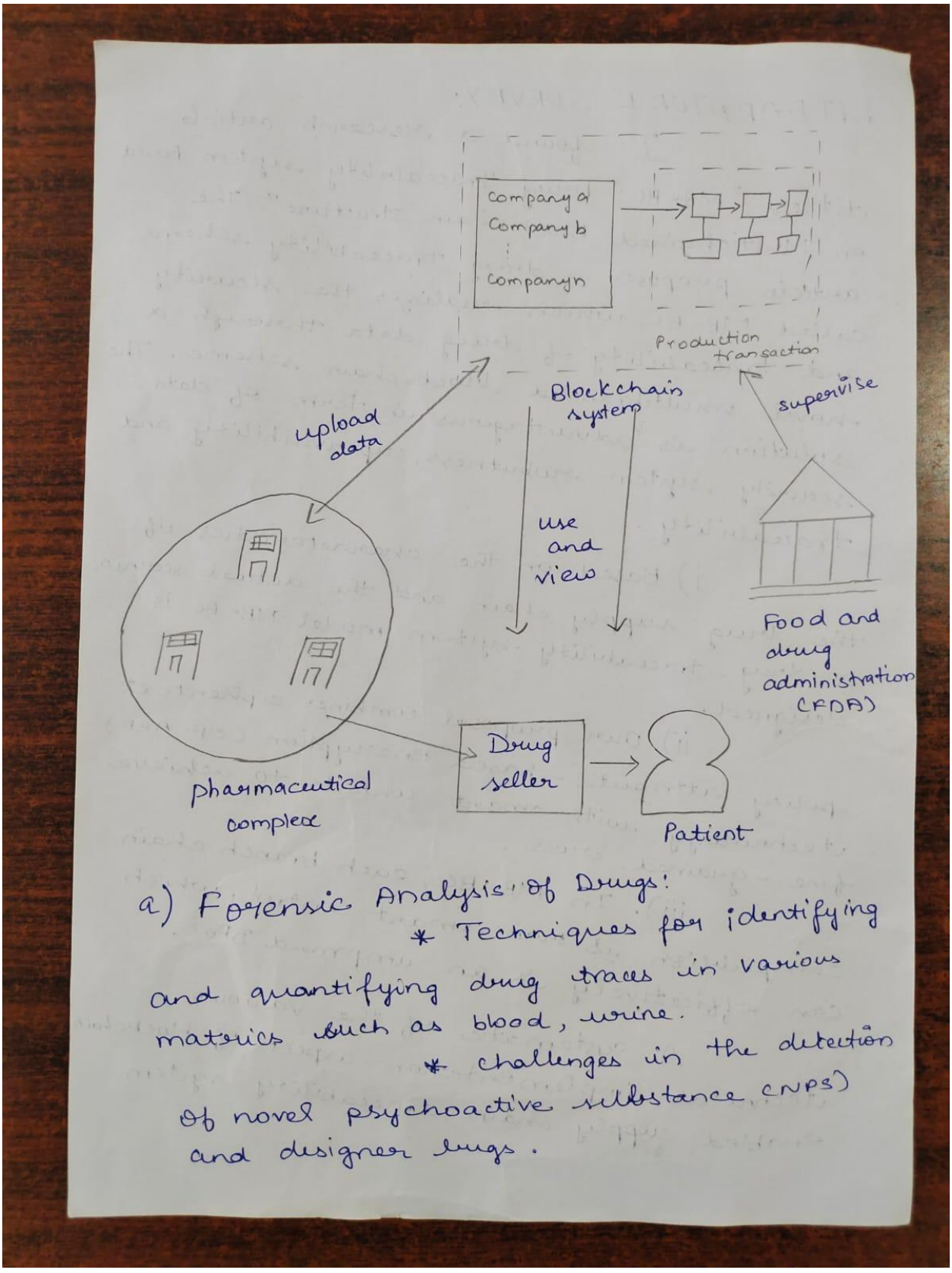
I found a research article titled "MB-BC: Drug Traceability system Based on Multichained Blockchain structure". The article proposes a drug traceability scheme called MB-BC, which realizes the security and traceability of drug data through a novel multibranded block chain scheme. The solution is advantageous in term of data security, system robustness, supervisibility and traceability.

i) Based on the characteristics of the drug supply chain and the actual scenario, a drug-traceability system model MB-BC is designed.

ii) Our proposal combines ciphertext policy attribute-based encryption (CP-ABE) technology with smart contacts to achieve fine-grained cross.

iii). In MB-BC, each branch chain can publish its own smart control, which can efficetively is an improved DPos.

A systematic of the various technical implementation aspects of blockchain enabled supply chain traceability system.



a) Forensic Analysis of Drugs:

* Techniques for identifying and quantifying drug traces in various matrics such as blood, urine.
* challenges in the detection of novel psychoactive substance (NPS) and designer drugs.

b). Drug Metabolism :

* Metabolism of drugs in the body and the formation of drug metabolities.
* The role of pharmacokinetics in drug trace analysis.

c) Legal and Ethical considerations:

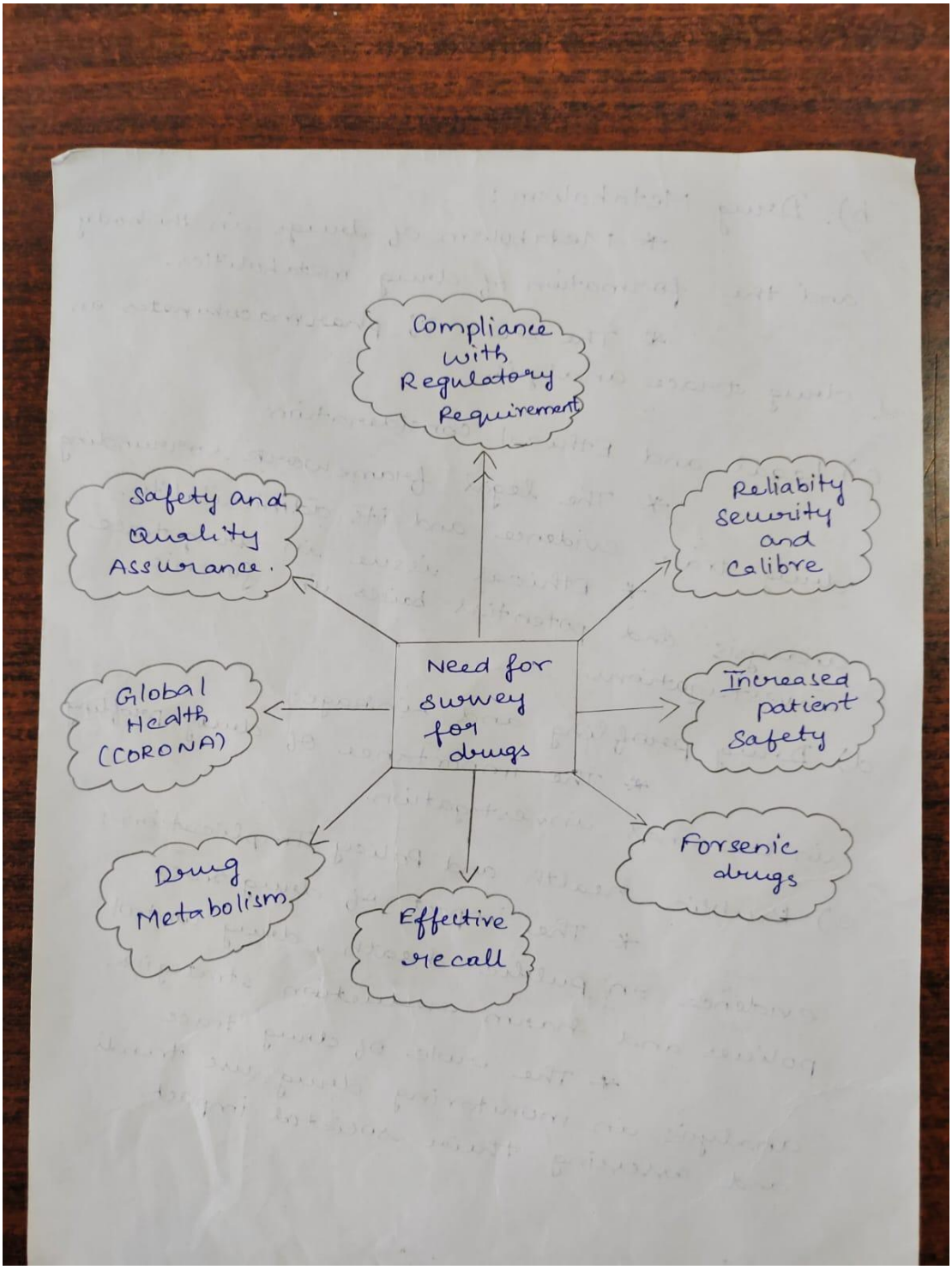
* The legal framework sorrounding drug trace evidence and its admissibility.
* Ethical issue in drug trace analysis and potential baises in forensic investigations.

d) Drug profling and Linkage:

* The importance of drug profling in criminal investigation.

e) Public health and Policy Implication :

* The impact of drug trace evidence on public heath, drug control policies and harm reduction strategies.
* The role of drug trace analysis in monitoring drug use trends and assessing their societal impact.


Compliance with Regulatory Requirement
Safety and Quality Assurance.
Reliabity security and calibre
Need for survey for drugs
Global Health (CORONA)
Increased patient Safety
Drug Metabolism
Effective recall
Forsenic drugs

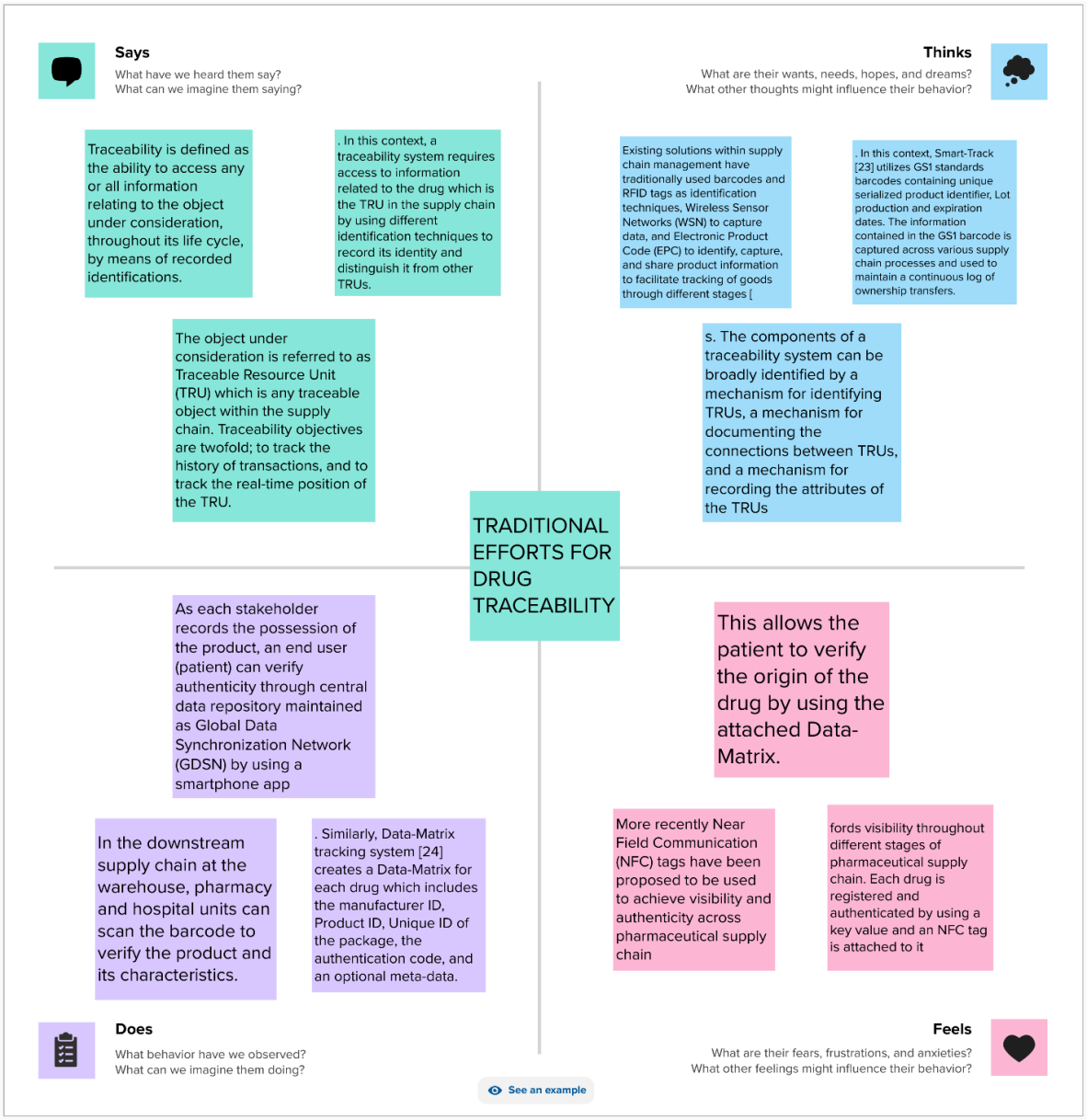
Ideation Phase
Empathize & Discover

Empathy Map Canvas:

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes. It is a useful tool to helps teams better understand their users. Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.

Example:

Reference: https://www.mural.co/templates/empathy-map-canvas



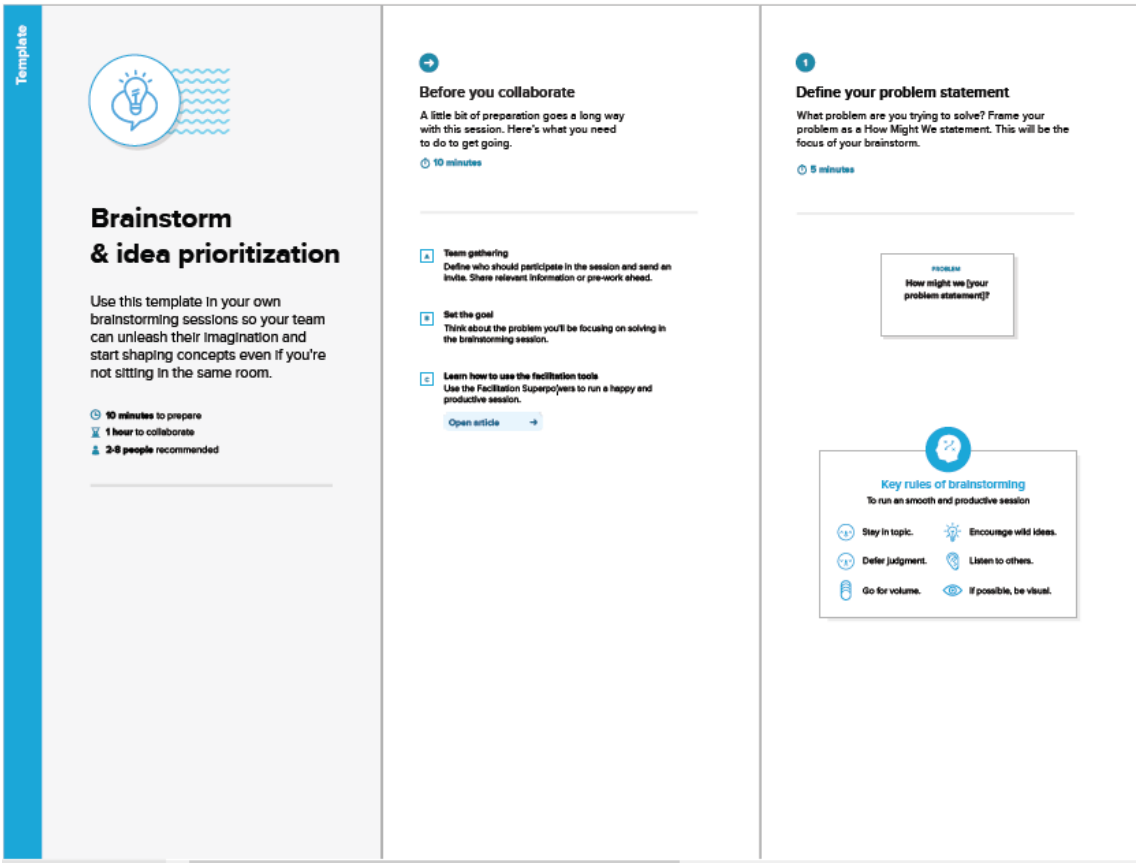
Ideation Phase
Brainstorm & Idea Prioritization Template

Brainstorm & Idea Prioritization Template:

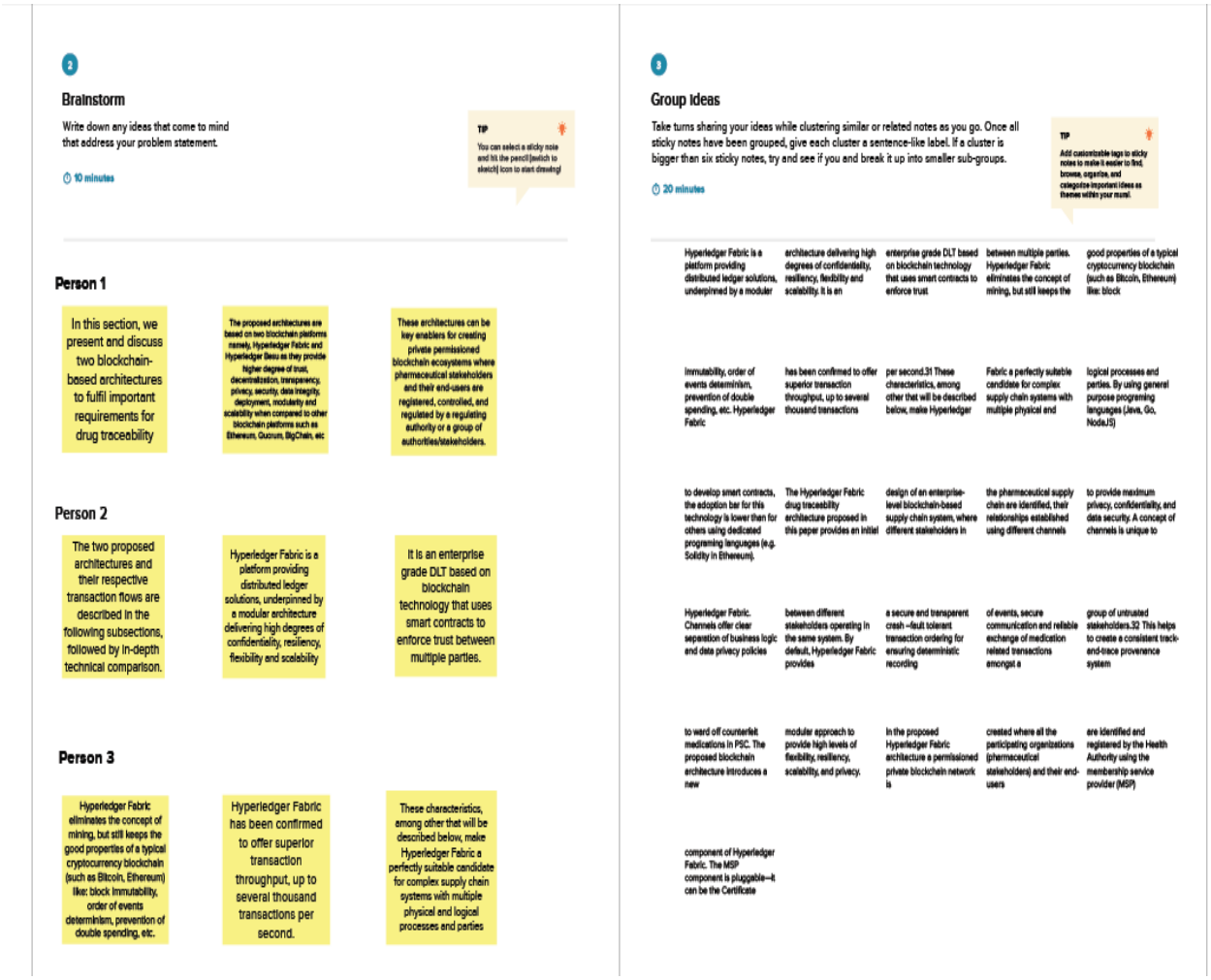
Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich amount of creative solutions. Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

