"Subsidy Chain: Promising Transparency and Integrity in Government Fund Distribution"

A PROJECT REPORT

Submitted by,

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Under the guidance of,

Ms. Arshiya Lubna

in partial fulfillment for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINEERING

(BLOCK CHAIN)

At

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY

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CERTIFICATE

This is to certify that the Project report **"Subsidy Chain: Promising Transparency and Integrity in Government Fund Distribution"** being submitted by **"Dyamalli K, Y.Harshitha Reddy, Monica N, Rupalagudi Likhitha"** bearing roll number(s) **"20211CBC0046, 20211CBC0039, 20211CBC0049, 20211CBC0061"** in partial fulfillment of the requirement for the award of the degree of Bachelor of Technology in Computer Science and Engineering(Blockchain) is a Bonafide work carried out under my supervision.

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DECLARATION

We hereby declare that the work, which is being presented in the project report entitled **"Subsidy Chain: Promising Transparency and Integrity in Government Fund Distribution"** in partial fulfillment for the award of Degree of **Bachelor of Technology** in **Computer Science and Engineering(Blockchain)**, is a record of our own investigations carried under the guidance of **Ms. Arshiya Lubna, Assistant Professor, School of Computer Science Engineering, Presidency University, Bengaluru.**

We have not submitted the matter presented in this report anywhere for the award of any other Degree.

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ABSTRACT

The Subsidy Chain project aims to revolutionize the distribution of government subsidies by enhancing efficiency, transparency, and trustworthiness in the system. It focuses on addressing the challenges within the PM-Kisan subsidy program, which provides financial assistance to farmers in India. Existing systems suffer from inefficiencies, delays, financial mismanagement, and a lack of transparency, leading to distrust and misuse of resources. The Subsidy Chain project proposes a blockchain-based solution to tackle these issues effectively.

Leveraging the Polygon blockchain, smart contracts, and the Solidity programming language, the project ensures a decentralized, secure, and transparent mechanism for disbursing subsidy funds. Smart contracts automate the distribution process, removing the need for intermediaries and ensuring that subsidies reach the rightful recipients directly. The blockchain's core features, including immutability and decentralization, uphold system integrity, providing a tamper-proof and auditable record of all transactions.

The project also integrates a user-friendly front-end interface for both beneficiaries and administrators. Beneficiaries can use the platform to verify eligibility, monitor the status of their subsidies, and confirm appropriate fund utilization. Administrators gain access to real-time data insights, enabling them to track distributions effectively and identify fraudulent activities. This transparency helps eliminate the problem of ghost beneficiaries and ensures that subsidies are allocated only to genuine recipients.

By addressing issues such as manual verification delays, liquidity challenges, and lack of accountability, the Subsidy Chain project ensures timely and secure disbursal of subsidies. This enables farmers to access their benefits without unnecessary delays and guarantees that funds are utilized for their intended purpose.

Additionally, this blockchain-powered framework offers scalability, making it adaptable for use in other government welfare programs. By providing a transparent, efficient, and fair subsidy distribution process, the Subsidy Chain project fosters financial inclusion, empowers citizens, and strengthens trust in government initiatives. It sets a new standard for modern welfare systems by prioritizing security, efficiency, and equity in managing public funds.

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CHAPTER-1

INTRODUCTION

Government subsidy programs play a critical role in empowering vulnerable sections of society by providing them with financial assistance and resources. Among these programs, PM-Kisan (Pradhan Mantri Kisan Samman Nidhi), an initiative by the Government of India, stands out as a flagship scheme aimed at ensuring the financial well-being of farmers. Despite its noble intentions and widespread implementation, PM-Kisan and similar programs have often encountered challenges that hinder their effectiveness. Issues such as delays in fund disbursement, corruption, fraudulent activities, and a lack of transparency compromise the trust of beneficiaries and prevent subsidies from reaching their intended recipients in a timely and secure manner.

The Subsidy Chain project addresses these persistent challenges by integrating blockchain technology, a revolutionary digital ledger system renowned for its transparency, immutability, and decentralized architecture. The project envisions a transformative approach where subsidy funds are distributed directly to beneficiaries without the involvement of intermediaries, ensuring efficiency, security, and trust in the system. By employing blockchain, the Subsidy Chain project introduces a scalable and auditable platform that mitigates the inefficiencies of traditional centralized subsidy distribution systems.

1.1 Blockchain Technology: A Game-Changer for Subsidy Distribution

Blockchain technology is a decentralized, peer-to-peer digital ledger system where transactions are recorded securely and immutably. Unlike traditional centralized systems, blockchain eliminates the need for intermediaries, replacing them with a transparent and trustless system. In the context of subsidy distribution, this decentralized model ensures that transactions are conducted directly between the government and beneficiaries, with all activities recorded on a tamper-proof ledger accessible to authorized stakeholders.

The key features of blockchain :

Transparency: Every transaction is publicly verifiable, reducing opportunities for corruption and fraud.

Immutability: Once a transaction is recorded on the blockchain, it cannot be altered or deleted, ensuring the integrity of the data.

Decentralization: By distributing the ledger across a network of nodes, blockchain eliminates reliance on a single point of control, reducing vulnerabilities.

Through these features, blockchain addresses the critical pain points in existing subsidy distribution mechanisms, ensuring that funds are used efficiently and effectively.

1.2 Challenges in Traditional Subsidy Systems

Traditional subsidy distribution systems face several issues that hinder their ability to deliver timely and secure financial assistance. Some of the most common challenges include:

Intermediary Involvement:

The presence of intermediaries often leads to delays in fund distribution as multiple layers of approval are required.

Corruption and leakage of funds are prevalent due to the lack of transparency in intermediary-led processes.

Manual Verification:

Beneficiary eligibility is often verified manually, a process that is time-consuming and prone to human error.

Fraudulent claims and ghost beneficiaries further complicate the verification process, leading to misallocation of resources.

Lack of Transparency:

Traditional systems provide little visibility into the flow of funds, making it difficult for stakeholders to track how subsidies are being utilized.

The absence of a robust audit trail allows fraudulent activities to go undetected.

Delays in Disbursement:

Lengthy administrative processes result in significant delays in the transfer of funds, often leaving beneficiaries without timely financial support.

Security Concerns:

Centralized databases storing beneficiary information are vulnerable to cyberattacks, risking the exposure of sensitive data.

These challenges underscore the need for a modernized system that prioritizes efficiency, transparency, and security. Blockchain technology, with its innovative capabilities, offers a comprehensive solution to these longstanding issues.

1.3 Leveraging Blockchain for the Subsidy Chain Project

The Subsidy Chain project leverages blockchain technology to create a decentralized platform for distributing subsidies directly to beneficiaries. Key components of the system include:

1.3.1 Smart Contracts

Smart contracts are at the core of the Subsidy Chain system, automating the distribution of funds based on predefined rules and conditions. These self-executing contracts ensure that:

Subsidies are released only to eligible beneficiaries who meet the specified criteria.

Intermediaries are eliminated, reducing the risk of fraud and manipulation.

The process is efficient, with minimal delays between fund allocation and disbursement.

