

| **Title: Prepare problem specification related to your mini project** |
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**Expected Outcome of Experiment:**

|  | **At the end of successful completion of the course the student will be able to** |
| --- | --- |
| CO1 | Define the problem statement and scope of problem |
| CO2 | Identify various hardware and software requirements for problem solution |
| CO5 | Prepare a technical report based on the Mini project. |

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**Books/ Journals/ Websites referred:**

**1. Somaiya Library**

**2. https://ieeexplore.ieee.org/**

**3. https://www.acm.org/**

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**Introduction:** Developing a successful software product requires a systematic approach, as studied in Software Engineering. The software development life cycle (SDLC) ensures a structured methodology to build reliable, scalable, and efficient applications. This experiment aims to prepare the foundational documents necessary for developing a software system, website, or mobile application that delivers essential services or functionalities. By following best practices in software engineering, we ensure clarity in requirements, structured development, and well-documented implementation processes.

This project specifically focuses on developing a **decentralized pharmaceutical supply chain management system using blockchain technology**. The pharmaceutical industry is one of the most critical sectors affecting human lives, yet it faces major challenges, including counterfeit drugs, inefficiency, and lack of transparency. Blockchain technology provides an innovative solution by offering a decentralized, tamper-proof, and transparent ledger to track drug movement securely across the supply chain.

The system we propose will ensure authenticity verification, real-time tracking, and an immutable record of transactions from manufacturers to end consumers. This will significantly reduce the risks of counterfeit drugs, streamline supply chain operations, and enhance trust among all stakeholders involved in the pharmaceutical ecosystem.

**Problem Statement:** The pharmaceutical supply chain faces several critical challenges, including **inefficiency, lack of transparency, and the proliferation of counterfeit drugs**. These issues not only compromise patient safety but also lead to significant financial losses for pharmaceutical companies, distributors, and retailers. Currently, **centralized supply chain management systems are prone to fraud, errors, and operational delays**, lacking a secure method to track and verify the movement of drugs from production to final delivery.

A **decentralized pharmaceutical supply management system using blockchain technology** is needed to address these challenges. Blockchain offers a **secure, transparent, and tamper-proof ledger** where each transaction is recorded and verified across multiple nodes, ensuring data integrity and authenticity. By integrating blockchain with smart contracts, we can **automate and enforce compliance in the supply chain**, reducing human intervention and minimizing errors. This solution will ultimately **enhance patient safety, improve operational efficiency, and restore trust in the pharmaceutical supply chain.**

**Motivation:**

1. **Public Health and Safety:** Counterfeit drugs pose severe risks, including adverse health effects, treatment failures, and even fatalities.
2. **Lack of Transparency:** Many pharmaceutical supply chains lack a clear, verifiable tracking system, leading to inefficiencies and financial losses.
3. **Advancements in Blockchain:** The inherent features of blockchain, such as immutability, transparency, and decentralization, make it a promising solution for supply chain integrity.
4. **Regulatory Compliance:** Governments and healthcare organizations worldwide are implementing stricter regulations to combat counterfeit drugs. A blockchain-based system will help meet compliance standards more effectively.
5. **Enhanced Trust and Accountability:** Providing a secure and verifiable tracking system ensures that all stakeholders, including manufacturers, distributors, pharmacies, and consumers, can trust the authenticity of pharmaceutical products.

**Objectives of the Project:**

1. **Develop a decentralized system using blockchain technology** to track the journey of pharmaceutical drugs from manufacturing to end consumers.
2. **Ensure transparency and immutability of supply chain data**, preventing unauthorized modifications or tampering.
3. **Authenticate and verify drug legitimacy** through blockchain-based digital signatures and product serialization.
4. **Streamline inventory management** using blockchain-powered automation to optimize stock levels and reduce wastage.
5. **Enhance stakeholder trust** by providing real-time access to verifiable supply chain records for manufacturers, wholesalers, pharmacies, and consumers.
6. **Integrate smart contracts** to automate compliance checks and transactions, reducing administrative overhead and manual intervention.