Reference: https://www.mural.co/templates/empathy-map-canvas

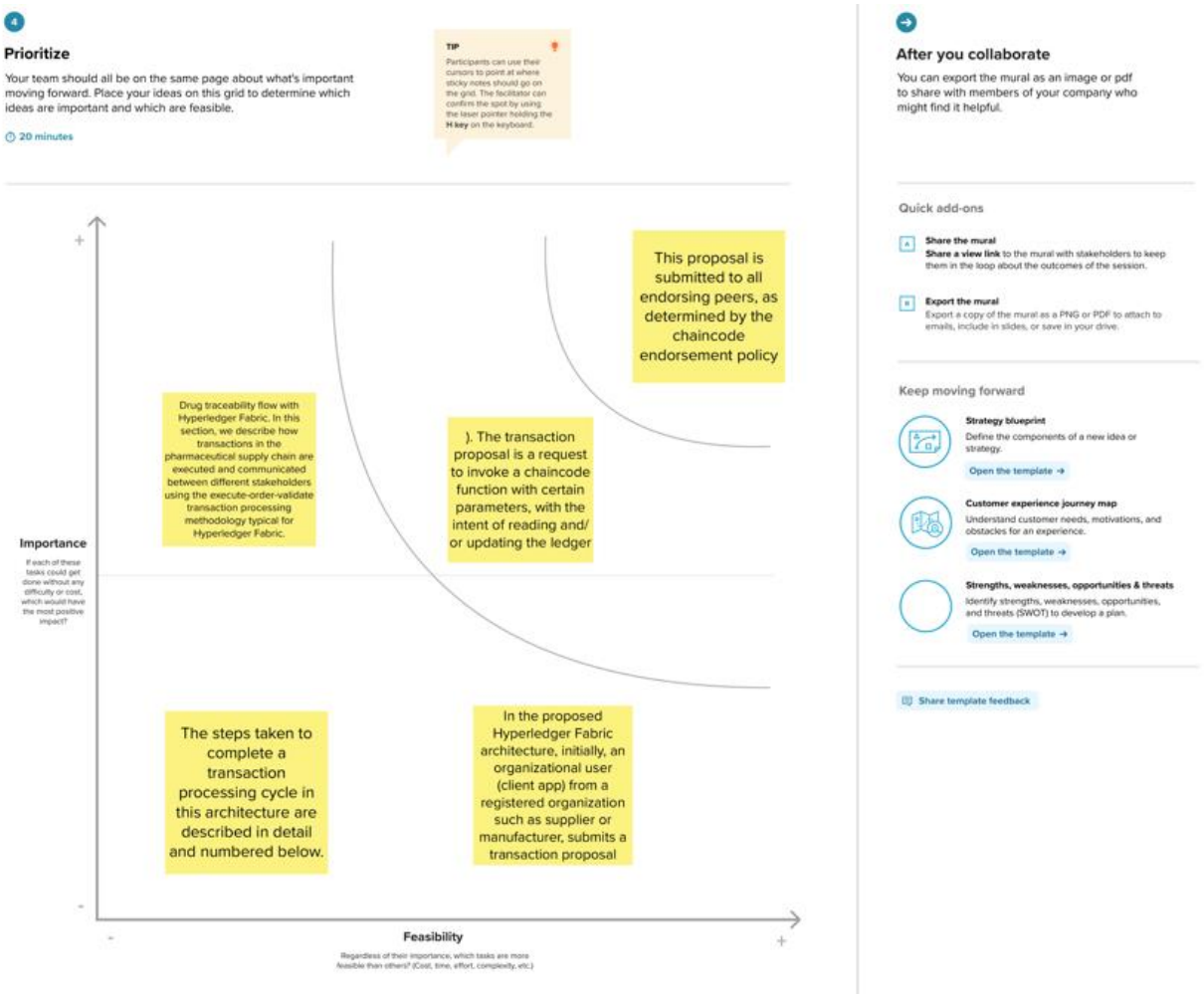
Step-1: Team Gathering, Collaboration and Select the Problem Statement



Step-2: Brainstorm, Idea Listing and Grouping



Step-3: Idea Prioritization



Project Design Phase-I
Solution Architecture

Solution Architecture:

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:

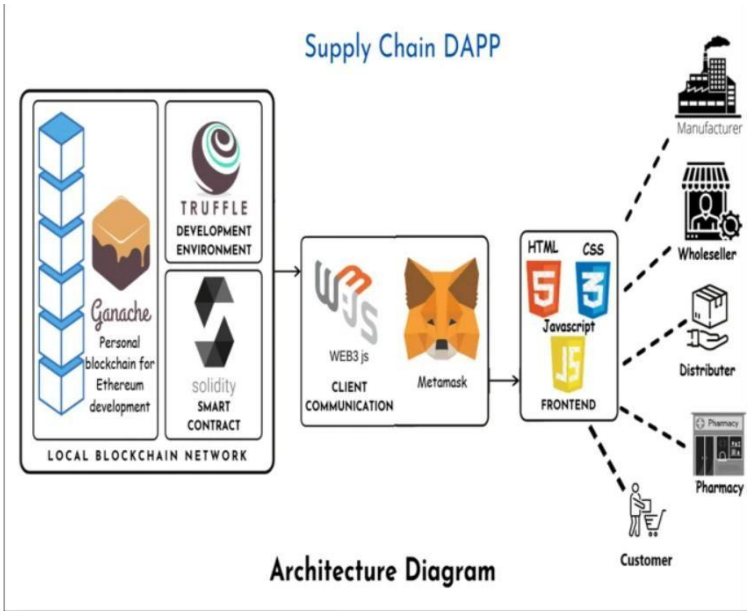
• Find the best tech solution to solve existing business problems.

• Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders.

• Define features, development phases, and solution requirements.

• Provide specifications according to which the solution is defined, managed, and delivered.

Example - Solution Architecture Diagram:



Prerequisite

1 download node.js : Node.js

2 download vs code: Li4nk

3 download metamask : https://metamask.io/

Steps to complete the project

Step 1:

-

1. Open the Zip file and download the zip file.
2. Extract all zip files

Step 2 :

1.Open vs code in the left top select open folder. Select extracted file and open .
2. Select the projectname.sol file and copy the code.
3. Open the remix ide platform and create a new file by giving the name of projectname.sol and paste the code which you copied from vs code.
4. Click on solidity compiler and click compile the projectname.sol
5. Deploy the smart contract by clicking on the deploy and run transaction.
6. select injected provider - MetaMask. In environment
7. Click on deploy. Automatically MetaMask will open and give confirmation. You will get a pop up click on ok.
8. In the Deployed contract you can see one address copy the address.
9. Open vs code and search for the connector.js. In contract.js you can paste the address at the bottom of the code. In export const address.
10. Save the code.

Step 3:

open file explorer
1. Open the extracted file and click on the folder.
2. Open src, and search for utiles.
3 . You can see the frontend files. Select all the things at the top in the search bar by clicking alt+ A. Search for cmd
4.Open cmd enter commands

```
npm install
npm bootstrap
npm start
```

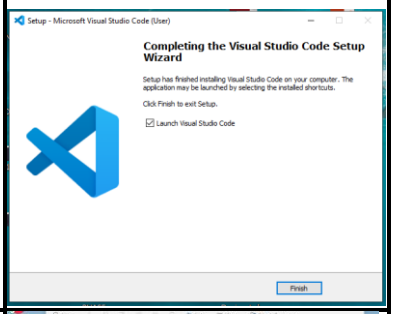
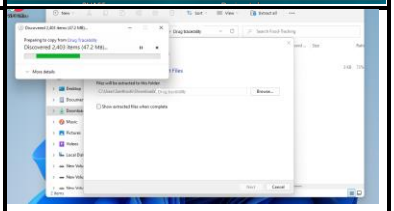
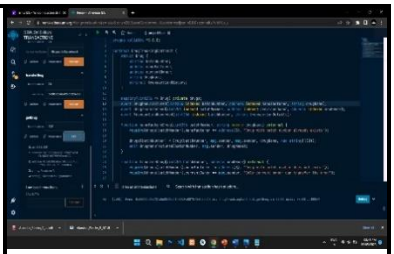
5. It will install all the packages and after completing it will open {LOCALHOST IP ADDRESS} copy the address and open it to chrome so you can see the frontend of your project.

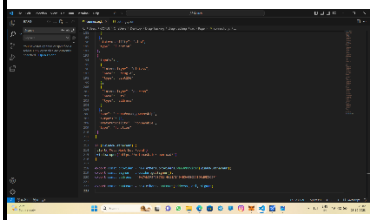
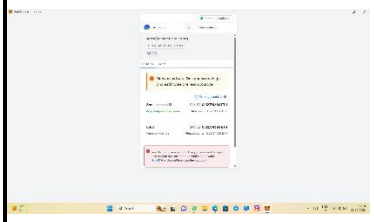
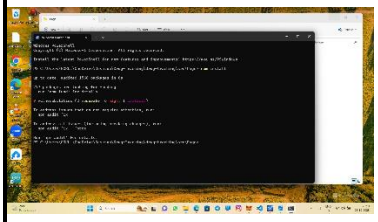
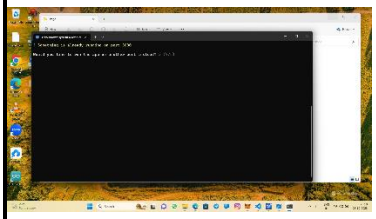
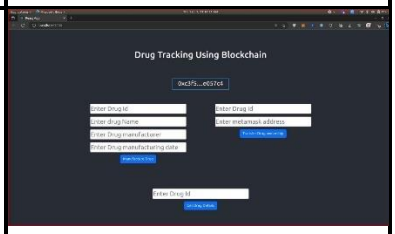
project Development phase

Model Performance Test

Model Performance Testing:

Project team shall fill the following information when working for blockchain.

S.No.	Parameter	Values	Screenshot
1.	Information gathering	Setup all the Prerequisite:	 
2.	Extract the zip files	Open to vs code	
3.	Remix Ide platform exploring	Deploy the smart contract code Deploy and run the transaction. By selecting the environment - inject the MetaMask.	

4	Open file explorer	Open the extracted file and click on the folder. Open src, and search for utiles. Open cmd enter commands 1.npm install 2.npm bootstrap 3. npm start	   
5	{LOCALHOST IP ADDRESS	copy the address and open it to chrome so you can see the front end of your project.	

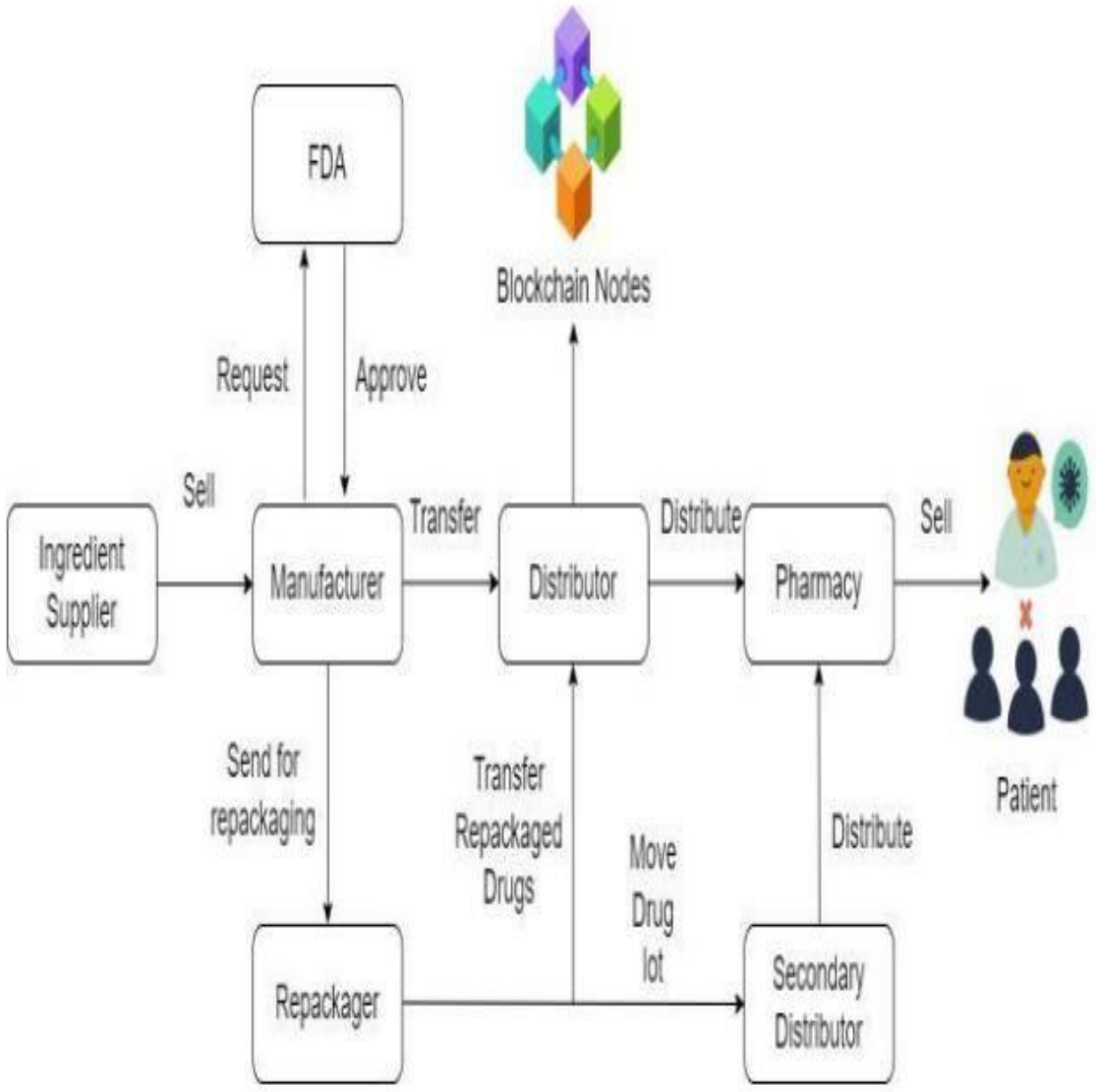
PROJECT PLANING & SCHEDULING

DRUG TRACEBILITY

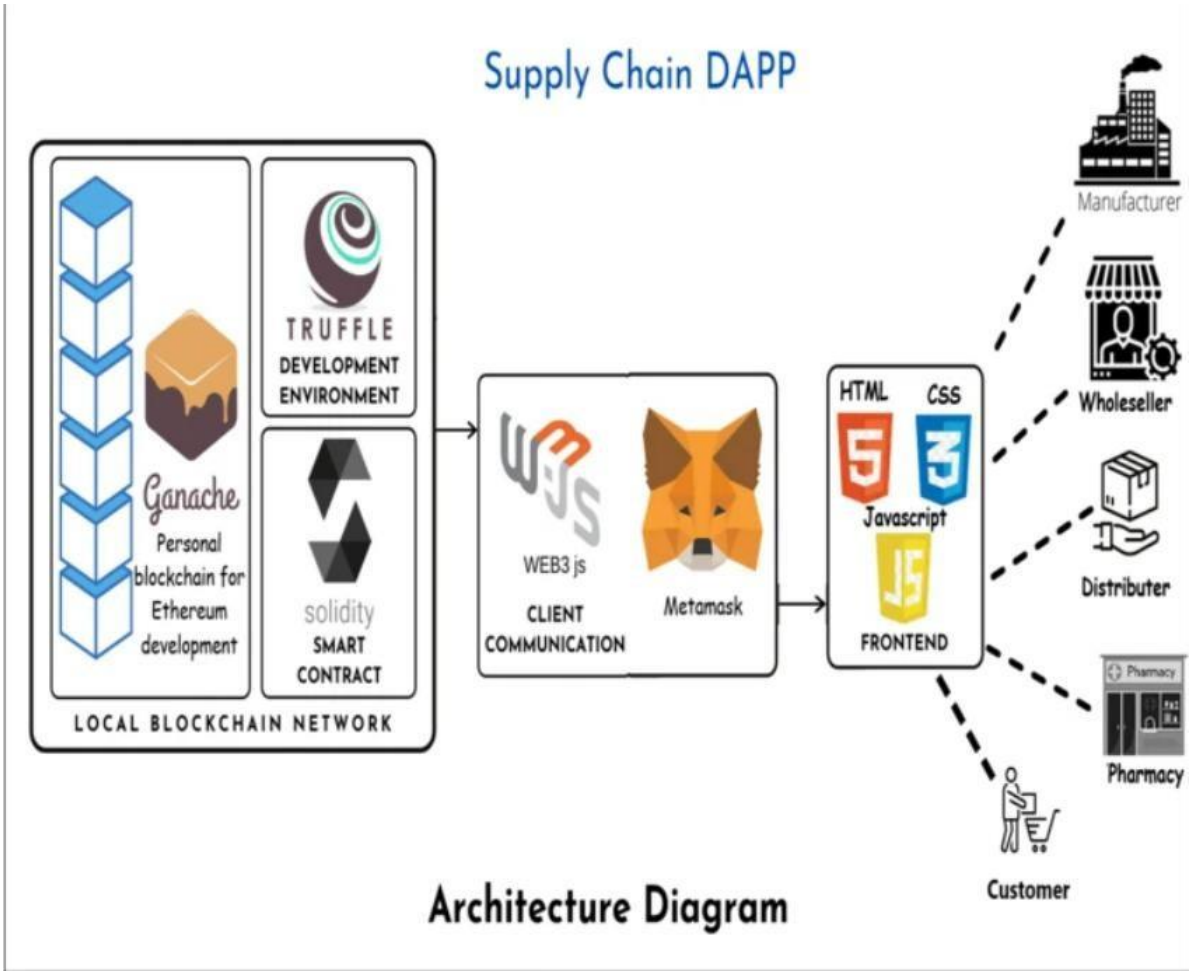
The "Drug Traceability Smart Contract on Ethereum Block chain" is a pioneeringsolution poised to revolutionist pharmaceutical supply chain management. In response to the urgent need for enhanced transparency and security in drug tracking, this smart contract leverages block chain technology. It establishes a decentralized network of nodes, underpinned by non-repudiation and robust security features, to ensure the verifiabletraceability of pharmaceuticals. Traditional drug management systems often struggle with issues of authenticity and accountability, making them susceptible to counterfeit drugs and inefficiencies. In contrast, this Ethereum-based smart contract offers a informativeness approach. It enables stakeholders to monitor the entire life cycle of drugs, from production to distribution and ultimately to the end-user, with unparalleled transparency and trust.This innovation promises to usher in a new era of pharmaceutical traceability, where each drug's journey can be traced immutably on the block chain. By doing so, it not only safeguards patient health but also protects the integrity of the pharmaceutical industry. This article explores the architecture and capabilities of this smart contract, shedding light on how it can instill confidence in drug tracking and contribute to a more secure and accountable pharmaceutical landscape.

A supply chain is defined as the process of acquiring a product from its manufacturer and delivering it to the end-user (customer). A supply chain can be for any product, such as an automobile, clothing, medical supply chain, etc.Like other supply chains, the health care supply chain has many stakeholders, starting with the raw material supplier and progressing to the manufacturer, then a wholesaler and distributor, and finally the pharmacist and the customer (patient) . When we examine health care supply chains, we see that they have a large and complex structure and numerous stakeholders. Traceability, transparency, dependability, cost efficiency, integrity, and sustainability are all lacking in earlier versions of supply chains that were not as digitally advanced. There is no proper method for tracking the history of medicine transitions and ownership from their origin to the patients. Due to a lack of traceability and transparency, there is uncertainty about the medicine’s originality and security, which leads to issues related to drug counterfeiting and falsification. In addition, the lack of these critical features leads to black-marketing ofmedicines, the intermediary falsifies the actual drugs and sells the irrelevant drugs at a lower price. These activities do not stop at lowering the prices of fake products; instead, black marketers raise the prices of original products to such an unpayable level that people in need are forced to switch to them. These actions not only cause a slew of healthproblems for the people, but they also result in a large number of casualties at times, which can cause panic among the people in times such as the Covid-19 pandemic.