1.3.2 Decentralized Identifiers (DIDs) and Verifiable Credentials (VCs)

To streamline beneficiary verification and ensure data privacy, the project incorporates decentralized identity solutions:

DIDs allow beneficiaries to control their digital identities, securely sharing only verified information with the system.

VCs provide cryptographic proof of eligibility, enabling secure and efficient verification without exposing sensitive personal data.

1.3.3 Use of the Polygon Blockchain

The Subsidy Chain project employs the Polygon blockchain, a Layer 2 scaling solution for Ethereum, to enhance the scalability and efficiency of the platform.

Polygon’s high transaction throughput ensures that the system can handle a large number of beneficiaries without performance bottlenecks.

Its low transaction fees make the platform cost-effective for large-scale implementation. The security and decentralization of Polygon align with the project's goals of transparency and trust.

1.4 Addressing Core Issues in Subsidy Distribution

The Subsidy Chain project targets the core issues in subsidy distribution with innovative solutions:

Eliminating Intermediaries:

By enabling direct transactions between the government and beneficiaries, the system reduces administrative overhead and prevents fund leakage.

Automating Processes:

Smart contracts automate the disbursement of funds, ensuring timely distribution without manual intervention.

Enhancing Transparency:

Every transaction is recorded on the blockchain, creating an auditable trail that allows stakeholders to monitor the flow of funds in real time.

Ensuring Data Security:

Decentralized identity management protects beneficiary data while maintaining the integrity of the system.

Preventing Fraud:

Blockchain's immutability and transparency eliminate opportunities for fraud, ensuring that subsidies are allocated to legitimate recipients only.

1.5 Broader Applications of the Subsidy Chain System

While the project is focused on the PM-Kisan program, its framework is adaptable to various other government welfare schemes, such as:

Healthcare: Distribution of medical subsidies and reimbursements.

Education: Allocation of scholarships and grants.

Housing: Assistance programs for affordable housing projects.

This adaptability makes the Subsidy Chain system a versatile tool for enhancing the efficiency and accountability of public welfare initiatives.

CHAPTER - 2
LITERATURE SURVEY

Blockchain technology has emerged as a groundbreaking innovation that addresses critical inefficiencies in government subsidy management, ensuring transparency, security, and accountability. Traditional subsidy systems often face significant challenges, including fraud, mismanagement, and a lack of trust due to their reliance on centralized databases, manual processes, and intermediaries. These limitations lead to delays, human errors, and potential misuse of funds. Blockchain's decentralized, transparent, and tamper-proof nature offers an effective solution, transforming how subsidies are distributed and managed. The PM Kisan Subsidy Chain is a pioneering initiative that leverages blockchain technology to optimize subsidy management, ensuring equitable, efficient, and secure delivery of benefits to eligible recipients.[1]

A core feature of blockchain technology is its immutable ledger, which ensures that once a transaction is recorded, it cannot be altered or deleted. This immutability is particularly crucial in subsidy management, where the integrity of transaction data is essential to maintaining public trust. In the PM Kisan Subsidy Chain, every transaction, from the allocation of funds to the final disbursement to beneficiaries, is recorded transparently on the blockchain. This enables real-time verification by stakeholders, including government officials, auditors, and recipients, fostering a high level of accountability. By eliminating the possibility of tampering or unauthorized changes, blockchain ensures that subsidies reach their intended recipients without diversion or fraud.[2]

Blockchain's robust security is further enhanced through consensus mechanisms such as Proof of Work (PoW) and Proof of Stake (PoS). These mechanisms validate and secure transactions across a decentralized network, making it nearly impossible for malicious actors to compromise the system. PoW relies on computational power to solve complex algorithms, while PoS selects validators based on their stake in the network, offering an energy-efficient alternative. These mechanisms protect user data from unauthorized access and ensure the

integrity of subsidy-related transactions. While many blockchain systems focus on securing data, they often lack features for real-time monitoring. The PM Kisan Subsidy Chain addresses this limitation by integrating advanced tracking systems that allow authorities to monitor disbursements and ensure timely delivery of benefits to eligible beneficiaries.[3]

Automation plays a pivotal role in optimizing subsidy management, and smart contracts are at the heart of this process. Written in programming languages like Solidity, smart contracts are self-executing agreements that automate tasks based on predefined rules and conditions. For instance, in the PM Kisan Subsidy Chain, a smart contract can automatically verify a farmer's eligibility criteria, such as landholding size, crop type, and income level, and trigger the disbursement of subsidies directly to their account. This eliminates the need for intermediaries, reducing delays, errors, and the risk of corruption. Smart contracts also enforce two key types of integrity: data integrity, which ensures that altering transaction data requires network consensus, and rule integrity, which prevents manipulation of the contract's logic. This automation not only streamlines subsidy distribution but also ensures compliance with government policies.[4]

Scalability is a critical challenge for blockchain systems, particularly in large-scale operations like the PM Kisan Subsidy Chain, which serves millions of beneficiaries nationwide. Public blockchains, such as Ethereum, often face limitations like high transaction fees and slower processing speeds during periods of heavy usage. To overcome these challenges, the PM Kisan Subsidy Chain integrates Polygon, a layer-2 scaling solution for Ethereum. Polygon enhances the system's scalability by enabling faster transaction processing and significantly reducing costs. With the ability to handle thousands of transactions per second, Polygon ensures that the PM Kisan Subsidy Chain can manage high transaction volumes in real-time, maintaining efficiency and affordability. This scalability is vital for ensuring the seamless operation of a nationwide subsidy system, even during peak periods.[5]

Accessibility is another crucial aspect of effective subsidy management, particularly in rural areas where digital literacy and infrastructure may be limited. User-friendly interfaces are essential to ensure that beneficiaries can interact with the system effortlessly. The PM Kisan Subsidy Chain achieves this by incorporating intuitive front-end designs developed using React, a popular JavaScript library. These interfaces enable beneficiaries to check their

eligibility, track payments, and raise queries without technical difficulties. Additionally, web3 technologies like MetaMask provide secure wallet management and direct interaction with smart contracts, empowering users to claim subsidies while maintaining control over their data. Features such as multi-language support, mobile-friendly designs, and offline accessibility further enhance the inclusivity of the system, making it accessible to diverse demographics, including those in remote areas.[6]

Transparency and accountability are central to the effectiveness of blockchain-based subsidy systems. Traditional systems often rely on centralized servers, which are vulnerable to tampering and unauthorized access. Blockchain's decentralized architecture ensures that all transactions are recorded permanently across multiple nodes, making it virtually impossible to alter or delete records. This transparency allows government authorities to monitor the disbursement process effectively, verify the legitimacy of transactions, and detect anomalies. The PM Kisan Subsidy Chain further enhances accountability by integrating audit trails and compliance checks directly into the system. These features ensure that every transaction is traceable and verifiable, building trust among beneficiaries and administrators.[7]

Beyond subsidy management, blockchain technology has broader implications for public services. Its potential extends to sectors such as healthcare, education, and social welfare, where transparency, efficiency, and security are paramount. For example, blockchain can be used to track medical supplies, manage scholarship programs, and ensure equitable distribution of welfare benefits. The PM Kisan Subsidy Chain serves as a model for these applications, demonstrating how blockchain's strengths can revolutionize public administration. By integrating blockchain with existing e-Government systems, governments can streamline operations, reduce administrative costs, and enhance service delivery across multiple domains.[8]