**Scope of the Project:**

1. **Drug Tracking:** The system will provide end-to-end tracking of pharmaceutical products from manufacturers to consumers.
2. **Blockchain Ledger:** Every transaction will be recorded on a **secure and tamper-proof blockchain ledger**, ensuring transparency and accountability.
3. **Product Authentication:** Unique product identifiers (QR codes, RFID tags) will be used for verifying drug authenticity at every stage of the supply chain.
4. **Stakeholder Access:** Manufacturers, distributors, pharmacies, and consumers will have role-based access to relevant supply chain data.
5. **Web-Based Application:** The system will be accessible via a **user-friendly web application**, ensuring seamless interaction for all stakeholders.
6. **Scalability:** The project will be designed to **scale for multiple regions and regulatory requirements**, making it adaptable to different markets.

**Hardware Requirements (For Development):**

* **Processor:** Intel i5 or higher - Ensures smooth execution of development tools, blockchain nodes, and API services.
* **RAM:** 8GB or higher - Required for efficient handling of multiple applications, including blockchain processes.
* **Storage:** 256GB SSD or higher - Ensures faster read/write operations, critical for processing blockchain transactions.
* **Internet Connection:** Stable high-speed connection - Necessary for real-time blockchain transactions and data synchronization.

***Justification:*** A powerful processor and sufficient RAM ensure optimal performance of blockchain nodes and development tools. SSD storage improves data access speeds, and a high-speed internet connection is essential for seamless blockchain interactions.

**Software Requirements (For Development):**

* **Frontend:** React with TypeScript - For building an interactive and responsive user interface.
* **Backend:** Node.js - Handles server-side logic, API requests, and integration with blockchain networks.
* **Blockchain Platform:** Ethereum - Ensures secure, decentralized transaction management.
* **Database:** MongoDB - Stores non-blockchain data such as user profiles, order history, and logs.
* **Smart Contracts:** Solidity - Used to write and deploy smart contracts for secure and automated transactions.
* **Tools:** Remix - For writing, testing, and deploying smart contracts.
* **Version Control:** Git/GitHub - For maintaining code integrity, collaboration, and version control.

**Hardware and Software Requirements (For Deployment):**

* **Cloud Infrastructure:** Vercel - For scalable and high-availability frontend hosting.
* **Blockchain Nodes:** Dedicated servers or third-party providers like Infura - For secure access to the Ethereum Sepolia testnet.
* **Storage:** IPFS - For decentralized storage of metadata related to transactions and product tracking.
* **Blockchain Integration:** Wagmi and RainbowKit - For seamless Ethereum wallet connections and blockchain interactions.
* **API Management:** Apollo Server with GraphQL - For efficient data querying and retrieval.
* **Containerization:** Docker - Ensures smooth deployment and management of microservices.
* **Authentication:** Wallet-based authentication using RainbowKit, MetaMask, and WalletConnect - Enhances security and user privacy.
* **Frontend Framework:** React with TypeScript and Shadcn - Provides an intuitive, aesthetically pleasing UI.
* **Backend Stack:** Node.js - Manages API requests, blockchain interactions, and application logic.

**Type of Application:** The system will be a **web application** with a responsive design, ensuring accessibility across **desktops, tablets, and mobile devices**. The potential to expand into a **Progressive Web App (PWA)** or a **mobile version** will be explored in future iterations.