TECHNICAL ARCHITECTURE;



TECHNICAL STACK;



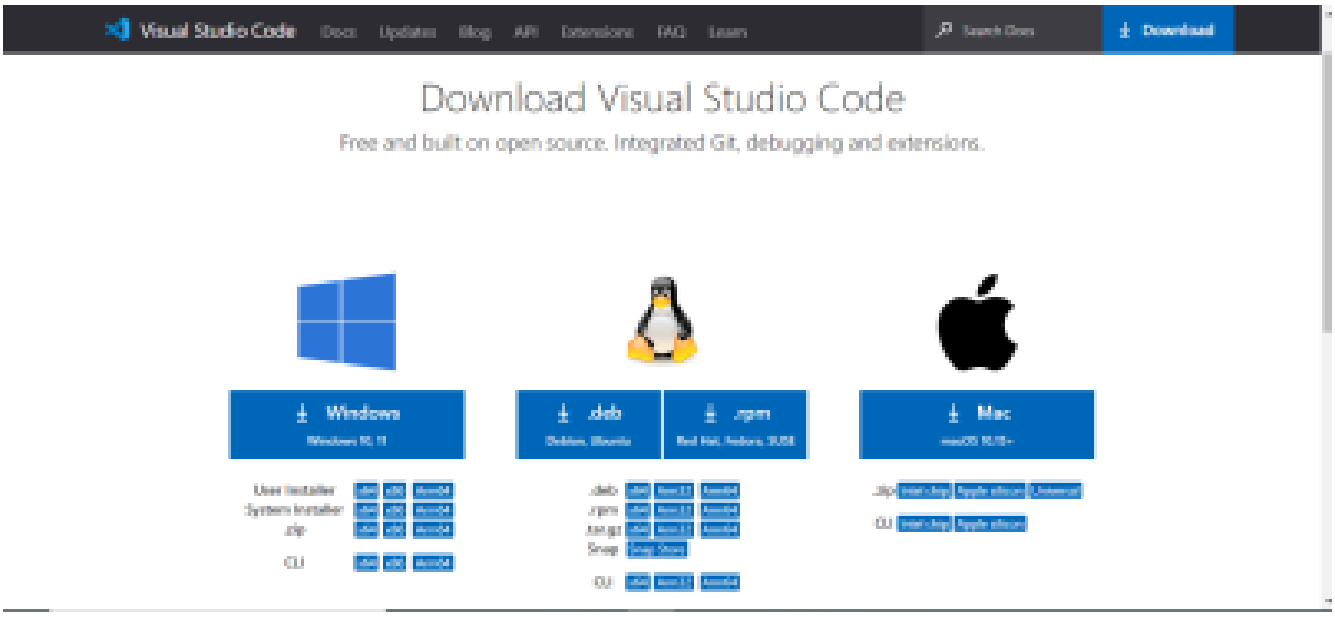
6. CODING & SOLUTIONING

6.1 Feature 1

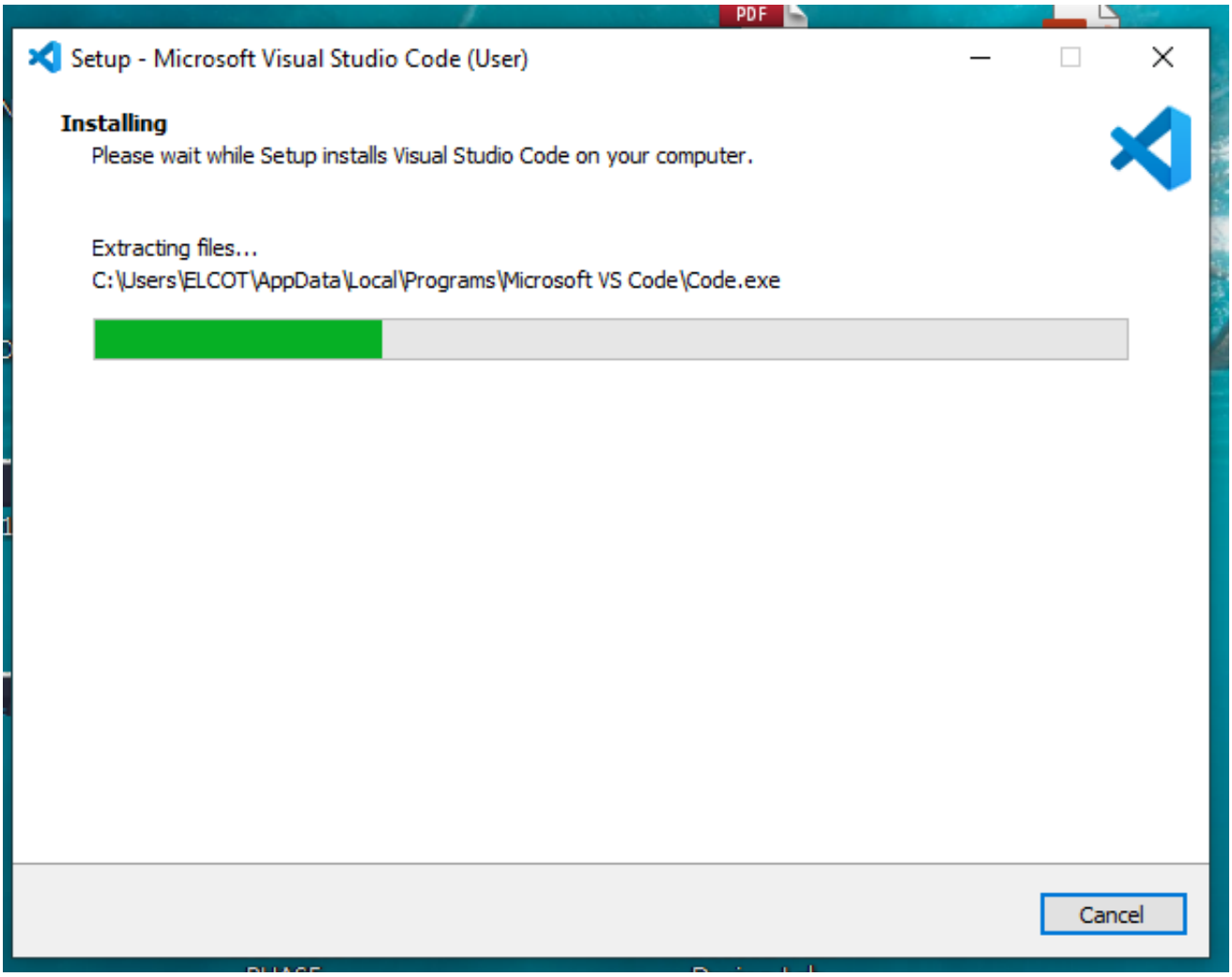
Download VS Code

- To install the VS Code follow the steps below

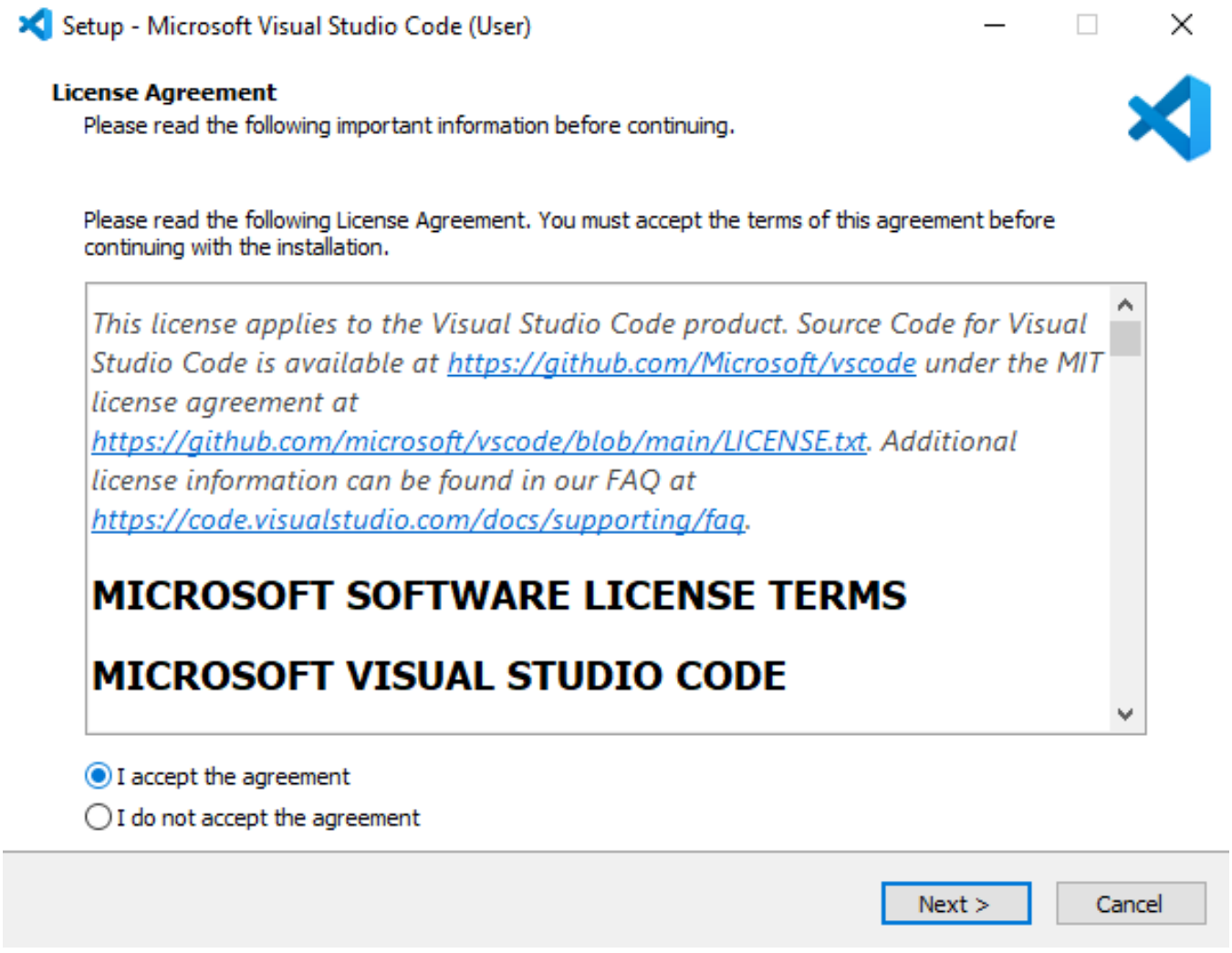
• STEP 1: Download VS code from here Link



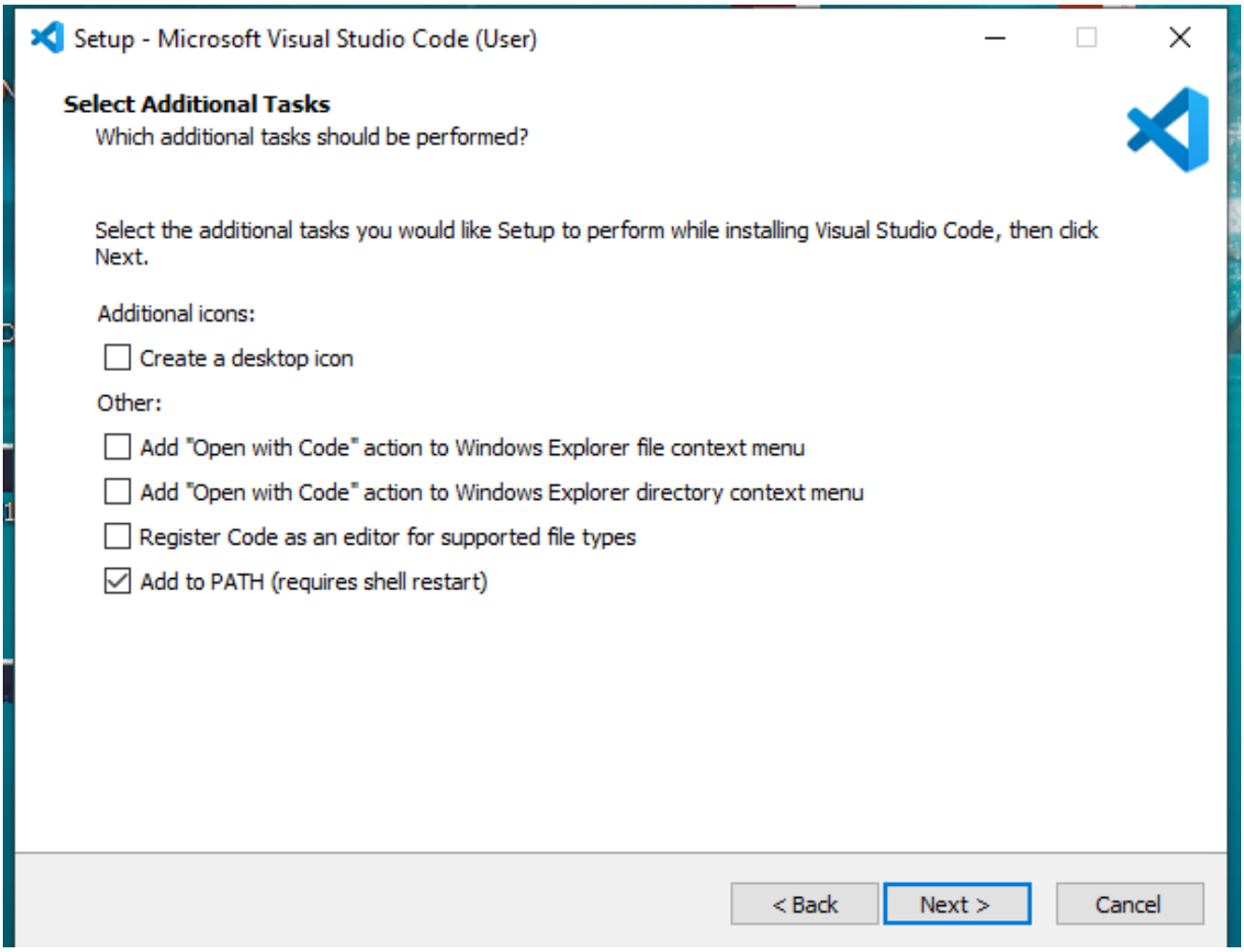
STEP 2: Download the Visual Studio Code installer for Windows



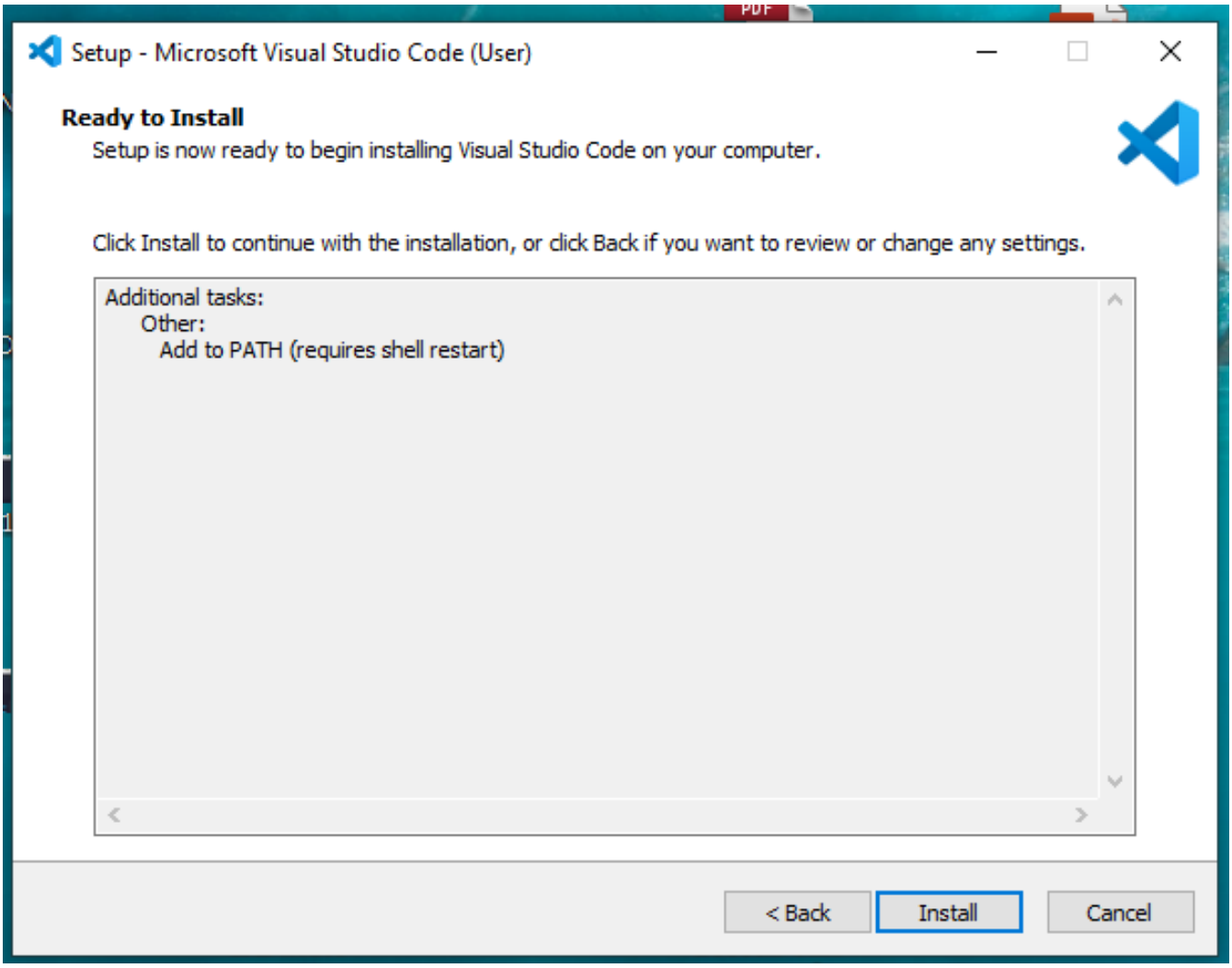
STEP 3: Once it is downloaded, run the installer (VSCodeUserSetup-{version}.exe). This will only take a minute.