The adoption of blockchain technology in government subsidy management represents a significant step toward creating a transparent, efficient, and equitable governance ecosystem. The PM Kisan Subsidy Chain showcases the transformative potential of blockchain by addressing the limitations of traditional systems and setting a benchmark for future innovations. By leveraging advanced technologies such as smart contracts, Polygon scaling

solutions, and user-friendly interfaces, the PM Kisan Subsidy Chain ensures that subsidies are distributed securely, efficiently, and inclusively. This approach not only improves the efficiency and accountability of subsidy systems but also paves the way for the broader adoption of blockchain in public services, fostering trust, transparency, and equity in society.[9]

This research shall discuss how blockchain technology can help make governance financial operations more transparent due to its system being secure and decentralized. Through smart contracts, the financial processing mechanisms are automated, thus reducing a lengthy time, mistakes, and third-party involvement. Its applicability is demonstrated in various countries, such as Estonia and Dubai, in handling public funds. However, it has drawbacks such as scalability, data privacy, and legal regulations. In a nutshell, blockchain provides the effective solution toward managing government expenses more transparent and efficient.[10]

In conclusion, blockchain technology has the potential to redefine how governments manage subsidies and deliver public services. By incorporating features like immutability, automation, scalability, and accessibility, blockchain systems like the PM Kisan Subsidy Chain offer a robust framework for addressing the challenges of traditional subsidy systems. The success of such initiatives highlights the transformative power of blockchain in public administration, creating opportunities for a future where governance is more transparent, inclusive, and technologically advanced. Through these innovations, blockchain is set to play a crucial role in building equitable and efficient systems that empower citizens and promote social welfare on a global scale.

CHAPTER - 3
RESEARCH GAPS OF EXISTING METHODS

Government subsidy distribution mechanisms are essential for addressing various socio-economic issues by ensuring resources and financial aid reach eligible individuals effectively. Despite significant advancements in technology, these systems still encounter inefficiencies, security gaps, and operational challenges. Current research underscores several deficiencies in existing methods, particularly in areas such as automation, scalability, security, and infrastructure. These gaps represent potential opportunities for innovation, especially through blockchain technology, to improve the efficiency, transparency, and dependability of subsidy distribution systems. The sections below detail the research gaps identified across various domains:

3.1 Automating Subsidy Distribution

Reliance on Manual Verification

Traditional subsidy systems frequently depend on manual processes to determine beneficiary eligibility, which introduces delays, errors, and a risk of fraudulent claims.

Issues Identified: Manual verification involves extensive paperwork and multiple layers of approvals, which slow down processes and increase the likelihood of inaccuracies. Fraudulent claims often go undetected due to insufficient cross-verification mechanisms.

Research Opportunity: Blockchain-based solutions, incorporating smart contracts and decentralized identity systems, could automate verification processes. By reducing human involvement, these systems can enhance accuracy and streamline operations.

Delays in Transaction Verification Traditional systems often experience lags in verifying and updating subsidy-related transactions, hampering timely fund disbursement.

Issues Identified: Delayed verification creates bottlenecks, affecting beneficiaries in need of urgent financial support. Real-time updates to subsidy records are frequently missing, leading to discrepancies.

Research Opportunity: Blockchain's capability for real-time transaction validation and automatic updates remains underutilized in large-scale projects. Developing frameworks to enable instantaneous verification while preserving data integrity is a promising area for exploration.

3.2 Scalability and Performance Challenges

High Transaction Costs

Public blockchain platforms, such as Ethereum, often face high transaction fees and congestion, limiting their viability for large-scale government applications.

Issues Identified: Elevated transaction costs make these systems less practical for programs handling high transaction volumes, especially in resource-constrained regions.

Research Opportunity: Layer 2 scaling solutions like Polygon address some of these issues, but their long-term effectiveness in subsidy distribution requires deeper analysis. Research should evaluate their scalability and cost-effectiveness in government use cases.

Enhancing Blockchain Efficiency

Blockchain networks sometimes struggle with slow transaction speeds and congestion during periods of heavy usage.

Issues Identified: Network bottlenecks undermine blockchain's potential for efficient subsidy distribution.

Research Opportunity: Further study into optimizing consensus algorithms, such as transitioning from Proof of Work (PoW) to Proof of Stake (PoS) or Delegated Proof of Stake

(DPoS), could improve network throughput, making blockchain better suited for large-scale applications.

3.3 Addressing Security and Fraud

Smart Contract Vulnerabilities

While smart contracts offer automation and transparency, they are not immune to coding errors and vulnerabilities that malicious actors could exploit.

Issues Identified: Poorly written or tested smart contracts can lead to unauthorized fund transfers or system failures.

Research Opportunity: Establishing robust frameworks for developing, testing, and auditing smart contracts is critical. These frameworks must ensure contracts are secure, efficient, and resilient against attacks. Security in Multi-Stakeholder Systems

Government subsidy programs involve multiple parties, such as financial institutions, government entities, and beneficiaries, each with unique security needs.

Issues Identified: Existing methods often fail to ensure secure collaboration and data sharing among stakeholders.

Research Opportunity: Blockchain's ability to facilitate secure and transparent interactions between diverse parties can be enhanced through research into access control mechanisms and encrypted communication channels.

Secure Identity Management

Decentralized identity systems, such as Decentralized Identifiers (DIDs) and Verifiable Credentials (VCs), hold promise for improving beneficiary identification, yet they remain underutilized in public programs.

Issues Identified: Striking a balance between privacy and transparency in identity verification is a persistent challenge.

Research Opportunity: Developing tamper-proof, privacy-preserving identity management systems can ensure data security while maintaining beneficiary authenticity.

3.4 Legal and Regulatory Challenges

Lack of Clear Legal Frameworks

The absence of comprehensive legal and regulatory guidelines for blockchain adoption in public services creates significant hurdles.

Issues Identified: Unresolved questions about data privacy, accountability, and the legal recognition of digital signatures hinder adoption.

Research Opportunity: Developing well-defined regulatory frameworks can address these challenges, paving the way for blockchain's integration into government systems.
Integrating with Legacy Systems Blockchain must function alongside traditional systems, such as Know Your Customer (KYC) and Anti-Money Laundering (AML) protocols.

Issues Identified: Integrating blockchain with legacy systems often results in operational inefficiencies and conflicts.

Research Opportunity: Hybrid models that seamlessly combine blockchain with traditional systems could ensure compliance and efficiency without disruption.

Privacy Concerns in Transparent Systems

The inherent transparency of blockchain raises concerns about the exposure of sensitive beneficiary data.

Issues Identified: Balancing transparency with privacy is critical in applications involving personal information**.**

Research Opportunity: Techniques like zero-knowledge proofs and privacy-preserving cryptographic methods could help address these concerns while maintaining accountability.

3.5 Infrastructure and Accessibility Issues

Digital Literacy in Underserved Areas

Beneficiaries in rural or underprivileged regions often lack the digital literacy required to interact with blockchain-based systems.

Issues Identified: Limited familiarity with digital tools creates barriers to adoption.

Research Opportunity: Designing intuitive user interfaces and implementing educational programs can improve accessibility and encourage adoption in these areas.