**Link to the Literature Survey Table:** <https://docs.google.com/spreadsheets/d/1vGMa3vE1g0KNeUEoRQHojmaB2hsVMIc2q2ifCGu-KQU/edit?usp=sharing>

**Literature survey:**

| **Sr. No.** | **Paper Title** | **Year** | **Journal** | **No. of Citations** | **Country / State** | **Methodology** | **Performance Metrics** | **Conclusion** | **Inferences from the Paper** | **Research Gap** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **1** | **Blockchain in Action: Enhancing Transparency and Traceability in the Pharmaceutical Supply Chain - A Case Study from Vietnam** | **2023** | **ASSE 2023** | **0** | **Vietnam** | **Developed PharmaFlow, integrating MS SQL and blockchain for tracking pharma supply chain** | **Black-box and white-box testing, functional validation, system examination** | **Blockchain enhances transparency and efficiency in pharma supply chains** | **Demonstrates how blockchain can improve traceability** | **Need for real-world large-scale implementation** |
| **2** | **Blockchain Technology in Pharmaceutical Supply Chain Management** | **2022** | **14th IEEE International Conference on Computational Intelligence and Communication Networks** | **4** | **India** | **Proposed blockchain-based pharma supply chain with smart contracts using Ethereum and Ganache** | **Security, data immutability, transaction verification** | **Blockchain can effectively mitigate drug counterfeiting and improve traceability** | **Highlights benefits of smart contracts for supply chain security** | **Needs further testing in real-world pharma logistics** |
| **3** | **Ontology-Based Blockchain Model for Pharmaceutical Supply Chain** | **2025 (Assumed)** | **EBSCO** | **981** | **Not mentioned** | **Uses ontology-based blockchain modeling for improved supply chain transparency** | **Interpretability, smart contract execution** | **Ontology-based modeling enhances blockchain’s traceability potential** | **Focuses on smart contracts for automating supply chain processes** | **Requires validation with actual pharma supply chain stakeholders** |
| **4** | **A Secure Blockchain-based Pharmaceutical Supply Chain Management System: Traceability and Detection of Counterfeit Covid-19 Vaccines** | **2022** | **IEEE MysuruCon** | **5** | **Malaysia** | **Uses permissioned blockchain for securing pharma supply chain transactions** | **Traceability, security, transparency** | **Blockchain can enhance visibility, traceability, and counterfeit detection** | **Highlights the importance of permissioned blockchain** | **Needs implementation on a large scale to test real-world effectiveness** |
| **5** | **Blockchain-based Pharmaceutical Drug Supply Chain Management System** | **2022** | **ICECCME Conference** | **3** | **India** | **Developed a decentralized blockchain model to ensure pharma supply chain security** | **Consensus mechanism efficiency, traceability, transparency** | **Blockchain improves transparency and reduces fraud in pharma supply chains** | **Stresses the need for a trustless, decentralized system** | **Requires real-world adoption and regulatory support** |
| **6** | **A Decentralized Application for the Traceability Process in the Pharma Industry** | **2020** | **Procedia Manufacturing** | **32** | **Italy** | **Developed an Ethereum-based DApp for tracking pharmaceutical distribution** | **Transaction verification, decentralization, immutability** | **Blockchain ensures secure and traceable transactions in pharma supply chain** | **Demonstrates feasibility of blockchain-based serialization** | **Needs integration with existing pharma supply chain regulations** |
| **7** | **Blockchain-Based Solution for Pharma Supply Chain Industry** | **2023** | **Computers & Industrial Engineering** | **68** | **UAE** | **Developed a blockchain framework integrating IoT and Ethereum smart contracts for pharma supply chains** | **Transparency, real-time tracking, security** | **Blockchain and IoT improve supply chain transparency and prevent counterfeiting** | **Demonstrates the benefits of integrating IoT with blockchain for secure pharma tracking** | **Needs large-scale deployment and industry-wide adoption** |
| **8** | **Hyperledger Blockchain-Enabled Decentralized Application for Drug Discovery Chain Management** | **2023** | **Computers & Industrial Engineering** | **10** | **India** | **Developed a Hyperledger Fabric-based DApp for drug discovery chain management integrating ML and blockchain** | **Throughput, latency, resource statistics** | **Blockchain and ML improve traceability, privacy, and scalability in drug discovery** | **Demonstrates the effectiveness of Hyperledger Fabric for secure research collaboration** | **Requires further real-world adoption and regulatory integration** |
| **9** | **Making Drug Supply Chain Secure, Traceable, and Efficient: A Blockchain and Smart Contract-Based Implementation** | **2023** | **Multimedia Tools and Applications** | **49** | **India** | **Ethereum-based blockchain system with smart contracts for tracking healthcare supply chains** | **Gas cost, security, smart contract efficiency** | **Blockchain improves traceability, prevents counterfeiting, and increases transparency in pharma supply chains** | **Demonstrates gas cost efficiency in smart contract-based supply chains** | **Needs large-scale real-world adoption and regulatory compliance** |
| **10** | **Securing Pharmaceutical Supply Chain using Blockchain Technology** | **2021** | **ITM Web of Conferences** | **20** | **India** | **Compared Hyperledger and Ethereum for pharmaceutical supply chains, implementing a Hyperledger Fabric-based system** | **Security, transparency, traceability** | **Blockchain enhances security and transparency in pharma supply chains** | **Demonstrates Hyperledger Fabric’s advantages over Ethereum for secure supply chains** | **Requires more robust implementation and industry-wide acceptance** |