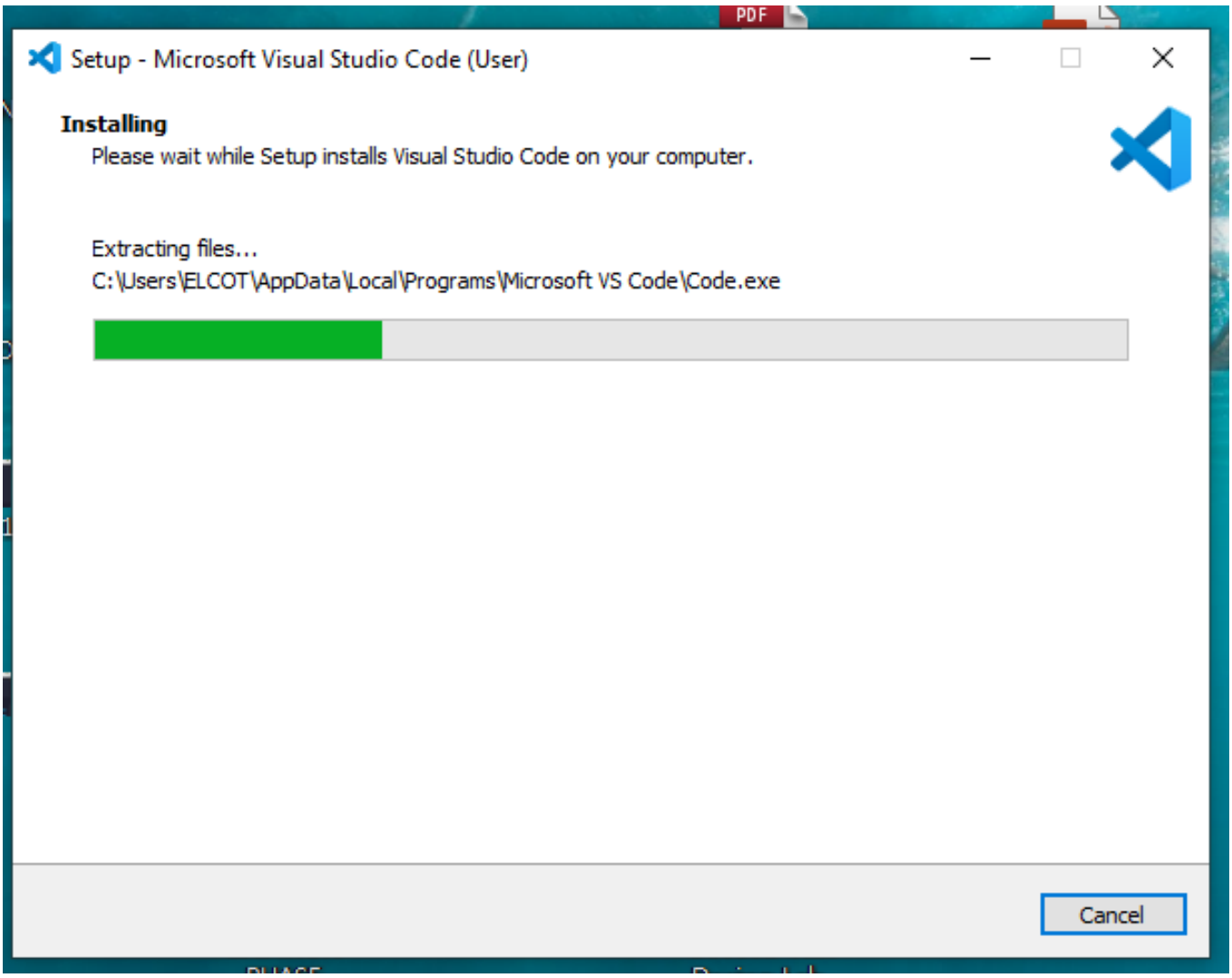
Step 4: click on Next



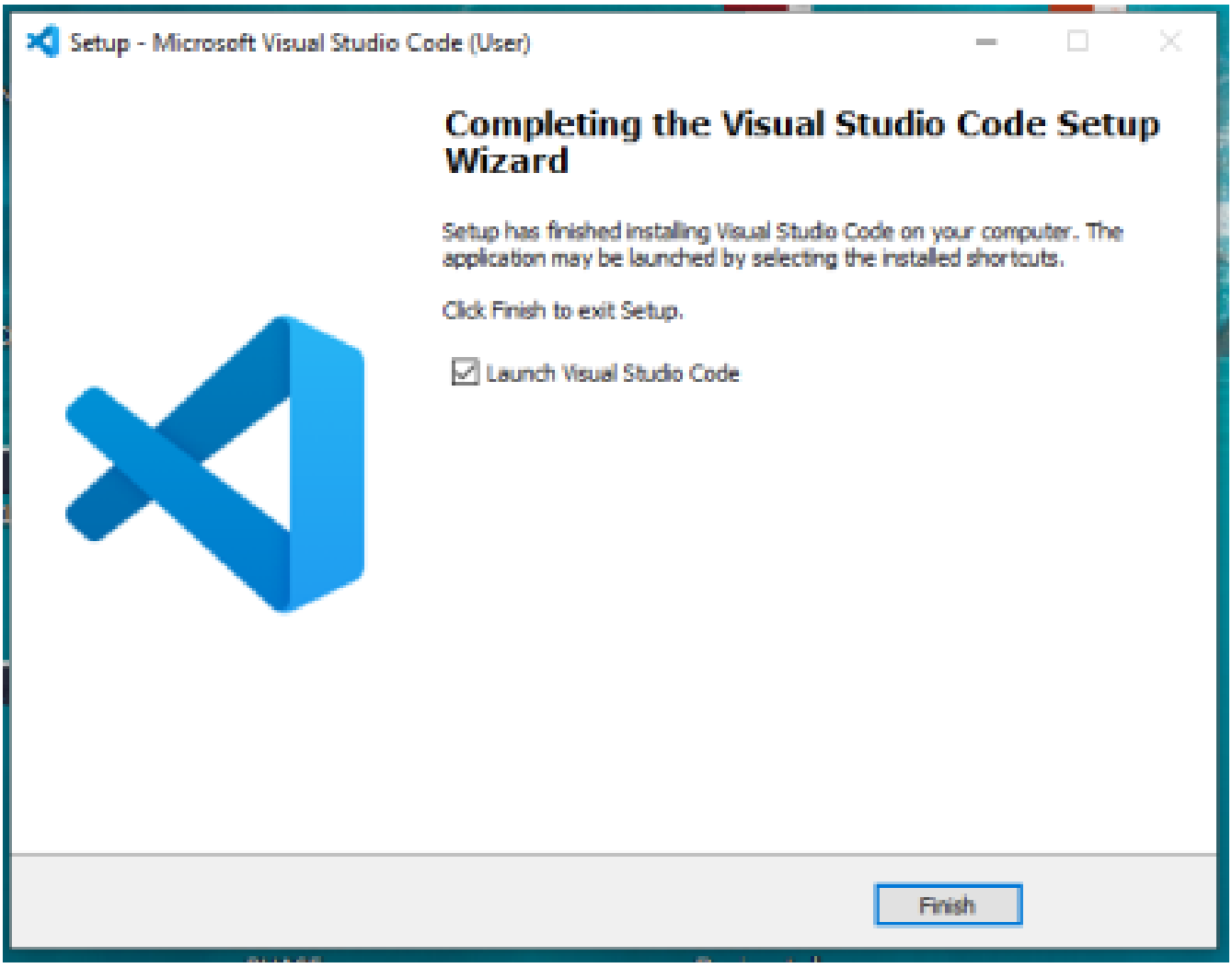
STEP 5: Click on install



STEP 6: Installing

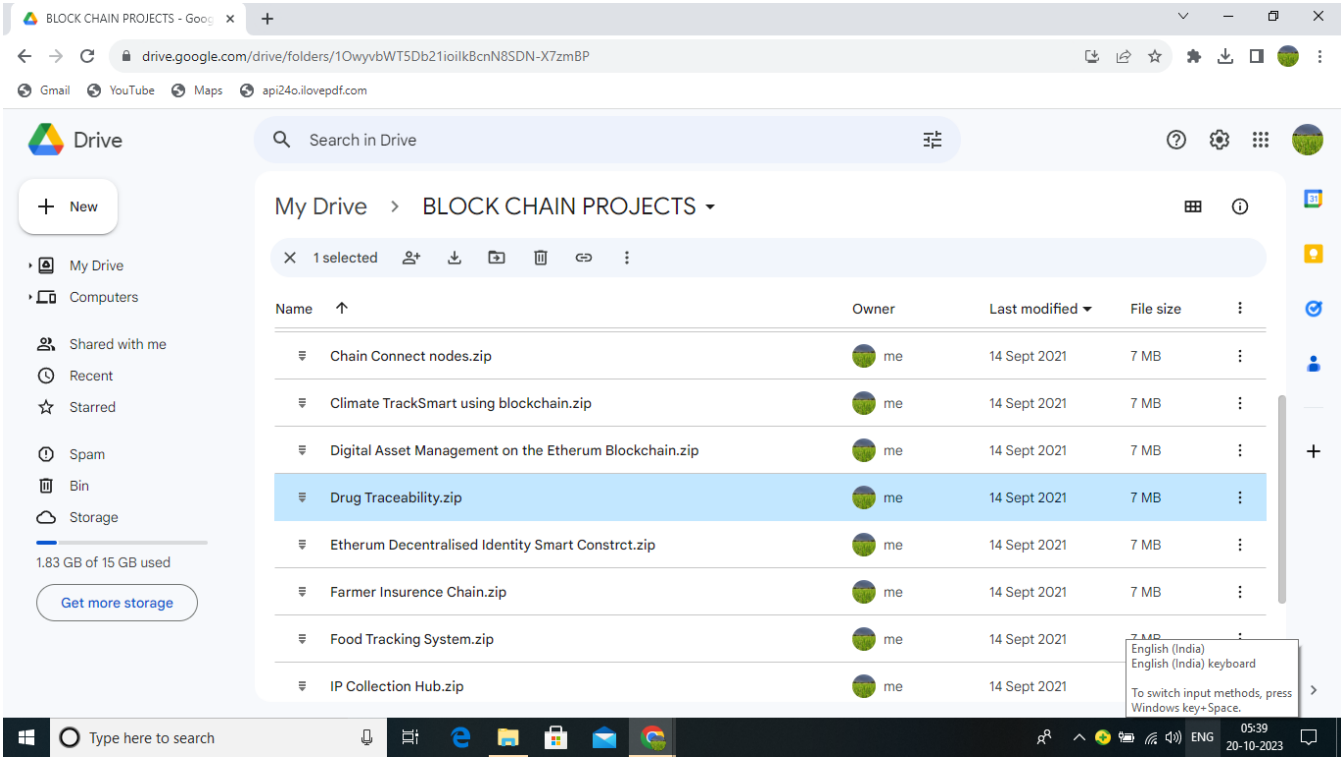


STEP 7: Click on finish

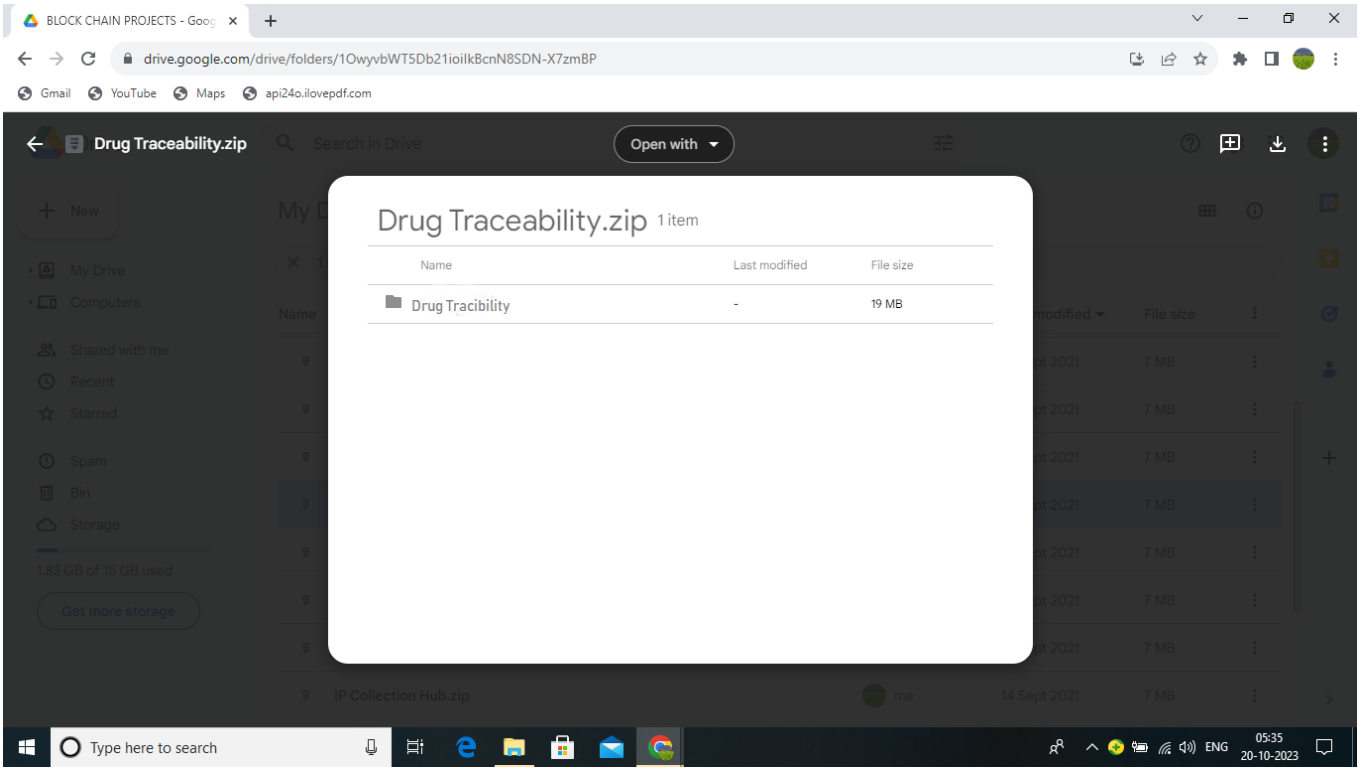


Download The Zip File For The Project And Extract It Open In VS Code

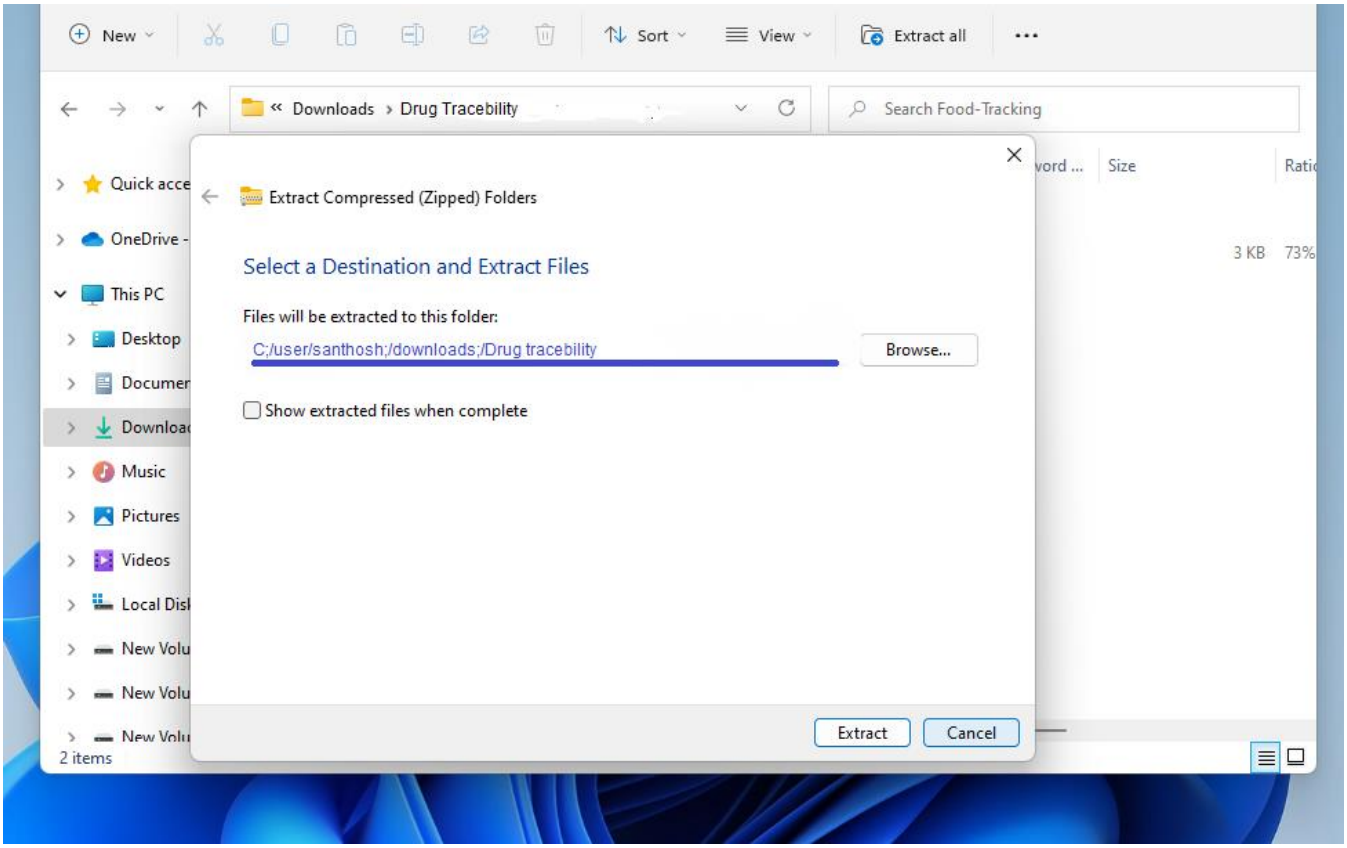
Step ;1



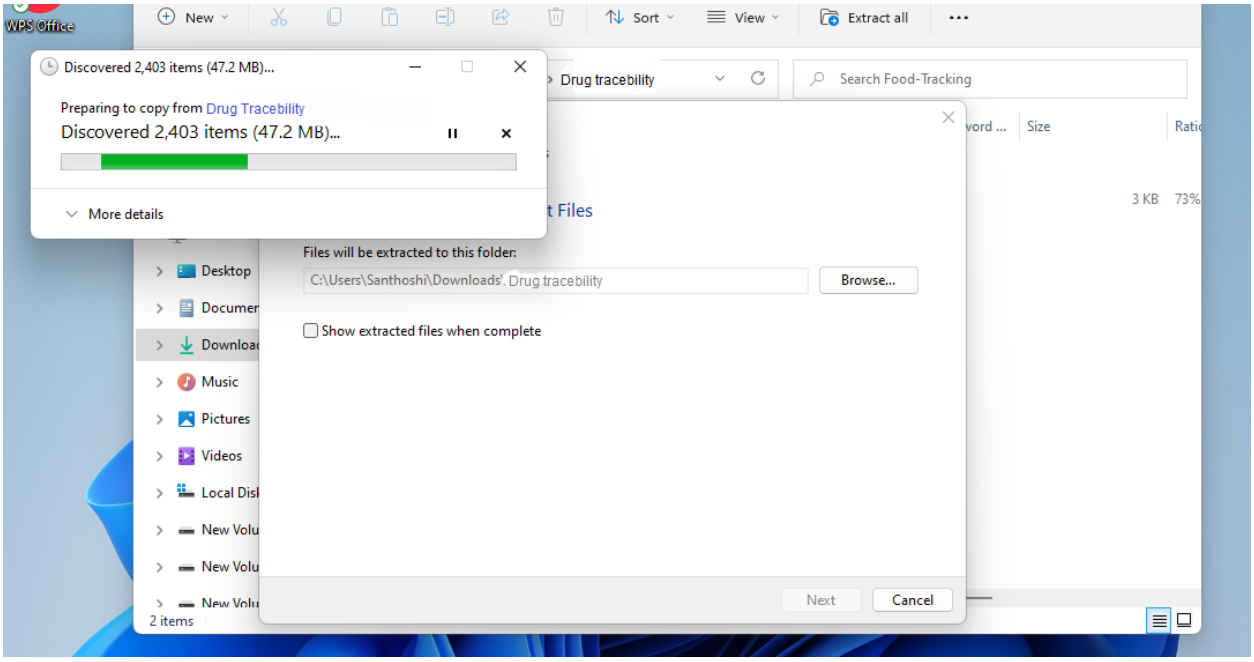
Step ;2


BLOCK CHAIN PROJECTS - Goog
drive.google.com/drive/folders/1OwyvbWT5Db21ioilkBcnN8SDN-X7zmBP
Gmail
YouTube
Maps
api24o.ilovepdf.com
Drug Traceability.zip
Search in Drive
Open with
Drug Traceability.zip 1 item
Name
Last modified
File size
Drug Tracibility
-
19 MB
New
My Drive
Computers
Shared with me
Recent
Starred
Spam
Bin
Storage
1.83 GB of 15 GB used
Get more storage
IP Collection Hub.zip
14 Sept 2021
Type here to search
ENG
05:35
20-10-2023

Step ;3


New
Sort
View
Extract all
Downloads › Drug Tracebility
Search Food-Tracking
Quick acce
OneDrive -
This PC
Desktop
Documer
Downloa
Music
Pictures
Videos
Local Disk
New Volu
New Volu
New Volu
2 items
Size
3 KB
73%
Extract Compressed (Zipped) Folders
Select a Destination and Extract Files
Files will be extracted to this folder:
C:/user/santhosh;/downloads;/Drug tracebility
Browse...
Show extracted files when complete
Extract
Cancel

Step ;4

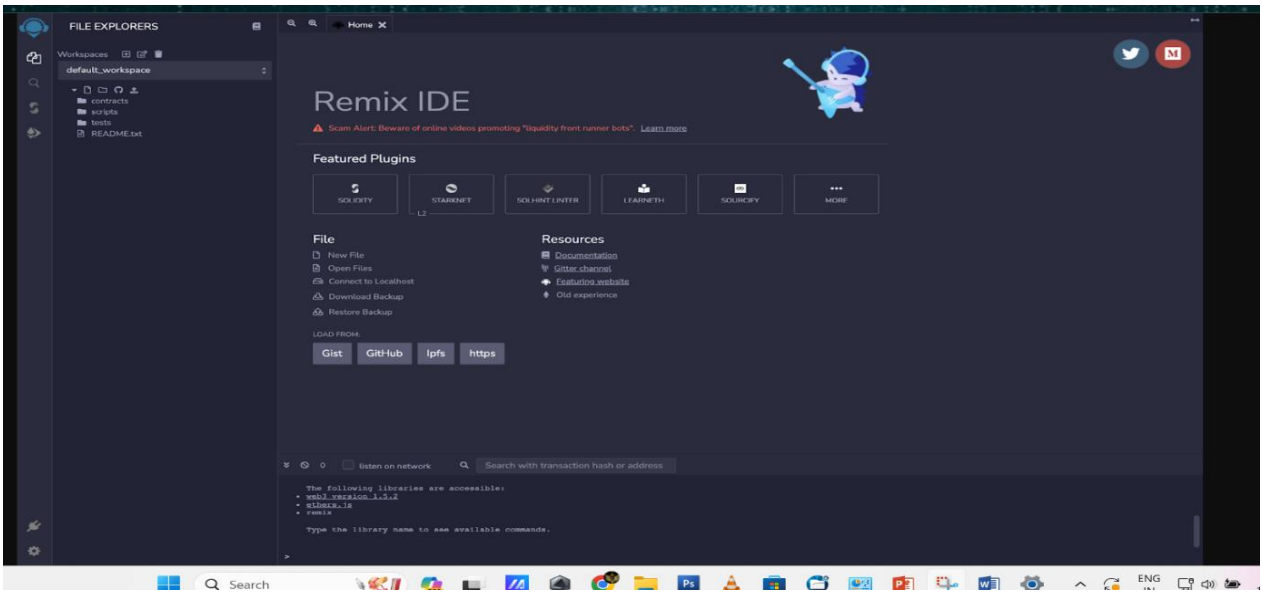

WPS Office
New
Sort
View
Extract all
Discovered 2,403 items (47.2 MB)...
Preparing to copy from Drug Tracebility
Discovered 2,403 items (47.2 MB)...
More details
Drug tracebility
Search Food-Tracking
Size
3 KB
73%
t Files
Files will be extracted to this folder:
C:\Users\Santhoshi\Downloads\ Drug tracebility
Browse...
Show extracted files when complete
Desktop
Music
Pictures
Videos
Next
Cancel
2 items

IMPLEMENTATION:

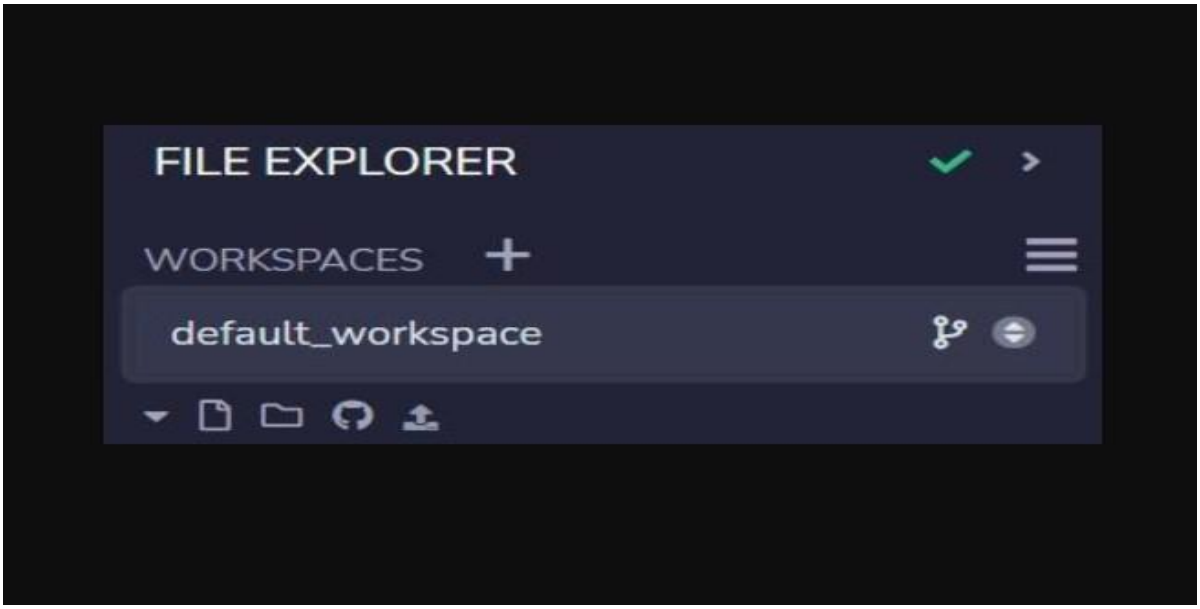
Remix IDE:

Remix IDE is a no-setup tool with a GUI for developing smart contracts. Used by experts and beginners alike, Remix will get you going in double time. Remix plays well with other tools, and allows for a simple deployment process to the chain of your choice. Remix is famous for its visual debugger.