Infrastructure Limitations

The adoption of blockchain requires reliable internet connectivity and access to smart devices, which are often lacking in remote regions.

Issues Identified: Infrastructure gaps hinder the deployment of blockchain systems in underserved areas.

Research Opportunity: Research should focus on developing cost-effective technological solutions to bridge these gaps, ensuring equitable access to subsidy programs.

3.6 Environmental Sustainability

Energy Efficiency of Blockchain Networks

Blockchain systems, especially those using Proof of Work (PoW), consume significant energy, raising concerns about environmental sustainability.

Issues Identified: High energy consumption is incompatible with large-scale applications requiring sustainability.

Research Opportunity: Exploring alternative consensus mechanisms, such as POS energy-efficient architectures can help reduce the environmental footprint of blockchain networks.

CHAPTER - 4

PROPOSED METHODOLOGY

The methodology for the "Subsidy Chain: Promising Transparency and Integrity in Government Fund Distribution" project focuses on leveraging blockchain technology to enhance transparency, security, and efficiency in the distribution of government funds, specifically in the context of PMKisan subsidies. The system is based on Ethereum for the blockchain, Solidity for smart contract programming, and Polygon to improve scalability. Below is a detailed breakdown of the proposed methodology.

4.1.Blockchain-Based Infrastructure

The system is built on Ethereum blockchain, known for its security and decentralization, with the addition of Polygon as a Layer 2 scaling solution. This combination ensures that the system is capable of handling high transaction volumes efficiently while minimizing transaction costs.

Steps:

Blockchain Selection: Ethereum is chosen due to its robust security features, wide adoption, and established infrastructure. Polygon is integrated as a Layer 2 solution to reduce transaction fees and improve scalability.

Smart Contract Development: Smart contracts written in Solidity will automate critical processes such as verifying eligibility, transferring funds, and logging transactions on the blockchain to ensure transparency.

4.2. Smart Contract Development

Smart contracts will automate the distribution of subsidies and maintain a transparent, tamper-resistant record of all transactions. These contracts will verify beneficiary eligibility, trigger payments, and log every action in a secure manner.

Steps:

Eligibility Verification: Smart contracts will include rules to check whether a beneficiary qualifies for the subsidy, based on government criteria.

Fund Transfer: After eligibility is confirmed, the smart contract will automatically execute the subsidy transfer to the beneficiary's account.

Audit Trail: Every transaction will be recorded on the blockchain, providing an immutable and transparent history of the distribution process.

4.3.Frontend Development

A user-friendly interface will be developed using React, a popular JavaScript library. The frontend will serve as the point of interaction for beneficiaries, government officials, and other stakeholders.

Steps:

User Authentication: Decentralized Identifiers (DIDs) will be used for secure authentication of users to protect privacy.

Interface Design: A responsive and easy-to-use interface will display real-time data, such as subsidy status and transaction history.

Smart Contract Interaction: The frontend will interact with the Ethereum blockchain using Web3.js or Ethers.js, enabling users to interact directly with the smart contracts.

4.4. Security and Privacy Measures

Given the sensitive nature of financial and personal data, the system will prioritize security and privacy.

Steps:

Decentralized Identity (DID): DIDs will be implemented to ensure secure, private authentication of users while maintaining user privacy.

Data Encryption: Both on-chain and off-chain data, including personal information and financial details, will be encrypted to prevent unauthorized access.

Role-Based Access Control: Access to different system features will be restricted based on user roles to ensure that only authorized personnel can perform certain actions.

4.5. Scalability and Performance

To ensure the system can scale to handle a large number of transactions, the Polygon network will be employed to enhance scalability and reduce the cost of transactions.

Steps:

Layer 2 Scaling with Polygon: Polygon's proof-of-stake mechanism will handle a high transaction volume, minimizing costs and reducing the load on the Ethereum network.

Performance Optimization: The system will undergo stress testing to ensure it can manage multiple users and transactions efficiently.

4.6. Testing and Deployment

Before deployment, the system will undergo extensive testing to ensure functionality, security, and performance. The system will be deployed on the Polygon network for real-world testing.

Steps:

Unit Testing: Each smart contract will be thoroughly tested to ensure it functions as expected under various scenarios.

Integration Testing: The entire system, including frontend and smart contracts, will be tested together to ensure seamless interaction.

User Acceptance Testing (UAT): Government officials and beneficiaries will test the system to confirm that it meets their needs and expectations.

4.7. Audit and Monitoring

Continuous monitoring and auditing are essential to ensure the system runs smoothly and securely after deployment.

Steps:

Blockchain Audits: The blockchain's immutable ledger will be used to provide transparency and traceability of all transactions.

Performance Monitoring: The system's performance will be monitored to ensure it remains efficient and secure, focusing on transaction speed, gas costs, and user activity.

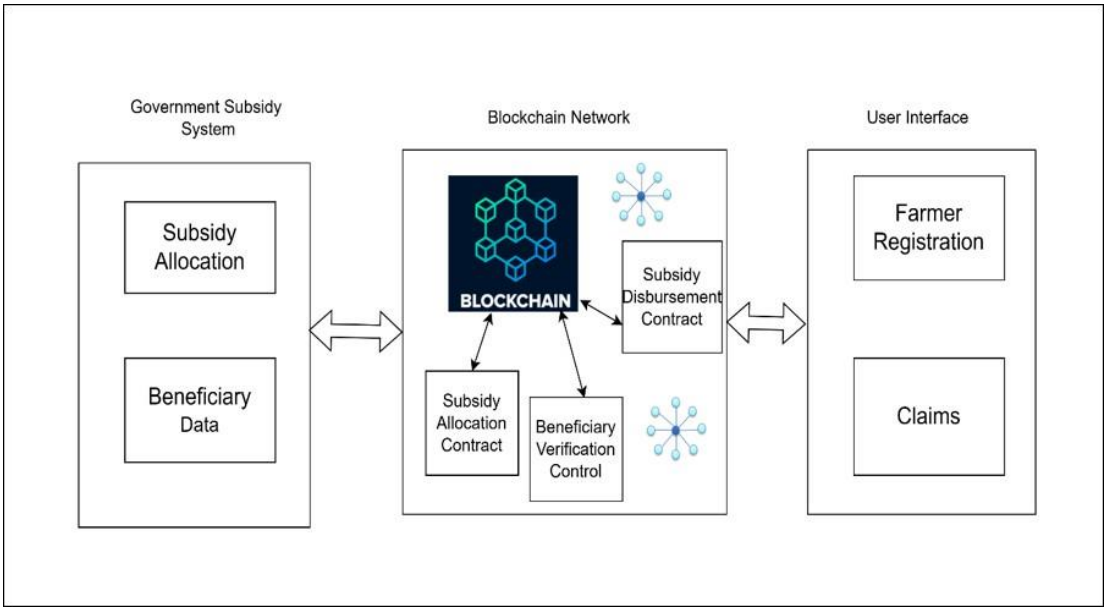


Fig. 1: Architecture of blockchain-based subsidy distribution.

1. Government Subsidy System

This section refers to the government's backend system responsible for managing and distributing subsidies. It consists of:

Subsidy Allocation:

Handles the identification and allocation of subsidies to eligible beneficiaries based on government policies and set criteria.