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1. **Tien, T. H. & Doan, C. T.** (2023). *Blockchain in Action: Enhancing Transparency and Traceability in the Pharmaceutical Supply Chain - A Case Study from Vietnam.* **ASSE 2023.** International School, Vietnam National University, Hanoi, Vietnam.
2. **Pathak, A., Shrivastava, S., Palempati, H. V., Meka, A., Swami, D., Hussain, Z., & Borah, M. D.** (2022). *Blockchain Technology in Pharmaceutical Supply Chain Management.* **14th IEEE International Conference on Computational Intelligence and Communication Networks.** National Institute of Technology Silchar, India.
3. **Kim, H. M. & Laskowski, M.** (2025). *Ontology-Based Blockchain Model for Pharmaceutical Supply Chain.* **EBSCO.** Schulich School of Business, York University, Canada.
4. **Authors Unknown** (2022). *A Secure Blockchain-Based Pharmaceutical Supply Chain Management System: Traceability and Detection of Counterfeit Covid-19 Vaccines.* **IEEE MysuruCon.**
5. **Shah, K., Desai, V., Rana, S., Prajapati, D., Solanki, N., & Vasita, U.** (2022). *Blockchain-based Pharmaceutical Drug Supply Chain Management System.* **ICECCME Conference.** Pandit Deendayal Energy University, India.
6. **Chiacchio, F., Compagno, L., D’Urso, D., Velardita, L., & Sandner, P.** (2020). *A Decentralized Application for the Traceability Process in the Pharma Industry.* **Procedia Manufacturing.** University of Catania, SIFI SPA, Frankfurt School Blockchain Center, Germany.
7. **Abdallah, S. & Nizamuddin, N.** (2023). *Blockchain-Based Solution for Pharma Supply Chain Industry.* **Computers & Industrial Engineering.** Abu Dhabi University, UAE & Zayed University, UAE.
8. **Sharma, N. & Rohilla, R.** (2023). *A Novel Hyperledger Blockchain-Enabled Decentralized Application for Drug Discovery Chain Management.* **Computers & Industrial Engineering.** Delhi Technological University, India.
9. **Bandhu, K. C., Litoriya, R., Lowanshi, P., Jindal, M., Chouhan, L., & Jain, S.** (2023). *Making Drug Supply Chain Secure, Traceable, and Efficient: A Blockchain and Smart Contract-Based Implementation.* **Multimedia Tools and Applications.** Medi-Caps University, Indore, India.
10. **Lingayat, V., Pardikar, I., Yewalekar, S., Khachane, S., & Pande, S.** (2021). *Securing Pharmaceutical Supply Chain Using Blockchain Technology.* **ITM Web of Conferences.** SCTR’s Pune Institute of Computer Technology, India.