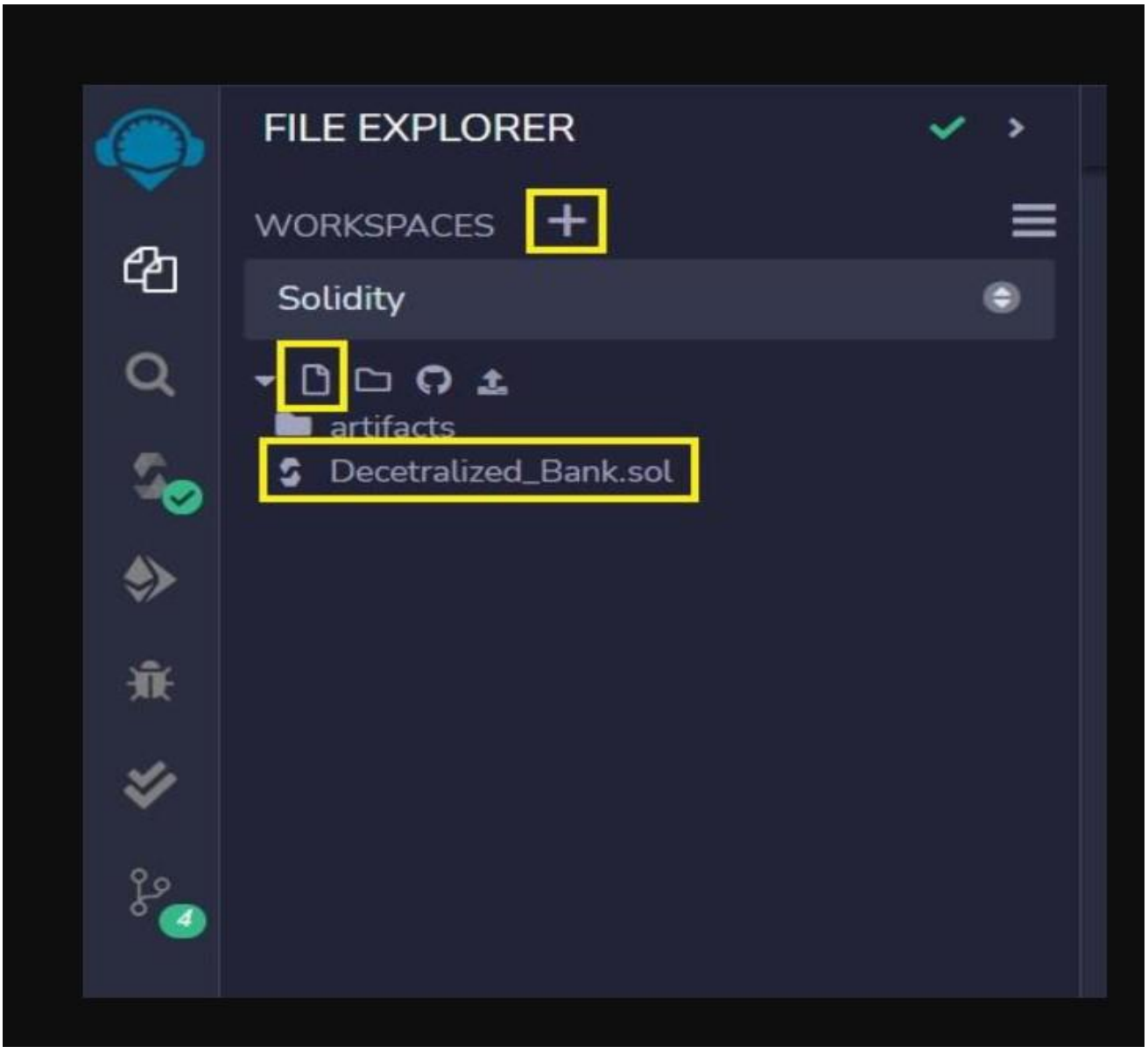
STEP 1: Open **Remix IDE**.



- Click on **File Explorers** and Create a new **WORKSPACE (by Clicking on the + icon).**

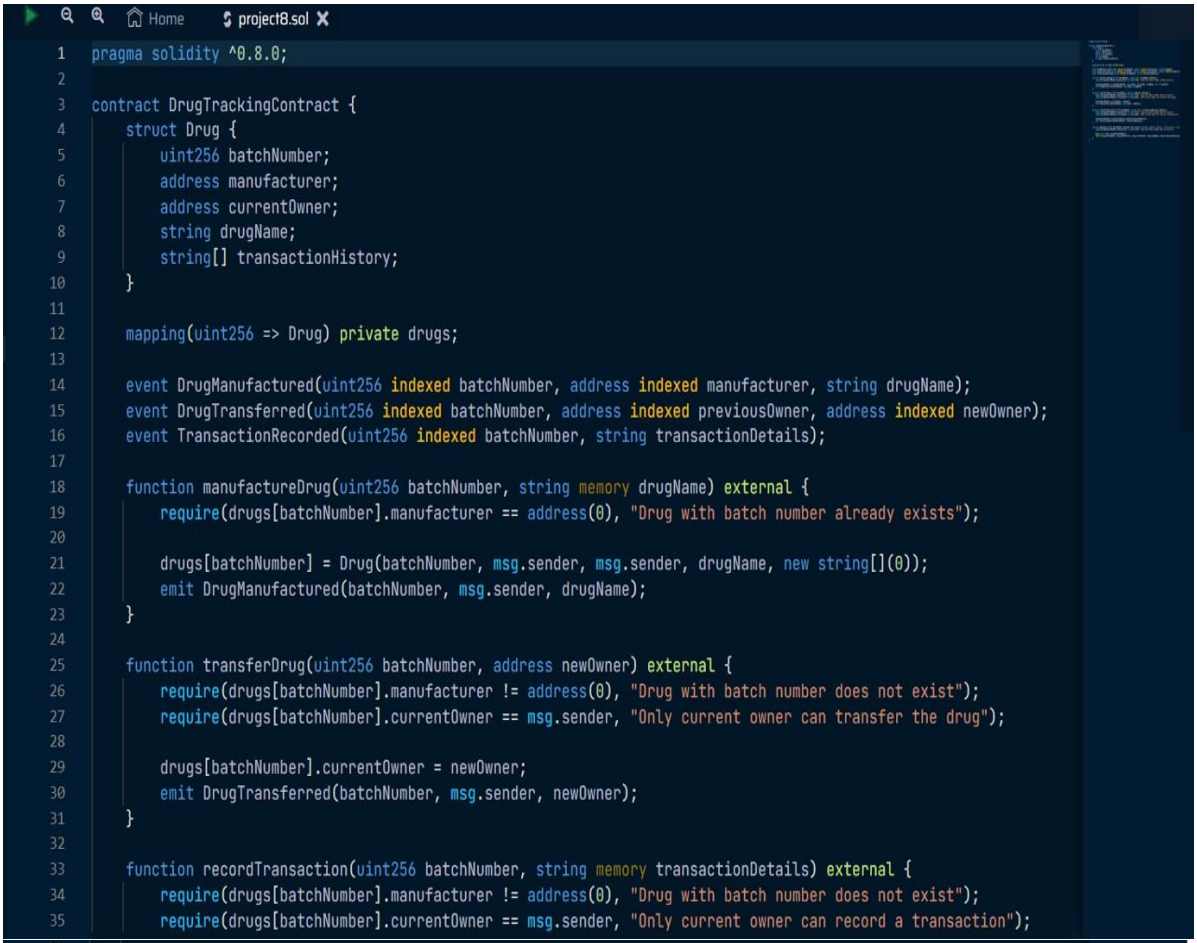


STEP 2:
Click on File Explorers and select Solidity in the environment and create a new file filename. sol by clicking on New File section.

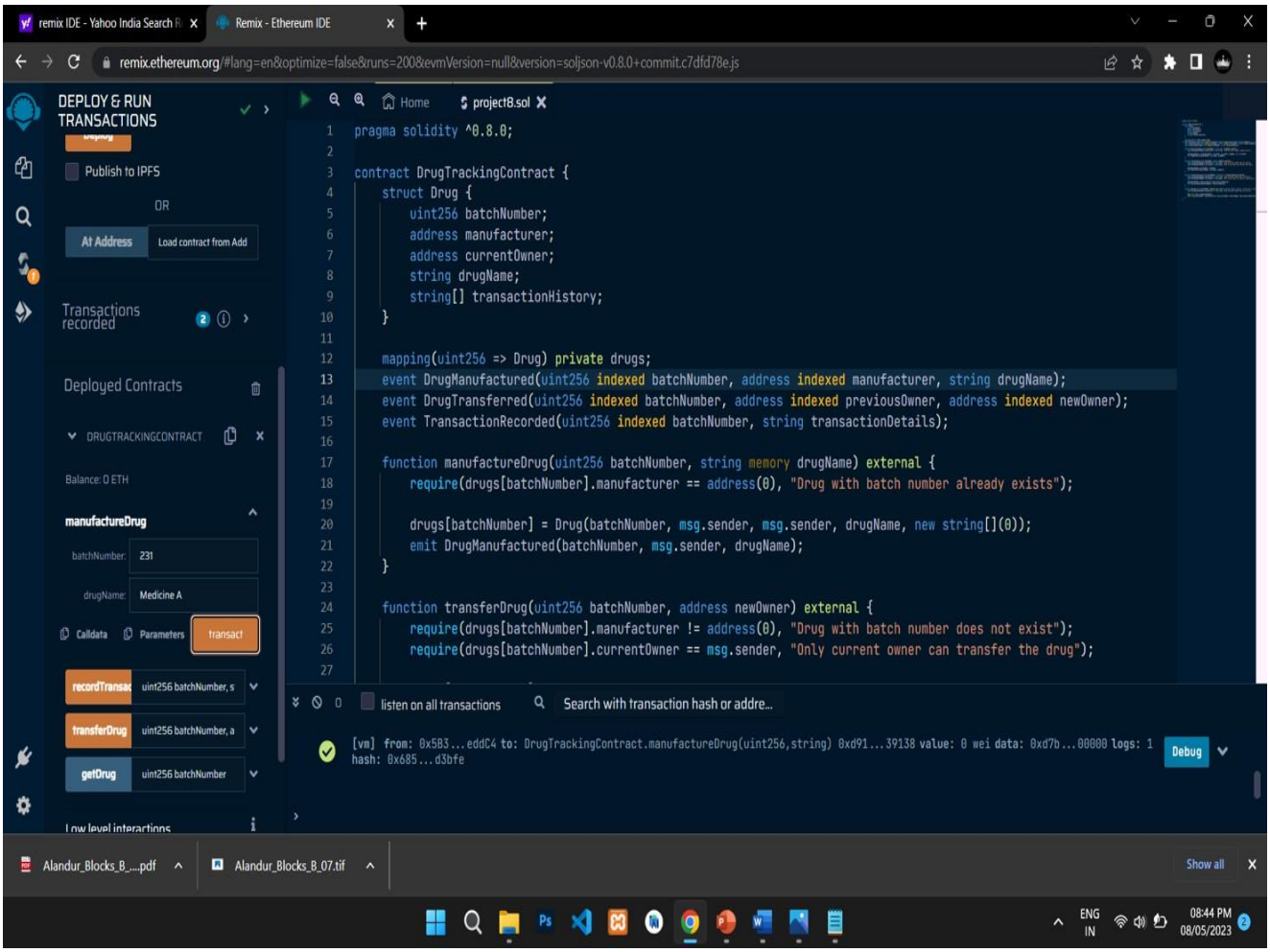


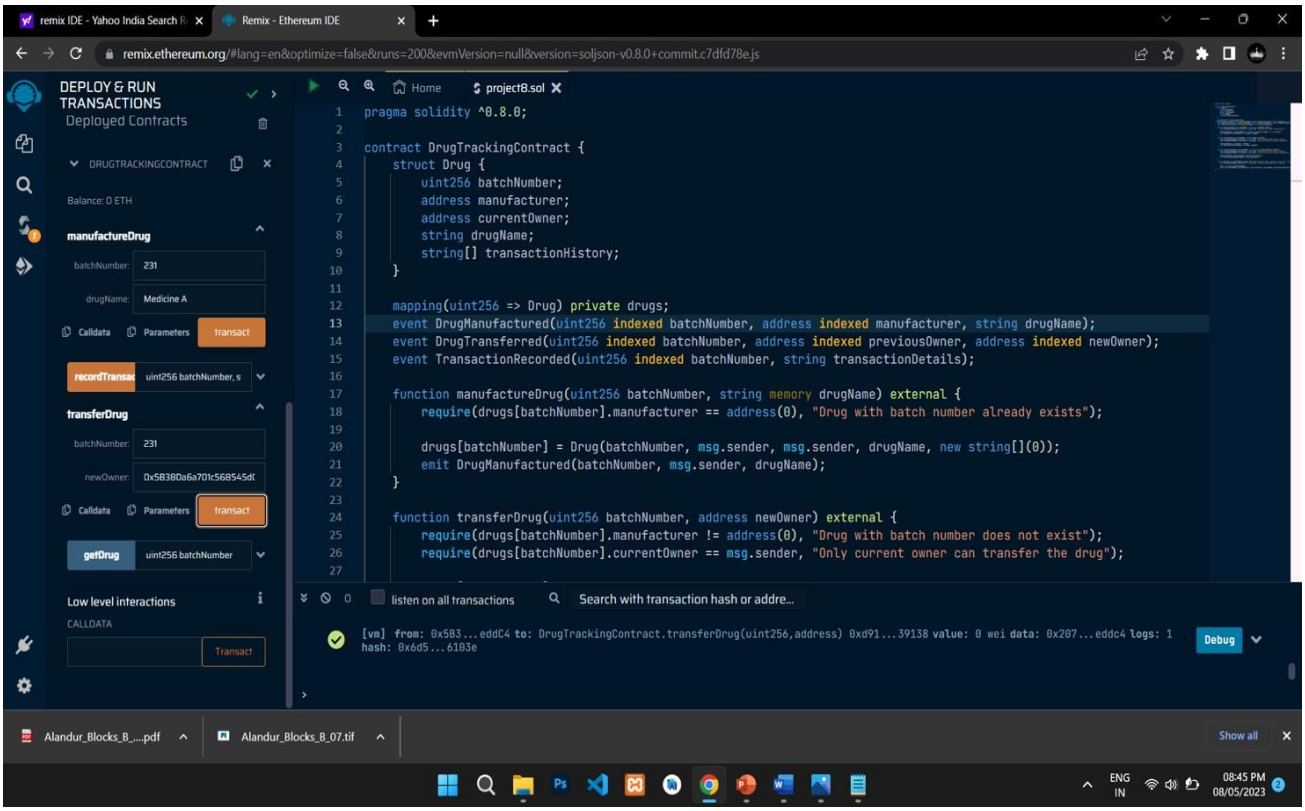
STEP 3:

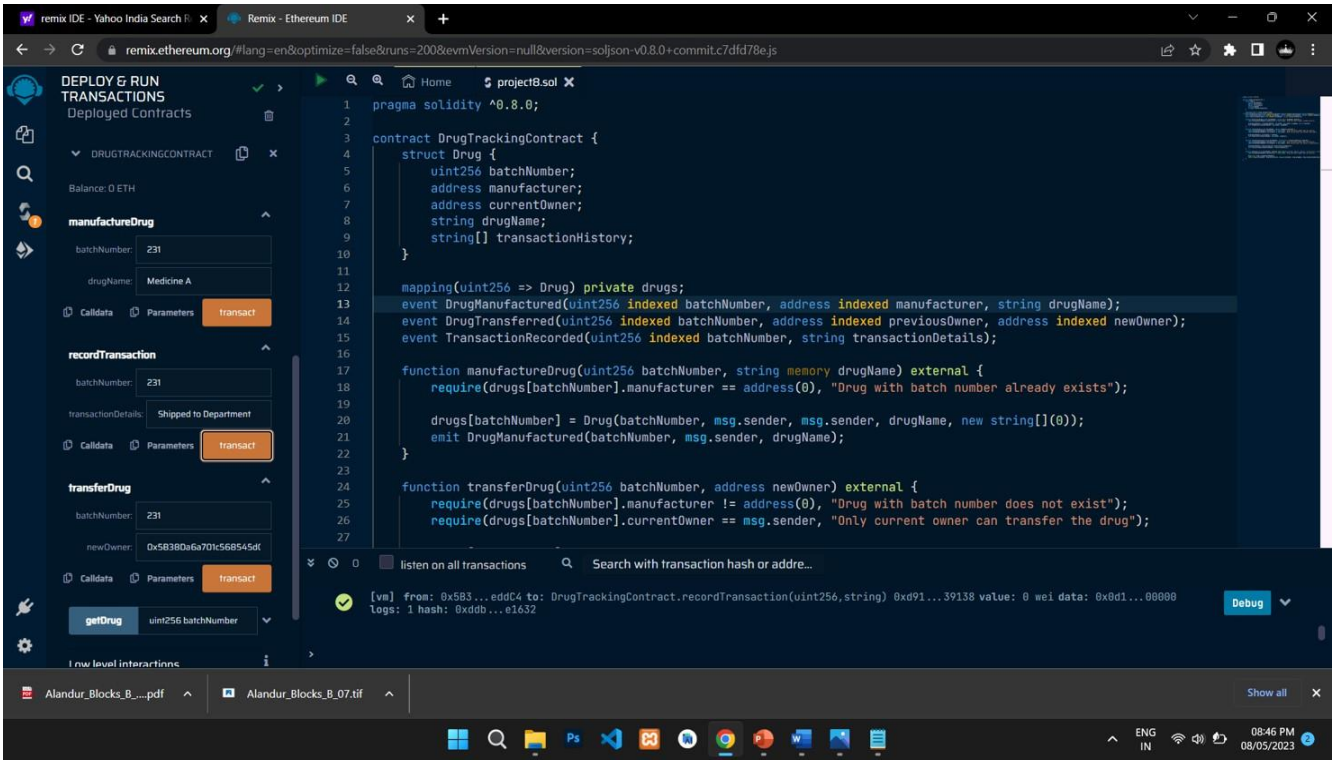
- Add the solidity code in the Filename. sol file.