Beneficiary Data:

Stores and maintains details of beneficiaries, including their unique identifiers (DIDs), eligibility information, and banking details.

This data is shared securely with the blockchain to enable further verification and automation.

2. Blockchain Network

The blockchain network serves as the foundation for decentralization, security, and transparency. It includes smart contracts and verification mechanisms that automate and validate subsidy processes:

Subsidy Allocation Contract:

This smart contract automates the allocation of subsidies based on the input received from the government system.

It checks the eligibility of beneficiaries and assigns the appropriate subsidy amount.

Beneficiary Verification Control:

This mechanism ensures the verification of registered farmers using secure identifiers like **Decentralized Identifiers (DIDs)** to protect privacy and avoid fraud.

Subsidy Disbursement Contract:

Once eligibility is verified and subsidies are allocated, this smart contract manages the disbursement of funds to the farmer's registered bank account.

3. User Interface

The User Interface acts as the bridge between the farmers (end-users) and the system. It provides two essential functionalities:

Farmer Registration:

Farmers can register their personal and banking details securely.

After registration, their eligibility is validated through the government and blockchain network.

Claims:

Farmers can check the status of their subsidy claims, monitor transactions, and ensure that funds have been disbursed.

Any successful subsidy disbursement is updated in real time, providing transparency to beneficiaries.

4.8. Interactions Between Components

1. Government Subsidy System ↔ Blockchain Network:

The government system transfers **beneficiary data** and subsidy details to the blockchain network for validation.

Smart contracts then manage the allocation and disbursement while maintaining immutable records.

2. Blockchain Network ↔ User Interface:

Farmers interact with the system through the user interface, submitting claims and monitoring subsidy status.

Smart contracts ensure that these processes are automated and transparent.

3.Transparency and Accountability:

All transactions are stored on the blockchain, ensuring auditability without altering records.

This transparency reduces corruption and ensures trust in the system.

4.9. Significance of the Diagram

This architecture is designed to achieve the following:

1.Transparency: All transactions and processes are recorded on an immutable blockchain, ensuring clear visibility for all stakeholders.
2.Security: Decentralized Identifiers (DIDs) and smart contracts secure beneficiary data and protect against fraud.
3.Efficiency: Automating verification, allocation, and disbursement processes significantly reduces delays.
4.Farmer Empowerment: Farmers gain real-time updates on subsidy status, enabling trust and confidence in the system.

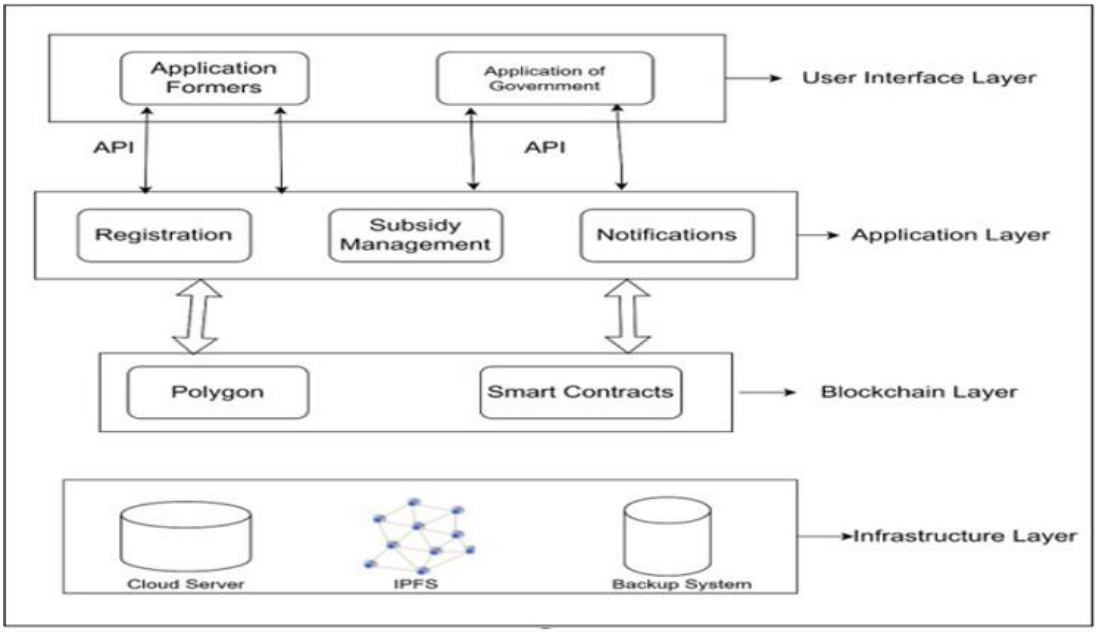


Fig. 2: Tech-stack of the proposed decentralized application

1.User Interface Layer

The User Interface Layer provides the **front-end applications** that allow users to interact with the system. This layer connects with the Application Layer through **APIs** to exchange data.

Application Formers:

Farmers and beneficiaries interact through this interface to **register, submit applications**, and monitor their subsidy status.

Application of Government:

Government officials access this interface to manage and monitor the overall subsidy process.

It allows authorities to verify and approve subsidy disbursements securely.

The API acts as a bridge, connecting the User Interface Layer to the next **Application Layer** for processing user data.

2.Application Layer

The Application Layer is responsible for handling the core operations and logic of the system. It processes data received from the User Interface and interacts with the Blockchain Layer. It includes the following components:

Registration:

Handles the **farmer registration process**, collecting essential data like personal details, eligibility criteria, and banking information.

Subsidy Management:
Manages the allocation and disbursement of subsidies to eligible beneficiaries.

Integrates with smart contracts on the blockchain to ensure automated and secure transactions.

Registration:

Handles the **farmer registration process**, collecting essential data like personal details, eligibility criteria, and banking information.

Subsidy Management:

Manages the allocation and disbursement of subsidies to eligible beneficiaries.

Integrates with smart contracts on the blockchain to ensure automated and secure transactions.

Notifications:

Provides real-time updates and notifications to beneficiaries and government officials about subsidy status, approvals, and disbursements.

This layer ensures smooth data flow and triggers transactions in the Blockchain Layer.

3.Blockchain Layer

The Blockchain Layer ensures the **security, transparency, and immutability** of all subsidy-related processes through the following components:

Polygon:

Polygon serves as the underlying blockchain network for executing and recording subsidy transactions.

It enables faster, scalable, and cost-effective deployment of blockchain-based applications.

Smart Contracts:

Smart contracts are pre-defined blockchain scripts that automate processes like eligibility verification, subsidy allocation, and fund disbursement.

Once conditions are met, the contract executes the operation and records the transaction securely on the blockchain.

4.Infrastructure Layer

The Infrastructure Layer provides the foundational technology and storage solutions required to support the entire system. It includes:

Cloud Server:

Stores non-sensitive application data, configurations, and user-related details. Ensures scalability and availability of the system.

IPFS (InterPlanetary File System):

A decentralized storage network for securely storing documents and large files such as farmer identity proofs, subsidy records, and related claims. Enhances transparency while reducing centralized control.

Backup System:

Ensures the system's reliability and redundancy by maintaining regular backups. Protects data from unforeseen failures and ensures recovery when needed.