**Plan:**

1. **Identify the Problem Domain** – Select the specific area of focus for the mini project (e.g., blockchain-based supply chain management for pharmaceuticals).
2. **Literature Review** – Research existing solutions, challenges, and gaps in the chosen domain by analyzing academic papers, industry reports, and case studies.
3. **Define the Problem Statement** – Clearly outline the problem that your mini project aims to solve, including its significance and impact.
4. **Specify Objectives & Scope** – Determine the key goals of the project and the boundaries within which the solution will be developed.
5. **List Functional & Non-Functional Requirements** – Identify the necessary features, performance criteria, and constraints of the system.
6. **Develop Use Cases & Methodology** – Describe potential scenarios where the system will be used and outline the methodology for implementation.
7. **Document the Problem Specification** – Compile all findings and specifications into a well-structured document.
8. **Review & Refine** – Verify the problem definition with peers or mentors and make necessary improvements before finalizing.

**Role and Responsibility Matrix:**

| Activity | R1 | R2 | R3 | Mentor |
| --- | --- | --- | --- | --- |
| **1.** **Requirement Gathering** |  |  |  |  |
| 1.1 Interaction with customer | Sanika | Romil | Minav | Prof. Poonam |
| 1.2 Preparing SRS | Romil | Sanika | Minav | Prof. Poonam |
| **2.** **Design** |  |  |  |  |
| 2.1 Preparing Block diagram | Minav | Sanika | Romil | Prof. Poonam |
| 2.2 Writing Functional Requirements | Minav | Romil | Sanika | Prof. Poonam |
| 2.3 Writing Non-Functional Requirements | Sanika | Romil | Minav | Prof. Poonam |
| 2.4 Developing Use Case | Minav | Sanika | Romil | Prof. Poonam |
| 2.5 Developing Test Cases | Romil | Minav | Sanika | Prof. Poonam |
| 1. **Planning** |  |  |  |  |
| 1. **Coding** |  |  |  |  |
| 4.1 Unit 1 | Minav | Sanika | Romil | Prof. Poonam |
| 4.2 Unit 2 | Romil | Minav | Sanika | Prof. Poonam |
| 4.3 Front end/ UI | Sanika | Minav | Romil | Prof. Poonam |
| 1. **Testing** |  |  |  |  |
| 5.1 Unit 1 | Romil | Sanika | Minav | Prof. Poonam |
| 5.2 Unit 2 | Sanika | Minav | Romil | Prof. Poonam |
| 5.3 System Testing | Minav | Romil | Sanika | Prof. Poonam |

**Activity Chart:**

| Activity | W1 | W2 | W3 | W4 | W5 | W6 | W7 | W8 | W9 | W10 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Requirement Gathering | ✔ | ✔ |  |  |  |  |  |  |  |  |
| Literature Review | ✔ | ✔ | ✔ |  |  |  |  |  |  |  |
| System Design |  | ✔ | ✔ | ✔ |  |  |  |  |  |  |
| Planning |  |  | ✔ | ✔ |  |  |  |  |  |  |
| Prototype Development |  |  |  | ✔ | ✔ |  |  |  |  |  |
| Coding(Implementation Phase 1) |  |  |  |  | ✔ | ✔ |  |  |  |  |
| Coding(Implementation Phase 2) |  |  |  |  |  | ✔ | ✔ |  |  |  |
| Testing (Unit & Integration) |  |  |  |  |  |  | ✔ | ✔ |  |  |
| System Optimization & Debugging |  |  |  |  |  |  | ✔ | ✔ | ✔ |  |
| Final Testing & Documentation |  |  |  |  |  |  |  | ✔ | ✔ | ✔ |
| Deployment & Review |  |  |  |  |  |  |  |  | ✔ | ✔ |

**Conclusion:**

The survey highlights the potential of blockchain technology to address inefficiencies and counterfeit issues in the pharmaceutical supply chain. A decentralized system can enhance transparency, ensure authenticity, and improve trust among stakeholders, ultimately ensuring patient safety and reducing financial losses.