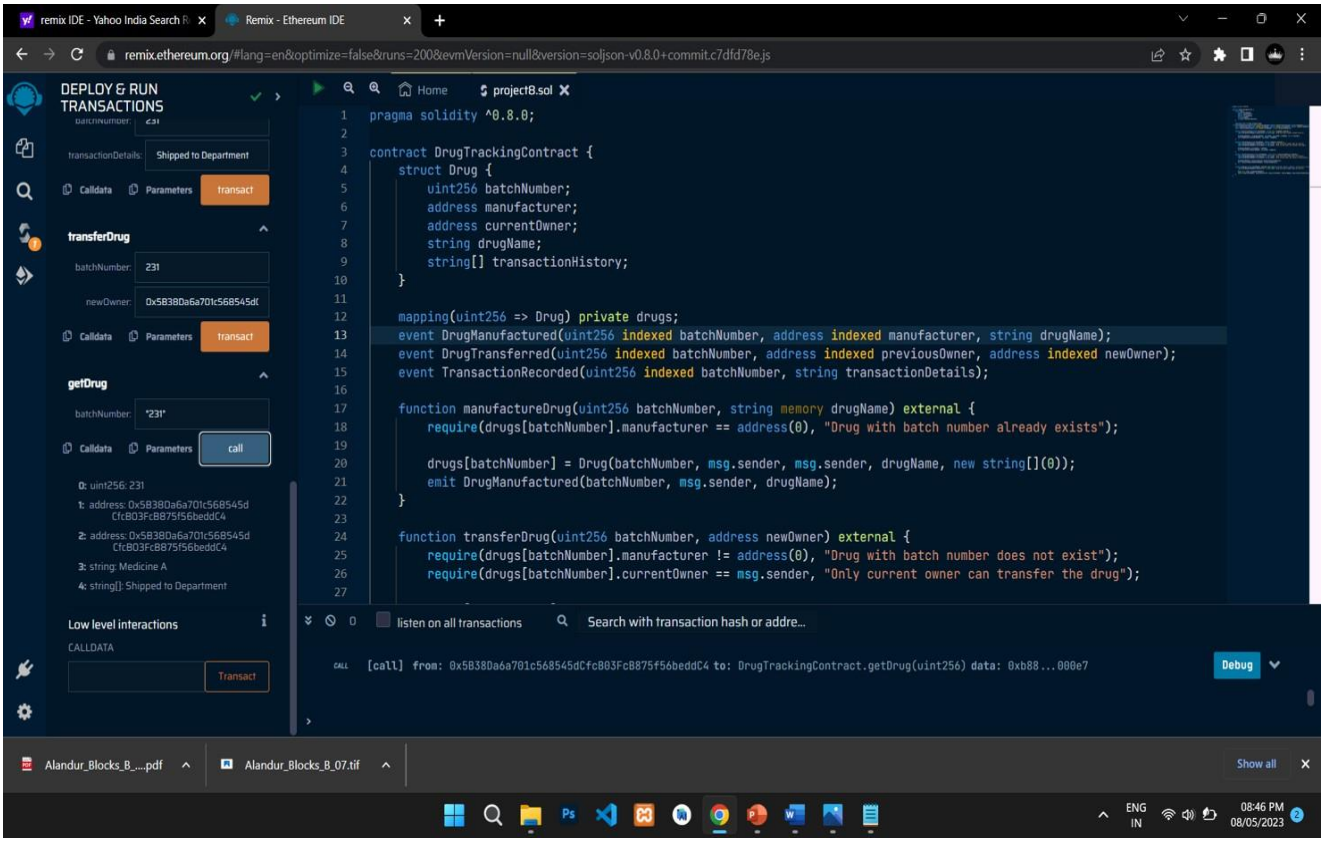


Step 4: Create a file in contract folder and paste the smart contract code in the file



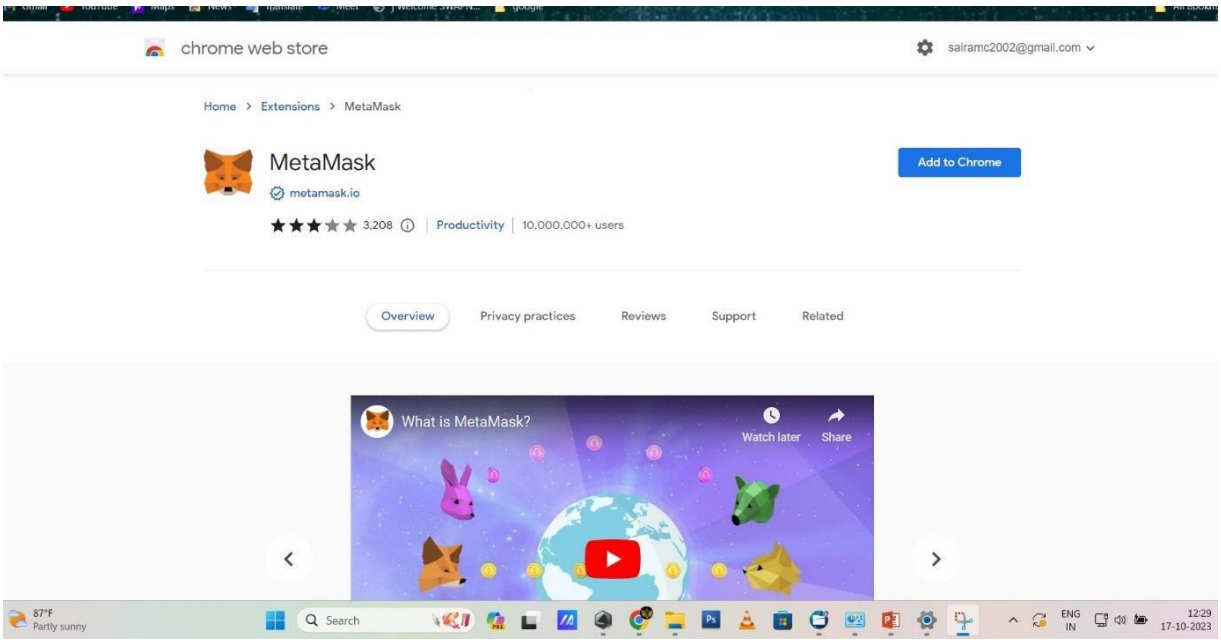

remix IDE - Yahoo India Search
Remix - Ethereum IDE
remix.ethereum.org/#lang=en&optimize=false&runs=200&evmVersion=null&version=soljson-v0.8.0+commit.c7dfd78e.js
DEPLOY & RUN TRANSACTIONS
Deployed Contracts
DRUGTRACKINGCONTRACT
Balance: 0 ETH
manufactureDrug
batchNumber: 231
drugName: Medicine A
Calldata
Parameters
transact
recordTransac
uint256 batchNumber, s
transferDrug
batchNumber: 231
newOwner: 0x5B38Da6a701c568545dC
Calldata
Parameters
transact
getDrug
uint256 batchNumber
Low level interactions
CALLDATA
Transact
Home
project8.sol
pragma solidity ^0.8.0;
contract DrugTrackingContract {
struct Drug {
uint256 batchNumber;
address manufacturer;
address currentOwner;
string drugName;
string[] transactionHistory;
}
mapping(uint256 => Drug) private drugs;
event DrugManufactured(uint256 indexed batchNumber, address indexed manufacturer, string drugName);
event DrugTransferred(uint256 indexed batchNumber, address indexed previousOwner, address indexed newOwner);
event TransactionRecorded(uint256 indexed batchNumber, string transactionDetails);
function manufactureDrug(uint256 batchNumber, string memory drugName) external {
require(drugs[batchNumber].manufacturer == address(0), "Drug with batch number already exists");
drugs[batchNumber] = Drug(batchNumber, msg.sender, msg.sender, drugName, new string[](0));
emit DrugManufactured(batchNumber, msg.sender, drugName);
}
function transferDrug(uint256 batchNumber, address newOwner) external {
require(drugs[batchNumber].manufacturer != address(0), "Drug with batch number does not exist");
require(drugs[batchNumber].currentOwner == msg.sender, "Only current owner can transfer the drug");
listen on all transactions
Search with transaction hash or addre...
[vm] from: 0x5B3...eddC4 to: DrugTrackingContract.transferDrug(uint256,address) 0xd91...39138 value: 0 wei data: 0x207...eddc4 logs: 1 hash: 0x6d5...6103e
Debug
Alandur_Blocks_B_....pdf
Alandur_Blocks_B_07.tif
Show all
ENG IN
08:45 PM 08/05/2023


remix IDE - Yahoo India Search
Remix - Ethereum IDE
remix.ethereum.org/#lang=en&optimize=false&runs=200&evmVersion=null&version=soljson-v0.8.0+commit.c7dfd78e.js
DEPLOY & RUN TRANSACTIONS
Deployed Contracts
DRUGTRACKINGCONTRACT
Balance: 0 ETH
manufactureDrug
batchNumber: 231
drugName: Medicine A
Calldata
Parameters
transact
recordTransaction
batchNumber: 231
transactionDetails: Shipped to Department
Calldata
Parameters
transact
transferDrug
batchNumber: 231
newOwner: 0x5B38Da6a701c568545dC
Calldata
Parameters
transact
getDrug
uint256 batchNumber
Low level interactions
Home
project8.sol
pragma solidity ^0.8.0;
contract DrugTrackingContract {
struct Drug {
uint256 batchNumber;
address manufacturer;
address currentOwner;
string drugName;
string[] transactionHistory;
}
mapping(uint256 => Drug) private drugs;
event DrugManufactured(uint256 indexed batchNumber, address indexed manufacturer, string drugName);
event DrugTransferred(uint256 indexed batchNumber, address indexed previousOwner, address indexed newOwner);
event TransactionRecorded(uint256 indexed batchNumber, string transactionDetails);
function manufactureDrug(uint256 batchNumber, string memory drugName) external {
require(drugs[batchNumber].manufacturer == address(0), "Drug with batch number already exists");
drugs[batchNumber] = Drug(batchNumber, msg.sender, msg.sender, drugName, new string[](0));
emit DrugManufactured(batchNumber, msg.sender, drugName);
}
function transferDrug(uint256 batchNumber, address newOwner) external {
require(drugs[batchNumber].manufacturer != address(0), "Drug with batch number does not exist");
require(drugs[batchNumber].currentOwner == msg.sender, "Only current owner can transfer the drug");
listen on all transactions
Search with transaction hash or addre...
[vm] from: 0x5B3...eddC4 to: DrugTrackingContract.recordTransaction(uint256,string) 0xd91...39138 value: 0 wei data: 0x0d1...00000 logs: 1 hash: 0xddb...e1632
Debug
Alandur_Blocks_B_....pdf
Alandur_Blocks_B_07.tif
Show all
ENG IN
08:46 PM 08/05/2023


remix IDE - Yahoo India Search R
Remix - Ethereum IDE
remix.ethereum.org/#lang=en&optimize=false&runs=200&evmVersion=null&version=soljson-v0.8.0+commit.c7dfd78e.js
DEPLOY & RUN TRANSACTIONS
transactionDetails: Shipped to Department
Calldata
Parameters
transact
transferDrug
batchNumber: 231
newOwner: 0x5B38Da6a701c568545dC
getDrug
batchNumber: "231"
call
0: uint256: 231
1: address: 0x5B38Da6a701c568545d CfcB03FcB875f56beddC4
2: address: 0x5B38Da6a701c568545d CfcB03FcB875f56beddC4
3: string: Medicine A
4: string[]: Shipped to Department
Low level interactions
CALLDATA
Transact
Home
project8.sol
pragma solidity ^0.8.0;
contract DrugTrackingContract {
struct Drug {
uint256 batchNumber;
address manufacturer;
address currentOwner;
string drugName;
string[] transactionHistory;
}
mapping(uint256 => Drug) private drugs;
event DrugManufactured(uint256 indexed batchNumber, address indexed manufacturer, string drugName);
event DrugTransferred(uint256 indexed batchNumber, address indexed previousOwner, address indexed newOwner);
event TransactionRecorded(uint256 indexed batchNumber, string transactionDetails);
function manufactureDrug(uint256 batchNumber, string memory drugName) external {
require(drugs[batchNumber].manufacturer == address(0), "Drug with batch number already exists");
drugs[batchNumber] = Drug(batchNumber, msg.sender, msg.sender, drugName, new string[](0));
emit DrugManufactured(batchNumber, msg.sender, drugName);
}
function transferDrug(uint256 batchNumber, address newOwner) external {
require(drugs[batchNumber].manufacturer != address(0), "Drug with batch number does not exist");
require(drugs[batchNumber].currentOwner == msg.sender, "Only current owner can transfer the drug");
listen on all transactions
Search with transaction hash or addre...
[call] from: 0x5B38Da6a701c568545dCfcB03FcB875f56beddC4 to: DrugTrackingContract.getDrug(uint256) data: 0xb88...000e7
Debug
Alandur_Blocks_B_....pdf
Alandur_Blocks_B_07.tif
Show all
ENG IN
08:46 PM 08/05/2023

METAMASK EXTENIONS;

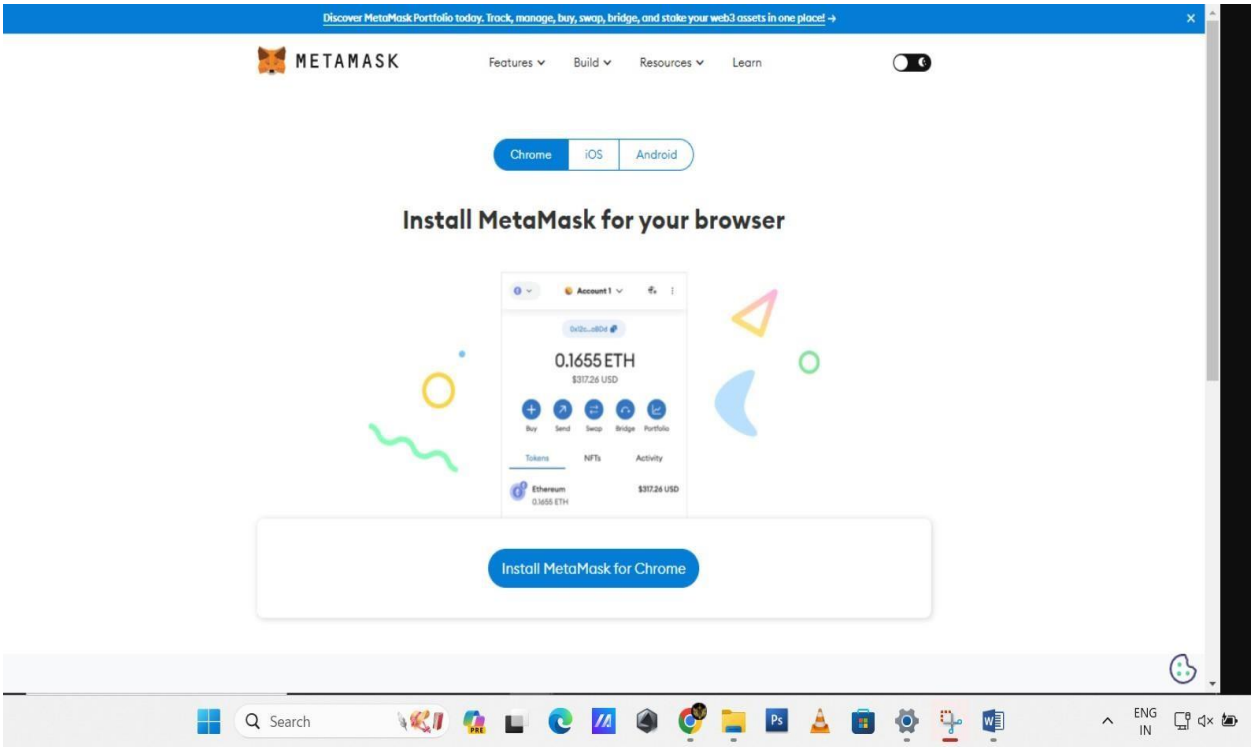
STEP1 : Open Meta Mask by clicking on link : https://metamask.io/

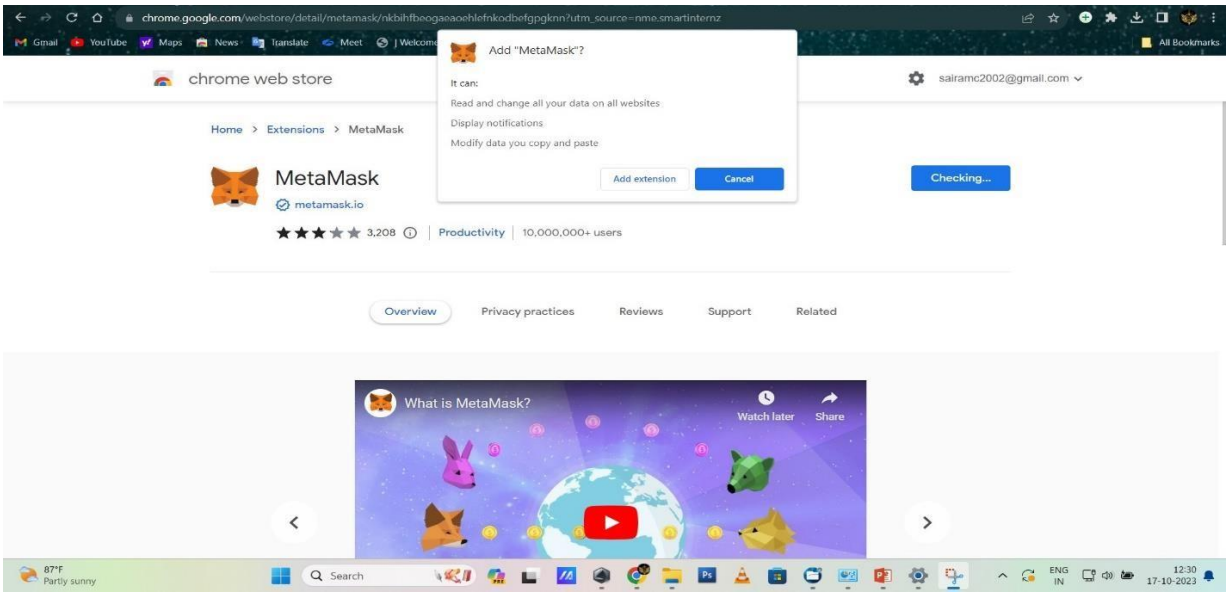


STEP 2 : Click on “Get start” and “ I Agree” and download.

STEP 3: Either click 'Get' or tap on the name of the app to see more details. Completethe usual App Store download confirmation process.