CHAPTER-5
OBJECTIVES

The project titled "Subsidy Chain: Promoting Transparency and Integrity in Government Fund Distribution" is a strategic initiative aimed at modernizing the existing government subsidy systems. These systems, which play a vital role in financial assistance programs like PM-Kisan, face several inefficiencies, including delayed transactions, fraud, lack of transparency, and operational complexity. By harnessing emerging technologies such as blockchain, smart contracts, and decentralized identity systems, this project seeks to address these challenges and establish a secure, transparent, and automated platform for subsidy distribution. Below are the core objectives that define the purpose and scope of the project.

5.1. Design and Implementation of a Blockchain-Based Subsidy Distribution System

A key element of the project is to create a blockchain-based system that records subsidy transactions on an immutable and decentralized ledger. Blockchain's features, such as transparency and security, make it ideal for ensuring that transactions are trustworthy and verifiable.

Objective: To build a system where each subsidy transaction is recorded and stored securely on the blockchain, eliminating the potential for fraud or unauthorized alterations.

Significance: By leveraging blockchain, this system ensures that all subsidy transfers are transparent and tamper-proof, enhancing trust among the beneficiaries and government bodies. The goal is to make the subsidy process more efficient, secure, and accountable.

5.2. Automation of the Subsidy Process with Smart Contracts

Manual processes are often slow and prone to errors, leading to delays and inefficiencies in subsidy distribution. The integration of smart contracts, written in Solidity, will automate critical processes such as beneficiary verification, fund disbursement, and eligibility checks.

Objective: To develop smart contracts that automatically enforce subsidy distribution rules without the need for human intervention, reducing the risk of errors and fraud.

Significance: Automating these processes ensures that subsidies are allocated fairly, efficiently, and transparently, while minimizing administrative costs and reducing the potential for human bias or manipulation.

5.3. Integrating Polygon for Scalability and Cost Efficiency

Handling large-scale subsidy programs with millions of beneficiaries can be challenging due to network congestion and high transaction costs. Polygon, a Layer 2 solution, will be used to address these issues by providing greater scalability and reducing costs.

Objective: To integrate Polygon's scalable infrastructure, which will allow the system to handle high transaction volumes with low fees and improved processing speed.

Significance: Polygon's integration will ensure that the system can manage subsidies across large populations without compromising on speed, reliability, or cost-effectiveness. This solution is particularly vital in regions with limited resources.

5.4. Securing Identity Management with Decentralized Identifiers (DIDs)

Effective subsidy distribution requires accurate and secure identity verification to prevent fraud. Decentralized Identifiers (DIDs) will be used to create secure, private, and tamper-resistant digital identities for beneficiaries.

Objective: To implement DIDs for securely authenticating the identity of subsidy recipients, ensuring that personal data remains confidential and is only accessed when necessary.

Significance: By using decentralized identities, the project enhances privacy while ensuring that only eligible individuals receive subsidies. This approach offers a more secure and efficient alternative to traditional identity management systems.

5.5. User-Friendly Frontend Interface Development

A key factor for the successful adoption of any digital system is its ease of use. The system will feature an intuitive, user-friendly frontend developed using React, ensuring accessibility for both beneficiaries and government officials.

Objective: To develop a simple and responsive interface that allows users to easily interact with the subsidy platform, track transactions, and access essential information.

Significance: A well-designed user interface will ensure that the system is easy to navigate for individuals with varying levels of technical expertise, promoting greater engagement and reducing the likelihood of user errors.

5.6. Real-Time Monitoring and Reporting

Transparency and accountability are crucial in managing public funds. The system will include a real-time monitoring dashboard for government officials to track the subsidy distribution process and ensure compliance.

Objective: To provide government authorities with a dynamic reporting tool that allows them to monitor ongoing transactions, flag discrepancies, and make data-driven decisions.

Significance: Real-time monitoring will facilitate timely intervention in case of system discrepancies, improving the overall efficiency and accountability of the subsidy process.

5.7. Auditability and Traceability of Subsidy Transactions

Blockchain’s transparency ensures that every subsidy-related transaction can be traced and audited. The project will focus on creating a system that allows for easy auditability without compromising on data privacy.

Objective: To ensure that every transaction is recorded in a manner that makes it easy to trace and audit, allowing stakeholders to track the flow of funds and verify the legitimacy of transactions.

Significance: These objective fosters trust by allowing independent audits and providing stakeholders with the assurance that funds are being used appropriately.

5.8. Mitigation of Corruption and Fraud

Corruption and fraud are major challenges in government subsidy programs, often due to human intervention and lack of transparency. By automating critical processes and utilizing blockchain's immutable ledger, this system aims to eliminate these risks.

Objective: To reduce human involvement in key subsidy processes, thus minimizing opportunities for fraud, bribery, and manipulation.

Significance: With reduced human intervention, the system becomes less susceptible to corrupt practices, ensuring that subsidies are distributed fairly and transparently.

5.9.Thorough System Testing

The system's security, functionality, and performance will undergo rigorous testing to ensure that it is reliable, secure, and ready for deployment.

Objective: To conduct extensive testing to identify and address potential vulnerabilities and ensure the system operates smoothly across all scenarios.

Significance: Comprehensive testing will ensure that the platform is resilient to security threats, performs efficiently under heavy loads, and meets the highest standards of quality.

5.10. Scalability for Other Government Schemes

While the initial focus is on PM-Kisan, the system is designed to be adaptable and scalable for other government programs. This flexibility ensures that the solution can support a range of different subsidy schemes across sectors like healthcare, education, and welfare.

Objective: To create a modular framework that can be easily extended to support additional government programs as needed.

CHAPTER - 6
SYSTEM DESIGN & IMPLEMENTATION

The design and implementation of the "Subsidy Chain: Promising Transparency and Integrity in Government Fund Distribution" project focuses on creating a decentralized system to enhance the PMKisan subsidy distribution process. By utilizing blockchain technology, the system ensures transparency, security, and efficiency in the allocation of government funds. This section provides an in-depth overview of the system architecture and the steps taken for its implementation, including the use of Ethereum blockchain, Solidity programming for smart contracts, and the integration of Polygon for scalability.

6.1. System Architecture

The system is designed with a decentralized approach, ensuring that no single entity has control over the entire subsidy distribution process. The architecture is composed of the following major components:

Blockchain Layer (Ethereum + Polygon): Ethereum serves as the core blockchain for smart contract deployment, while Polygon, a Layer 2 scaling solution, ensures faster transactions and lower costs.