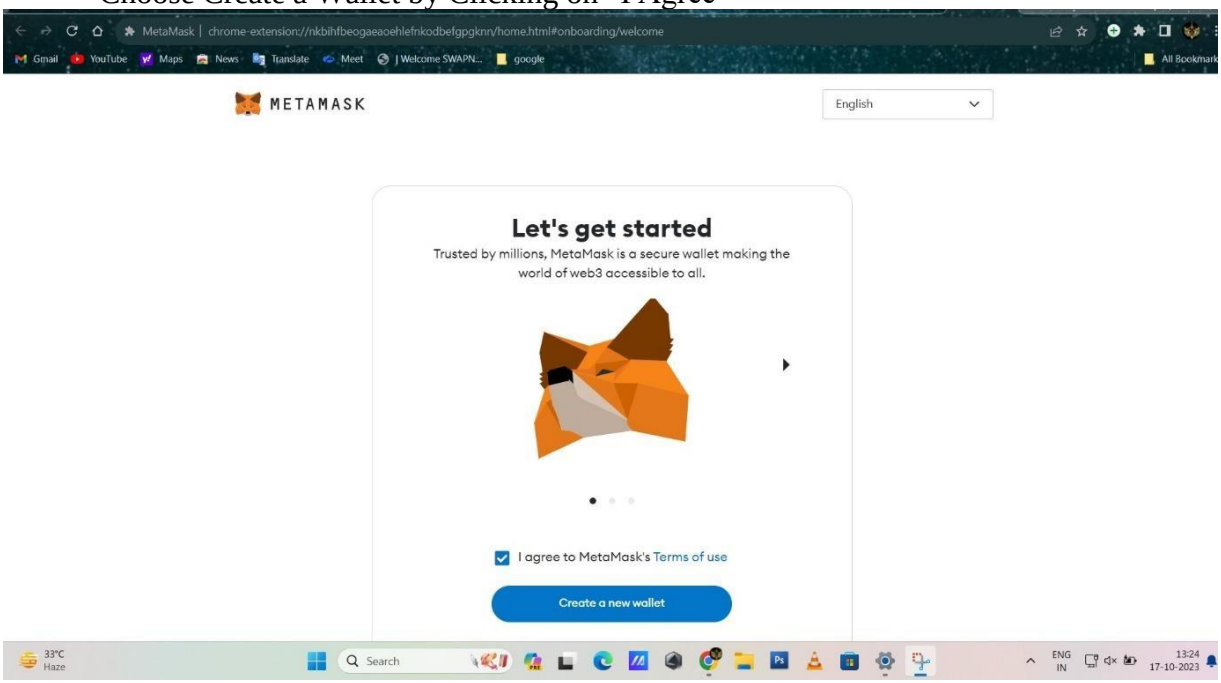
- Once installed, open the app and follow the prompts to create your wallet.
- Back up your Secret Recovery Phrase somewhere safe and offline!
- Create Password and agree to the document.
- Click on next. And relieve
- Copy paste in notepad “all the letters”
- Click on next
- Arrange all the words in the same order as in the notepad.
- Confirm
- All done
- **Install MetaMask for your browser**



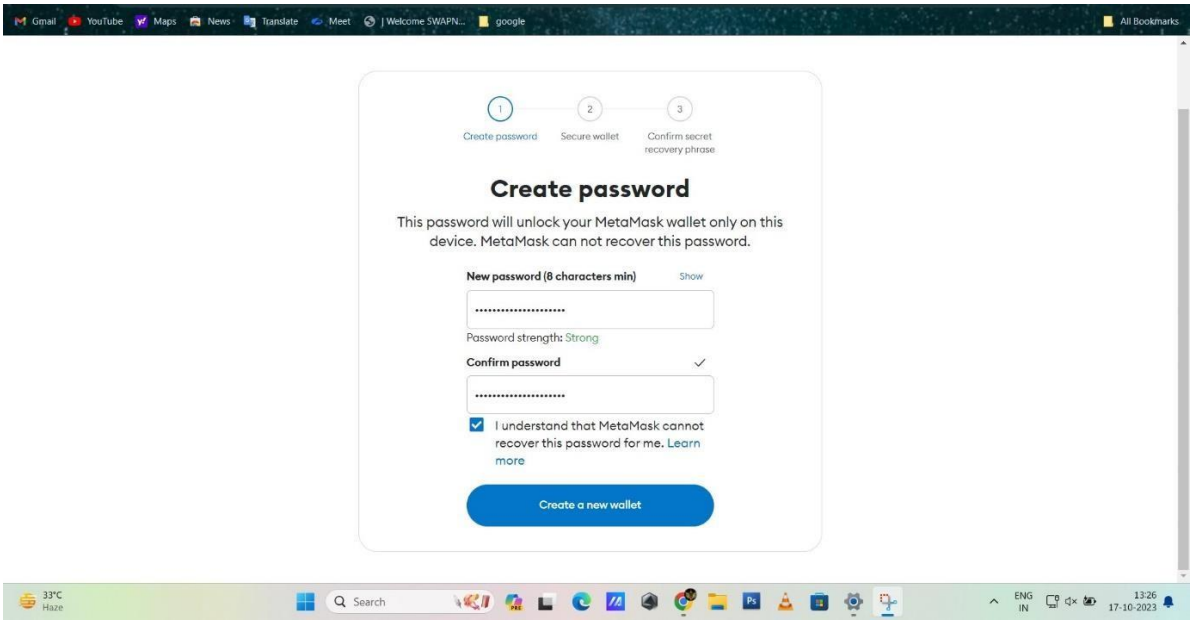


- Click “Add to Add MetaMask Extension and confirm the pop up. Tap AddExtension and Click on get started

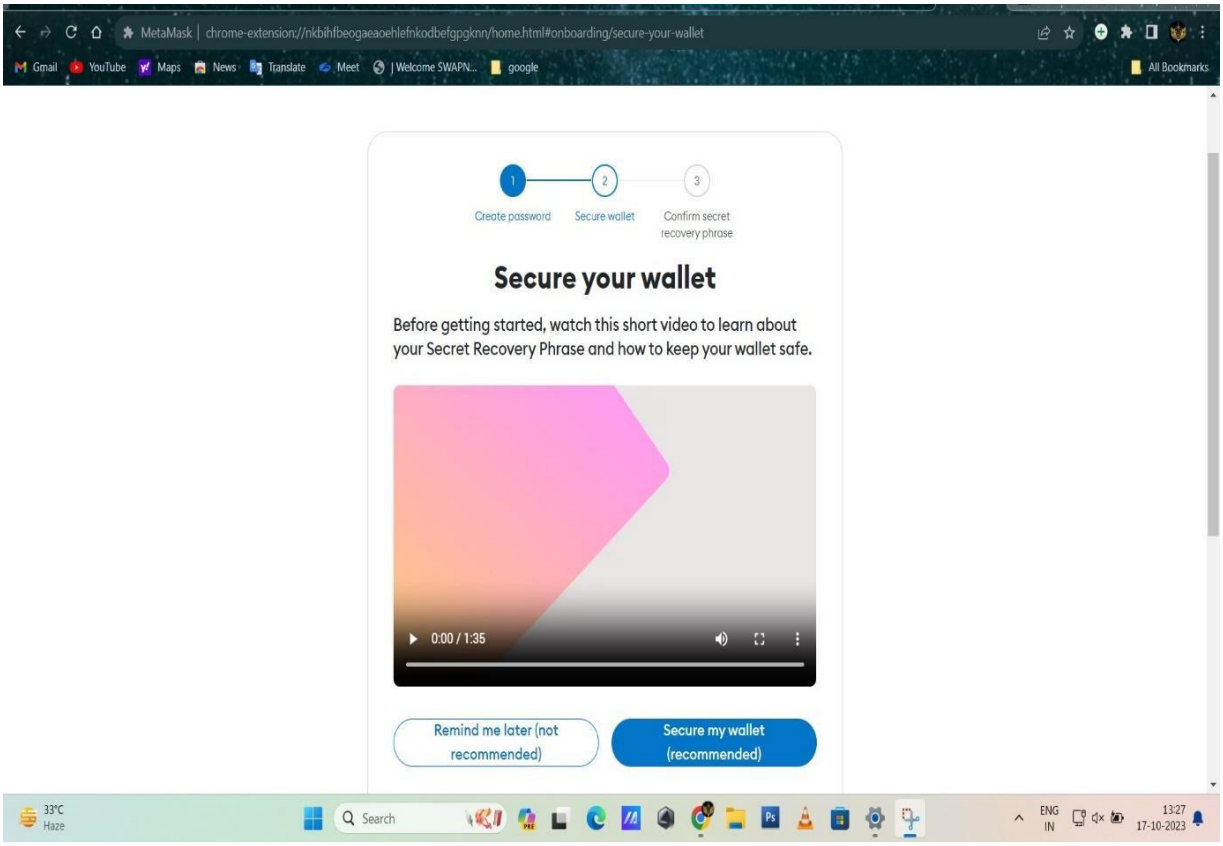
- Choose Create a Wallet by Clicking on “I Agree”



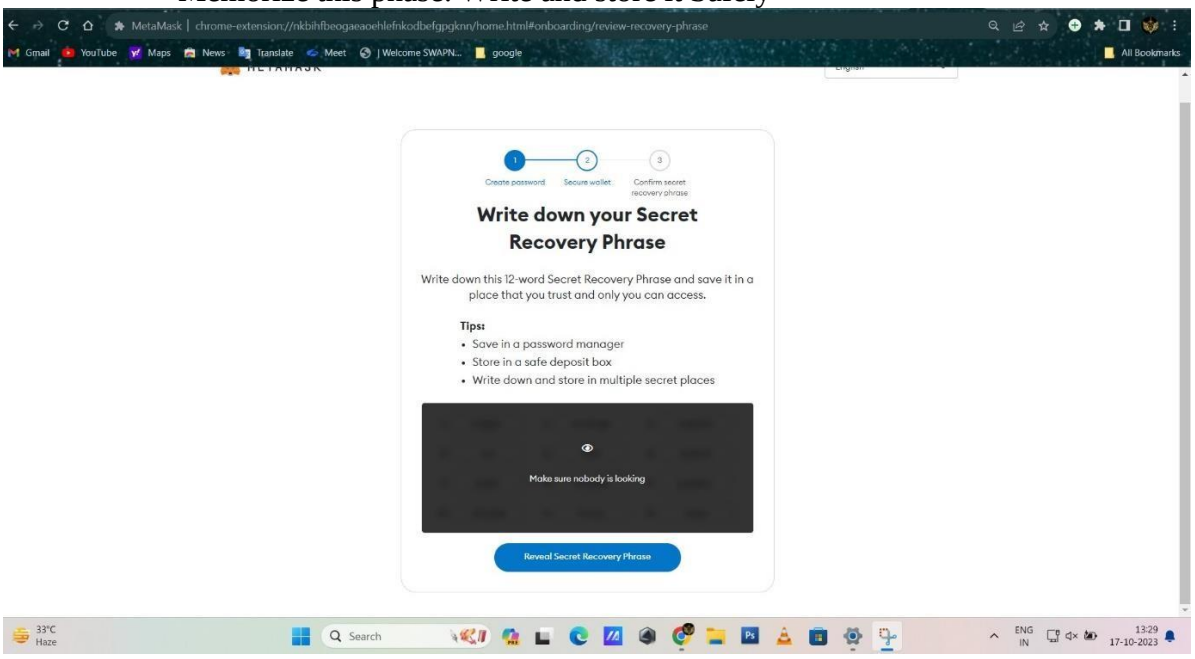
- Click on Create to set up password



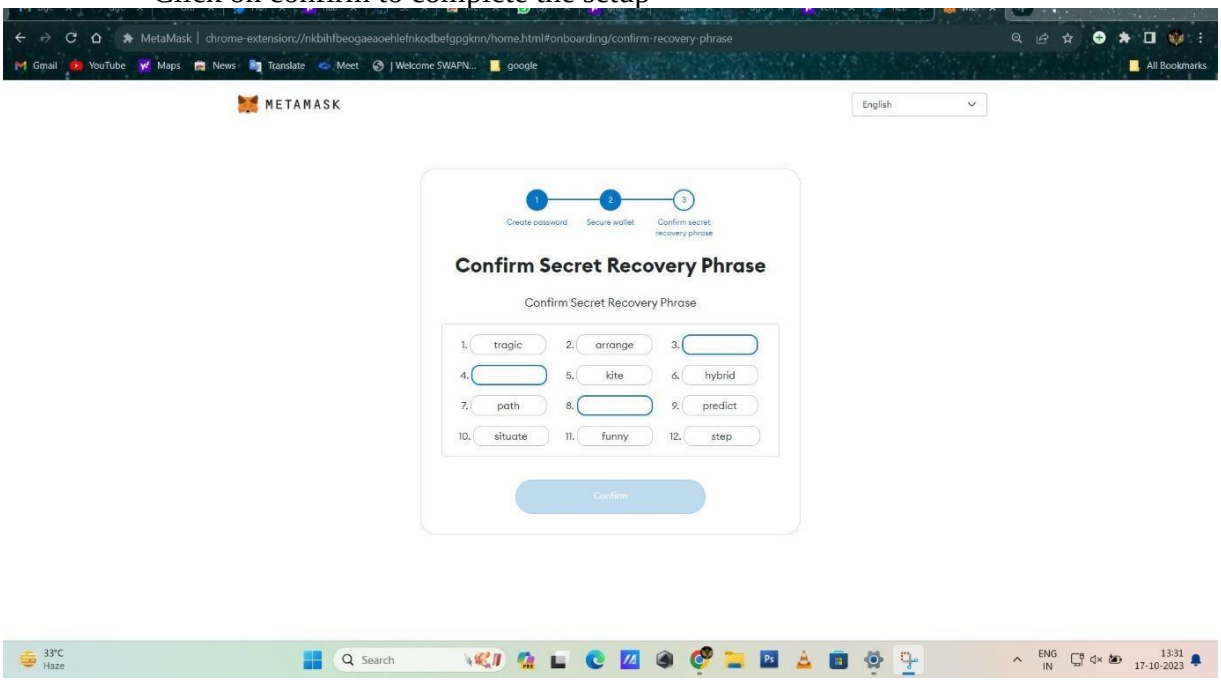
- Click on next.



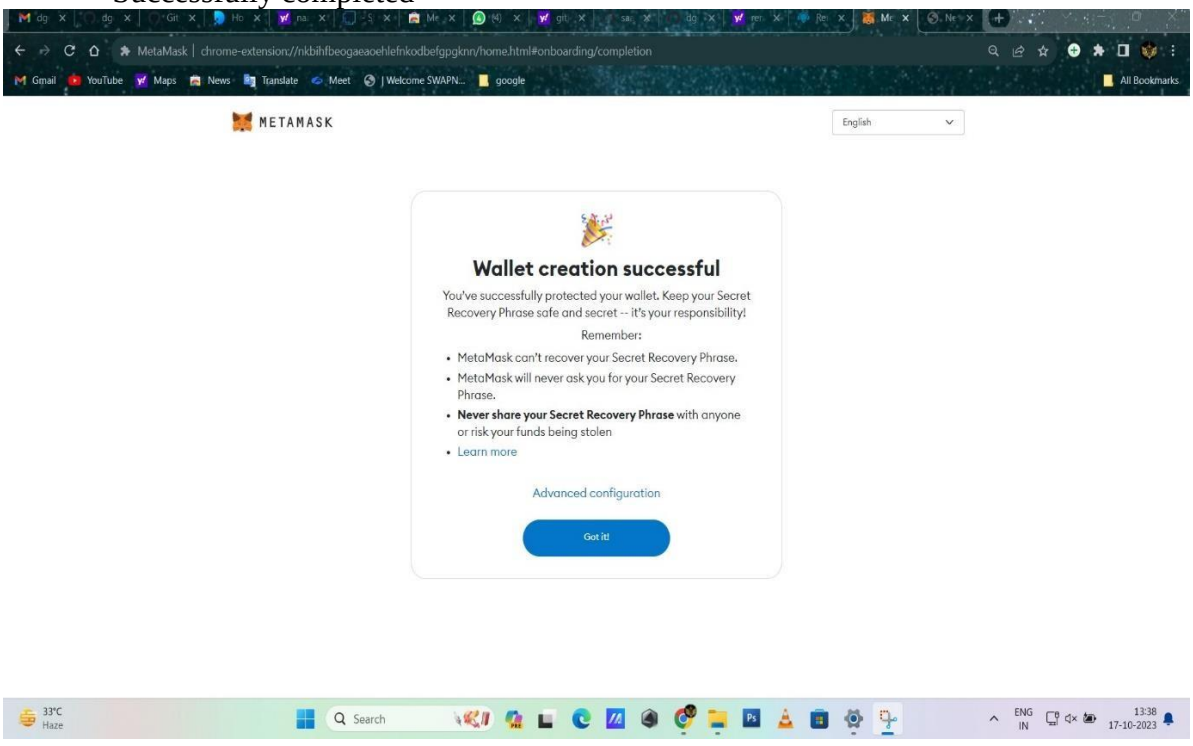
- IMPORTANT! Tap Click Here to Reveal Secret Words
- Memorize this phase. Write and store it Safely

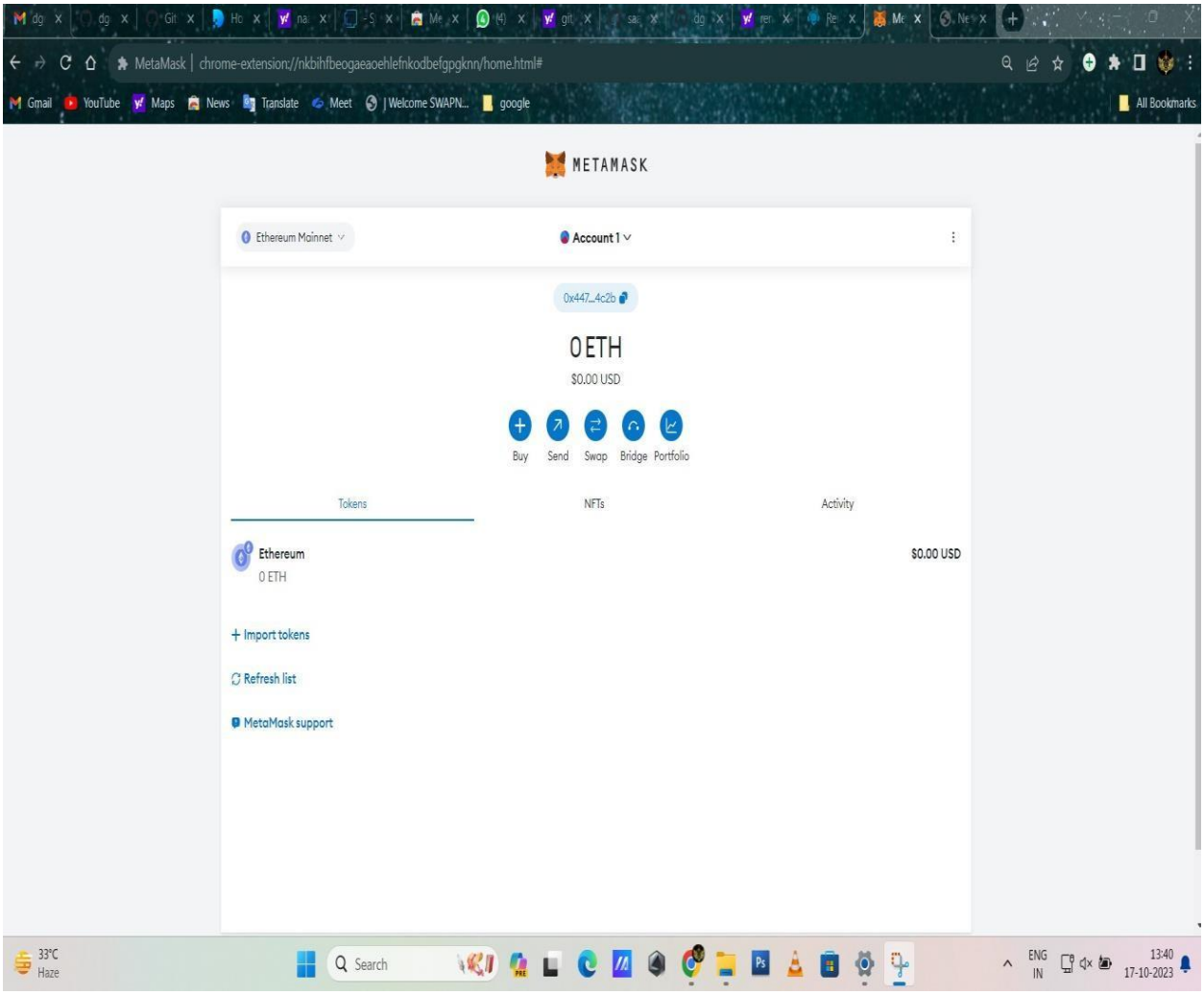


- Confirm your secret Recovery Phrase by Selecting each phrase in order
- Click on confirm to complete the setup



- Successfully completed




MetaMask | chrome-extension://nkbihfbeogaeaoehlefnkodbefgpgknn/home.html#
Gmail
YouTube
Maps
News
Translate
Meet
| Welcome SWAPN...
google
All Bookmarks
METAMASK
Ethereum Mainnet
Account 1
0x447...4c2b
0 ETH
$0.00 USD
Buy
Send
Swap
Bridge
Portfolio
Tokens
NFTs
Activity
Ethereum
0 ETH
$0.00 USD
+ Import tokens
Refresh list
MetaMask support
33°C
Haze
Search
ENG
IN
13:40
17-10-2023

DRUG TRACEABILITY

PROGRAM:

```
// SPDX-License-
Identifier: MIT
pragma solidity
^0.8.0;

contract Drug{
  address
    public
    owner;
    constructo
    r() { owner
    =
    msg.send
    er;
  }

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

     struct
    Drug {
    string
    drugNa
    me;
    string
    manufacturer;
    uint256
    manufacturingD
    ate;     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
    initialHistor
    y;
```

```
        initialHistor
        y = 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);
    }
}
```

DRUG TRACEBILITY

CONNECTOR CODE;

```
const { ethers } = require("ethers");

const abi = [
 {
  "inputs": [],
  "stateMutability": "nonpayable",
  "type": "constructor"
 },
 {
  "anonymous": false,
  "inputs": [
   {
    "indexed": true,
    "internalType": "uint256",
    "name": "drugId",
    "type": "uint256"
   },
   {
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 "stateMutability": "nonpayable",
 "type": "function"
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]
```

```
if (!window.ethereum) {
 alert('Meta Mask Not Found')
 window.open("https://metamask.io/download/")
}
```

```
export const provider = new ethers.providers.Web3Provider(window.ethereum);
export const signer = provider.getSigner();
export const address = "0x7Ab3F242E762f4611A1404E5A9E9D6f93d9D562F"
```

```
export const contract = new ethers.Contract(address, abi, signer)
```

IMPLEMENTATION OF SMART CONTRACT:

The health care supply chain is a complex system that involves obtaining resources, managing supplies, and delivering goods and services to patients across multiple teams, stakeholders, and geographical boundaries. With such a complex structure, the healthcare supply chain is vulnerable to fraud, inaccurate data, and lack of transparency. To address these issues, the health care supply chain needs an end-to-end decentralized track-and-trace system. Most centralized systems risk drug and data safety.

One solution to this problem is the implementation of block chain technology. Block chain technology provides a secure and transparent way to track and trace drugs in the health care supply chain. Smart contracts can be used to automate agreement execution so all parties know the outcome instantly, without an intermediary or time loss. This ensures that all parties involved in the supply chain have access to the same information and can make informed decisions.

It presents an Ethereum block chain-based solution for a health care supply chain track-and-trace mechanism that uses smart contracts and data immutability. Hash functions store data in a public distributed ledger. This protects and discloses data. The proposed system tracks goods' histories (medicine). The average gas cost for all accounts is 18,027.2. Overall, log gas costs 48,118.6 to buy medicine, gas costs 229,607.5, and to log out 14,275.

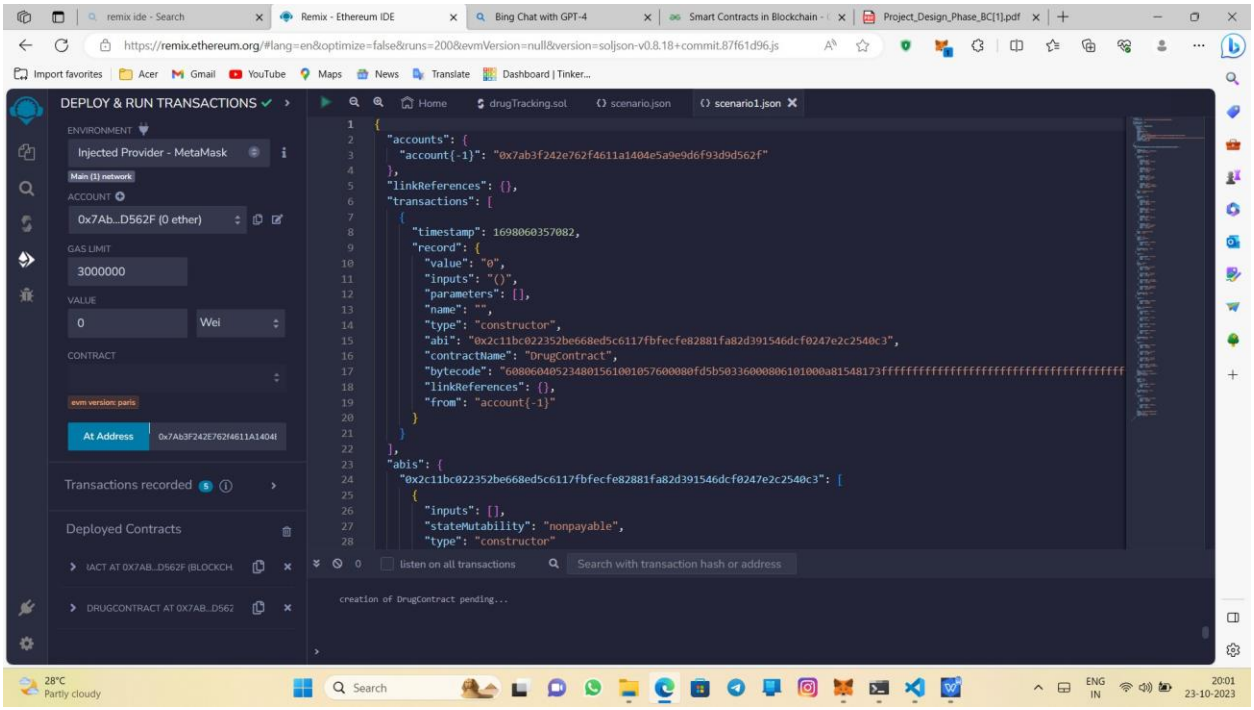
It presents an Ethereum block chain-based approach leveraging smart contracts and decentralized off-chain storage for efficient product traceability in the health care supply chain.

Thus, block chain technology can be used to create a secure and transparent drug trace ability system in the health care supply chain.

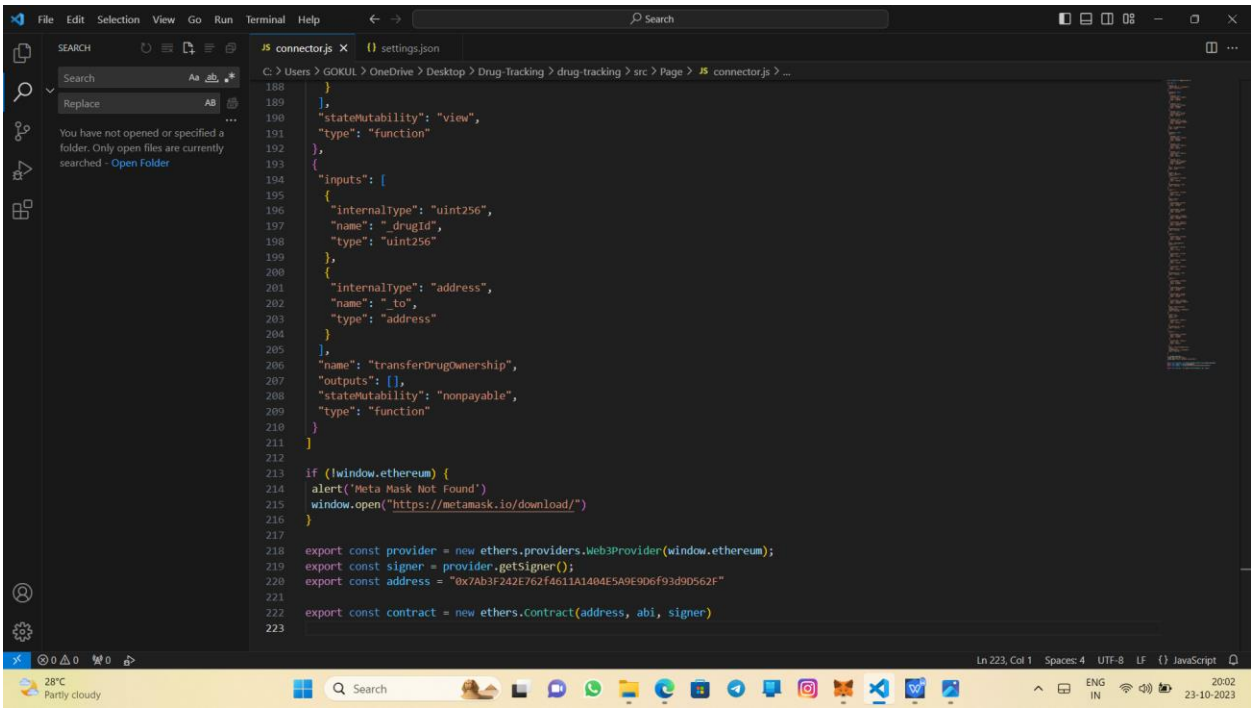
Implementing smart contracts in drug traceability on the block chain is a trans formative approach to ensuring the safety and authenticity of pharmaceutical products. Smart contracts automate and secure various aspects of the drug supply chain, from manufacturing and distribution to prescription and dispensing. Each step in the process is recorded on the block chain, providing an immutable and transparent ledger. This ensures that drugs can be traced back to their source, helping to prevent counterfeit medications from entering the market. Additionally, smart contracts can facilitate real-time verification, reducing the risk of drug recalls, enhancing patient safety, and improving compliance with regulatory standards, ultimately revolutionist pharmaceutical trace ability and safety.

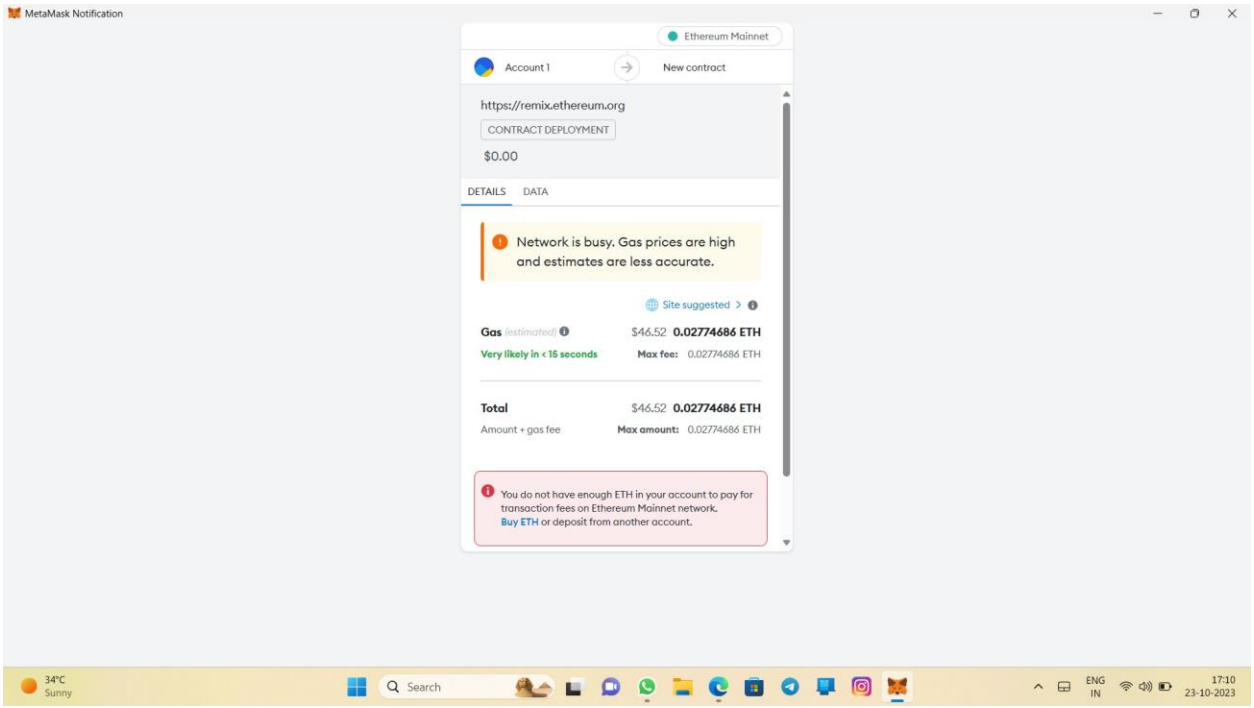
A smart contract in drug traceability on the block chain is a self-executing digital agreement designed to enhance the security and transparency of pharmaceutical supply chains. These contracts encode and automate the tracking and verification of pharmaceutical products at each

stage of the supply chain. By recording crucial data on the block chain, such as manufacturing details, shipping, and distribution, smart contracts ensure a tamper-resistant and immutable ledger. This empowers stakeholders to verify the authenticity and safety of drugs, preventing counterfeits from entering the market. Smart contract-based drug traceability thus safeguards patient health, streamlines compliance with regulatory requirements, and establishes trust among all participants in the pharmaceutical industry.



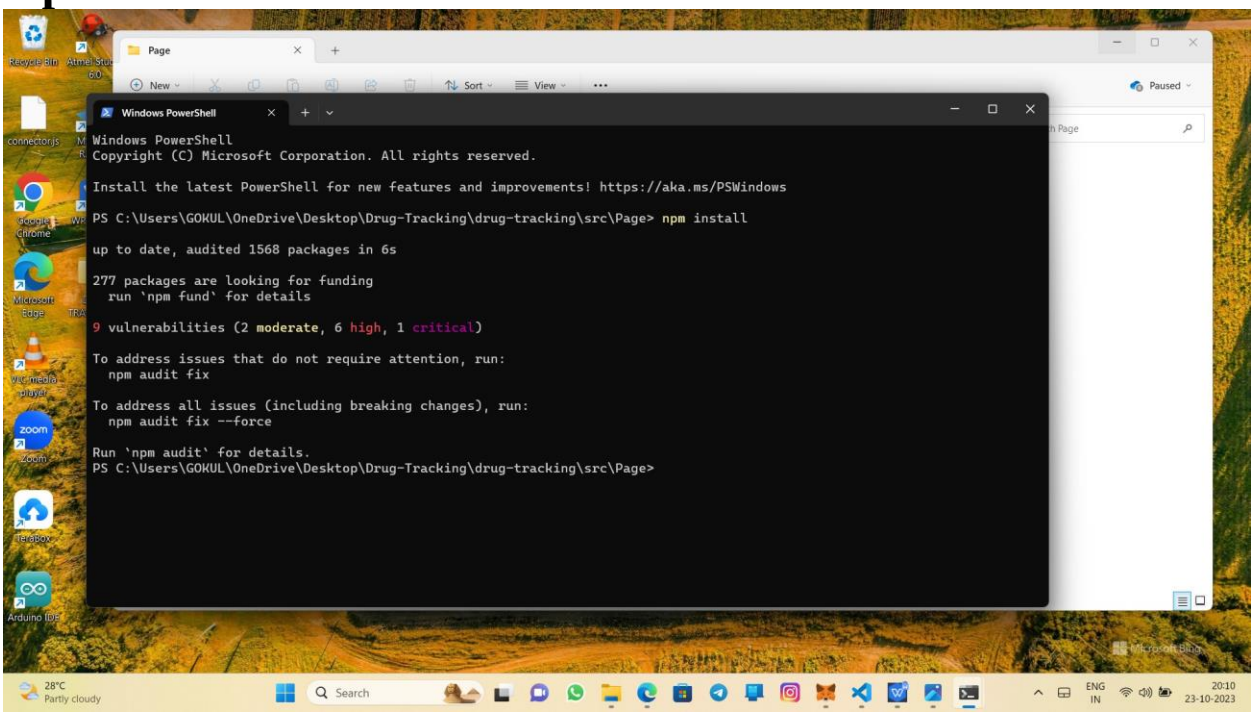
PASTE THE NEW CONTRACT ADDRESS:



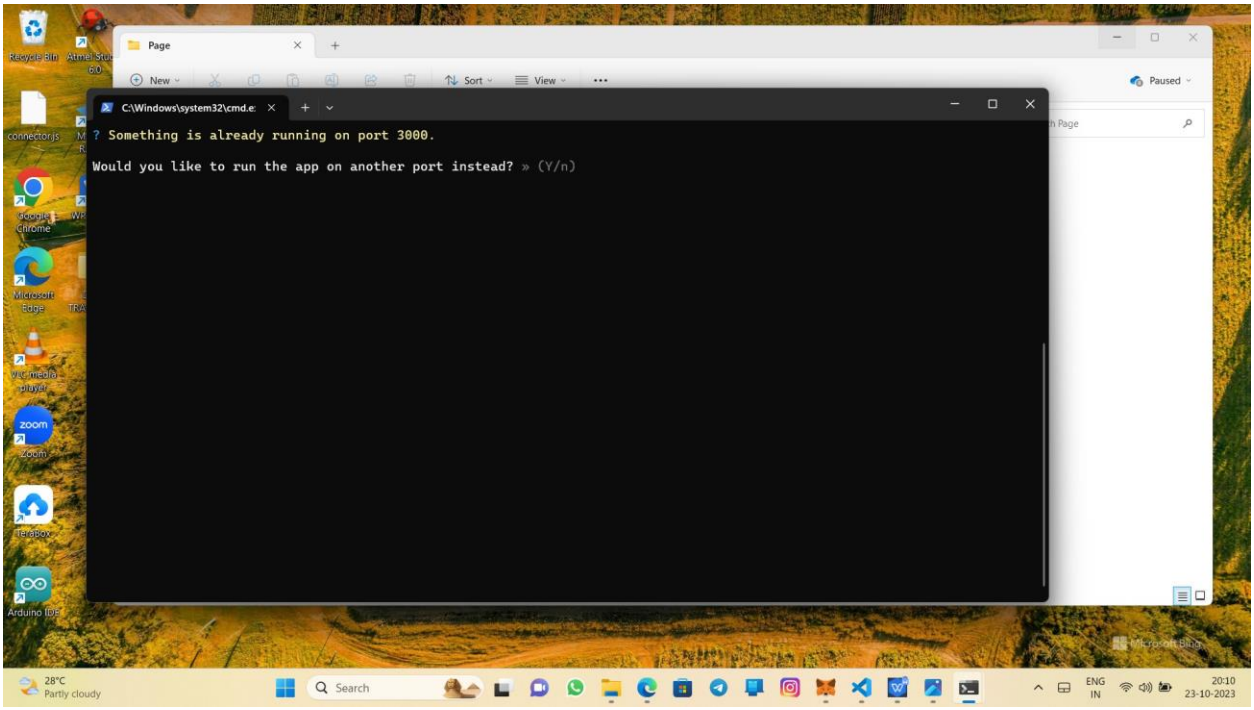


USING FILE CONNECTOR.JS:

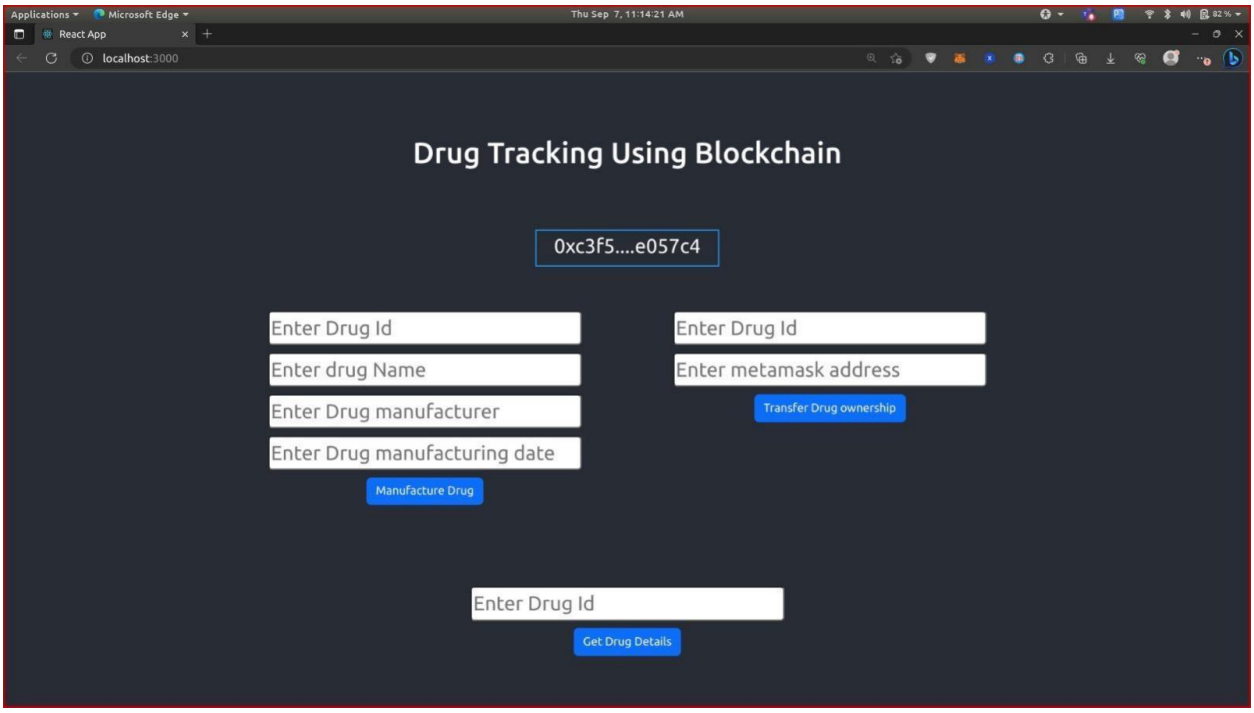
npm install:



Npm run start:



INTERACTION WITH FRONTEND;



ADVANTAGES;

In addition, digitizing track and trace process provides significant benefit for regulatory oversight and ensures product safety. Blockchain-based drug traceability offers a potential solution to create a distributed shared data platform for an immutable, trustworthy, accountable and transparent system in the PSC.

DISADVANTAGES;

Immutability: Blockchains are immutable where any information appended to the ledger cannot be altered or removed. While this can be beneficial for data integrity, it presents a major challenge, there is no way to correct inaccuracies on a blockchain because they are immutable.

CONCLUSION;

In this paper, we have investigated the challenge of drug traceability within pharmaceutical supply chains highlighting its significance especially to protect against counterfeit drugs. We have developed and evaluated a blockchain-based solution for the pharmaceutical supply chain to track and trace drugs in a decentralized manner. Specifically, our proposed solution leverages cryptographic fundamentals underlying blockchain technology to achieve tamper-proof logs of events within the supply chain and utilizes smart contracts within Ethereum blockchain to achieve automated recording of events that are accessible to all participating stakeholders.

We have demonstrated that our proposed solution is cost efficient in terms of the amount of gas spent in executing the different functions that are triggered within the smart contract. Moreover, the conducted security analysis has shown that our proposed solution achieves protection against malicious attempts targeting is integrity, availability and nonrepudiation of transaction data which is critical in a complex multi-party settings such as the pharmaceutical supply chain.

We continue our efforts to enhance the efficiency of pharmaceutical supply chains and envision to focus on extending the proposed system to achieve end to end transparency and verifiability of drugs use as future work.

FUTURE SCOPE;

It is anticipated that the implementation of blockchain technology will enhance the traceability and authenticity of the pharmaceutical supply chain [43–45]. As prescription pharmaceuticals gain wider usage, blockchain technology has the potential to effectively monitor all the adverse impacts associated with them.

APPENDIX;

GitHub; https://github.com/dgokulsai/NM2023TMID06560/tree/main

Project Demo Link; https://youtube.com/watch?v=UNS9m6JYEjc&si=NHdxZa6HLOspZS4b