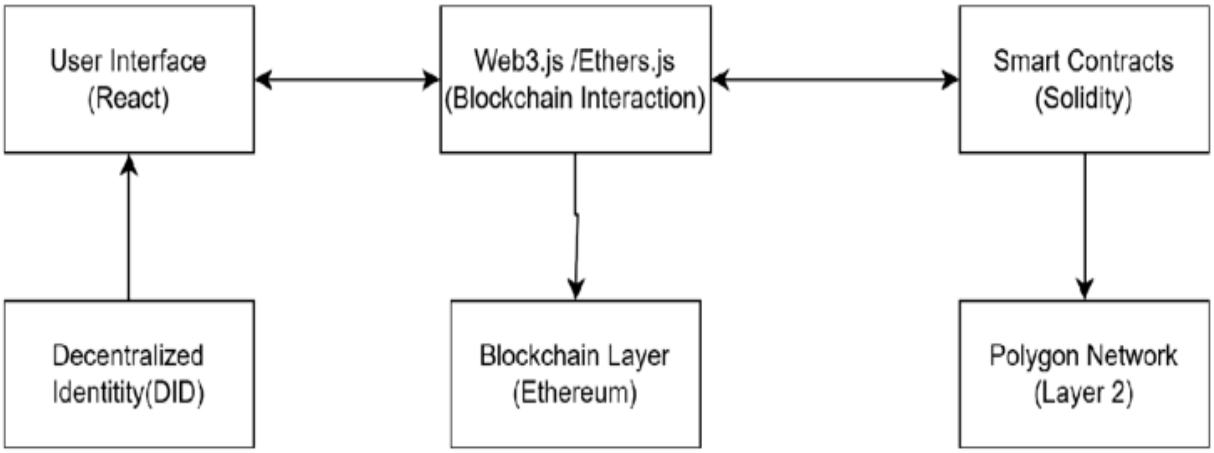
Smart Contracts (Solidity): Smart contracts are developed using Solidity to automate the subsidy distribution, ensuring that all processes are tamper-proof and executed in a decentralized manner.

Frontend Interface (React): The user interface will be built using React, providing a responsive and intuitive platform for users to interact with the system.

Backend (Web3.js/Ethers.js): The backend layer facilitates the interaction between the frontend and the blockchain using Web3.js or Ethers.js.

Decentralized Identifiers (DID): DIDs are used to securely authenticate beneficiaries and other stakeholders without exposing sensitive personal information.

Fig 3**.** System Components and Implementation



6.1.1. Blockchain Layer (Ethereum and Polygon)

The blockchain layer ensures that transactions are secure, transparent, and immutable. Ethereum serves as the main blockchain, where all critical functions like subsidy transactions are stored. To improve scalability and reduce transaction costs, Polygon is integrated as a Layer 2 solution. This integration ensures that the system can handle a large number of transactions without compromising performance.

6.1.2. Smart Contract Development (Solidity)

Smart contracts are at the heart of the system, automating critical operations such as:

Eligibility Verification: The smart contract will check the eligibility of beneficiaries based on predefined criteria, such as agricultural land ownership or income verification.

Fund Transfer: Once eligibility is confirmed, the subsidy amount will be automatically transferred to the beneficiary's wallet.

Transaction Recording: Every subsidy-related transaction will be recorded on the

blockchain, ensuring a transparent and immutable audit trail.The smart contracts will be implemented in Solidity and tested on Ethereum test networks (Rinkeby, Ropsten) before deployment on Polygon.

6.1.3. Frontend Development (React)

The frontend of the system will be developed using React to provide an intuitive and dynamic user interface. Key features include:

Dashboard: A dashboard that displays subsidy distribution details, including transaction history and eligibility status.

Authentication: Beneficiaries and government officials can securely log in using Decentralized Identifiers (DID), ensuring that their personal data remains private.

Interaction with Smart Contracts: The frontend will enable users to interact with the smart contracts via Web3.js or Ethers.js, facilitating seamless blockchain communication.

6.1.4. Backend Integration (Web3.js/Ethers.js)

Web3.js and Ethers.js are JavaScript libraries used to enable communication between the frontend and the blockchain. These libraries will handle:

Smart Contract Interaction: Facilitating the connection between the React frontend and the deployed smart contracts.

Transaction Execution: Ensuring that all transactions are processed and recorded on the blockchain.

Wallet Integration: Allowing users to link their wallets (e.g., MetaMask) for transaction signing and interaction with the smart contracts.

6.1.5. Decentralized Identity (DID)

DIDs are implemented to provide secure, privacy-preserving authentication for users. With

DID, beneficiaries and officials can authenticate themselves without revealing their private data. This approach enhances the security of the system and ensures that sensitive personal information is only shared when absolutely necessary.

6.2.System Flow

The flow of the subsidy distribution process is as follows:

1. **Beneficiary Registration**: The beneficiary registers on the platform, and their information is securely stored using DID.
2. **Eligibility Verification**: A smart contract verifies the beneficiary's eligibility based on specific criteria (e.g., land records or income verification).
3. **Subsidy Distribution**: Upon confirmation of eligibility, the smart contract automatically transfers the subsidy to the beneficiary's wallet.
4. **Transparency and Monitoring**: All transactions are recorded on the blockchain, ensuring that the process is transparent and tamper-proof.
5. **Feedback Mechanism**: Government officials can monitor the distribution and provide feedback through the platform.

6.3.Testing and Debugging

Before the system is deployed, extensive testing will be conducted to ensure its functionality and security:

Unit Testing: Testing individual functions of the smart contracts to ensure that each component works as expected.

Integration Testing: Ensuring that all components (frontend, backend, and blockchain) integrate seamlessly.

Security Testing: Conducting penetration tests and vulnerability assessments to ensure the system is secure from potential attacks.

User Acceptance Testing (UAT): Testing the system with real users (beneficiaries and

government officials) to verify its usability and effectiveness.

6.4.Deployment

Once testing is complete, the system will be deployed on the Polygon network to handle real-world transactions. Continuous monitoring will be carried out to identify any issues and make necessary improvements.

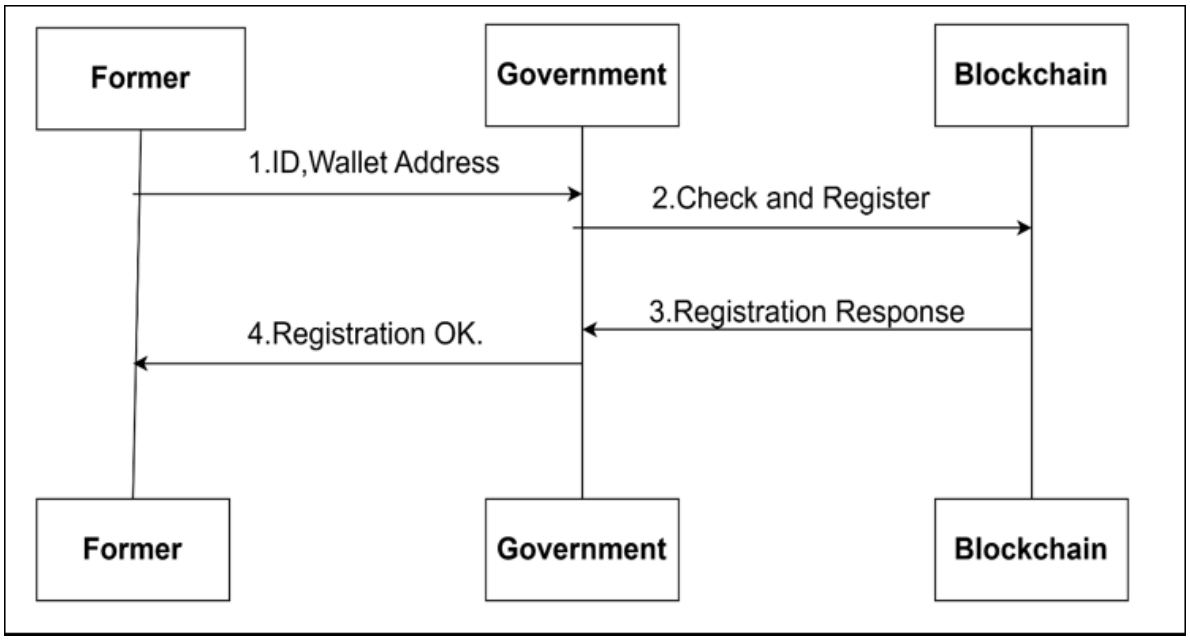


Fig 4. Registration Phase[Sequence Diagram]

6.4.1. Entities and Their Roles

- **Farmer:**

Farmers (beneficiaries) submit subsidy applications with their eligibility details for verification.

They track the status of their subsidy claims and confirm the disbursement process.

- **Government:**

The government acts as the approval authority, responsible for verifying eligibility and allocating subsidies.

It triggers subsidy disbursement and ensures compliance with rules and processes.

- **Blockchain:**

  Blockchain serves as a decentralized and immutable ledger for recording subsidy transactions.

  Smart contracts automate the verification, approval, and disbursement of subsidies.

6.4.2. Interaction Flow

- **Farmer → Government:**

  Farmers submit their application details, including eligibility and identity credentials, for subsidy approval.

- **Government → Blockchain:**

  The government verifies the eligibility conditions.

  Upon approval, the blockchain records the transaction, and smart contracts trigger subsidy disbursement.

- **Blockchain → Farmer:**

  After disbursement, farmers receive the subsidy confirmation and can verify the record on the blockchain.

  Farmers are also able to check the disbursement status and report discrepancies if necessary.

- **Farmer → Blockchain:**

  Farmers access the blockchain to retrieve transaction details and ensure successful processing of their subsidy.

- **Government → Blockchain:**

  The government consistently monitors and audits the blockchain records to verify the integrity of transactions.

- ## Key Features of the System

- **Transparency:**

  Blockchain records every transaction, ensuring complete visibility for both farmers and government officials.

- **Automation via Smart Contracts:**

  Smart contracts eliminate delays by automating the disbursement process based on pre-approved conditions.

- **Decentralization:**

  Blockchain eliminates intermediaries, secures data, and prevents tampering or manipulation.

- **Trust and Verification:**

  Farmers can independently check transaction records to confirm the success of the disbursement process.

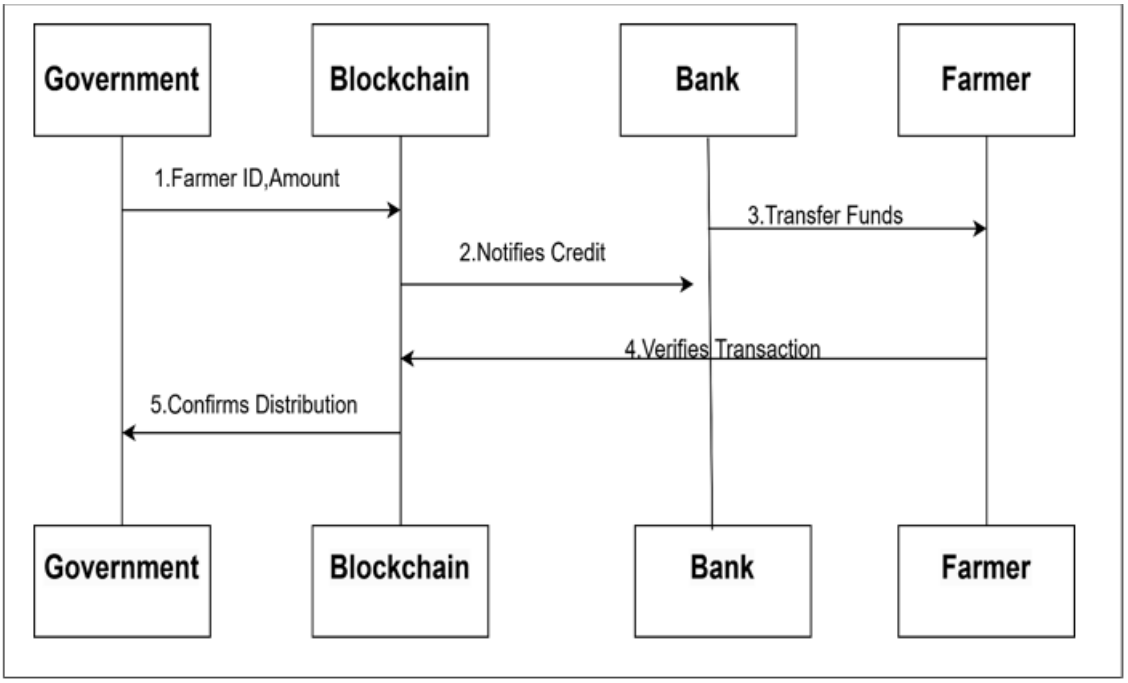


Fig 5. Sequence Diagram for Subsidy Distribution

6.4.3 Entities and Their Responsibilities

- **Government:**

  Verifies farmers' eligibility for receiving subsidies. Initiates the process of fund allocation and disbursement.

  Records all approved transactions on the blockchain for transparency and accountability.
- **Blockchain:**

  Functions as a decentralized digital ledger to securely store subsidy-related records.

  Smart contracts automate the verification and disbursement process, ensuring accuracy.

  Provides immutable and tamper-proof records accessible to all stakeholders.
- **Bank:**

  Manages the transfer of funds from the government to the farmer's bank account.

  Works in collaboration with the blockchain to confirm and validate transactions.

  Notifies farmers when funds are successfully transferred.
- **Farmer:**

  Submits required details for eligibility verification. Receives funds into their registered bank account. Can verify subsidy transactions on the blockchain to ensure accuracy and resolve disputes.

6.4.4. Interaction Process

- **Government to Blockchain:**
  The government confirms farmers' eligibility and records the approved subsidy details on the blockchain.
  This triggers a smart contract, automating the next steps.
- **Blockchain to Bank:**
  Once the subsidy is approved, the blockchain notifies the bank to proceed with fund disbursement.
  The smart contract ensures funds are sent to the correct farmer account.
- **Bank to Farmer:**
  The bank credits the subsidy to the farmer's account and sends a notification of the successful transfer.
- **Blockchain to Farmer:**
  Farmers can access the blockchain to check the status of their subsidy, ensuring transparency and accuracy.
- **Farmer Verification:**
  Farmers independently confirm the disbursement using blockchain data. Any errors or issues can be reported back to the government for resolution.

- **Key Advantages of the System**

- **Transparency:**
  The blockchain provides a clear and unalterable record of all transactions, promoting trust.
- **Automation through Smart Contracts:**
  Manual processes are minimized as smart contracts automatically execute subsidy disbursements based on predefined conditions.
- **Enhanced Security:**
  The decentralized nature of blockchain prevents unauthorized access or tampering of data.

- **Efficiency:**

  The system ensures faster and more accurate fund transfers by reducing delays caused by intermediaries.

- **Empowerment of Farmers:**

  Farmers can independently verify their subsidy details and transfer status, ensuring they are informed throughout the process.

CHAPTER - 7

TIMELINE FOR EXECUTION OF PROJECT

(GANTT CHART)

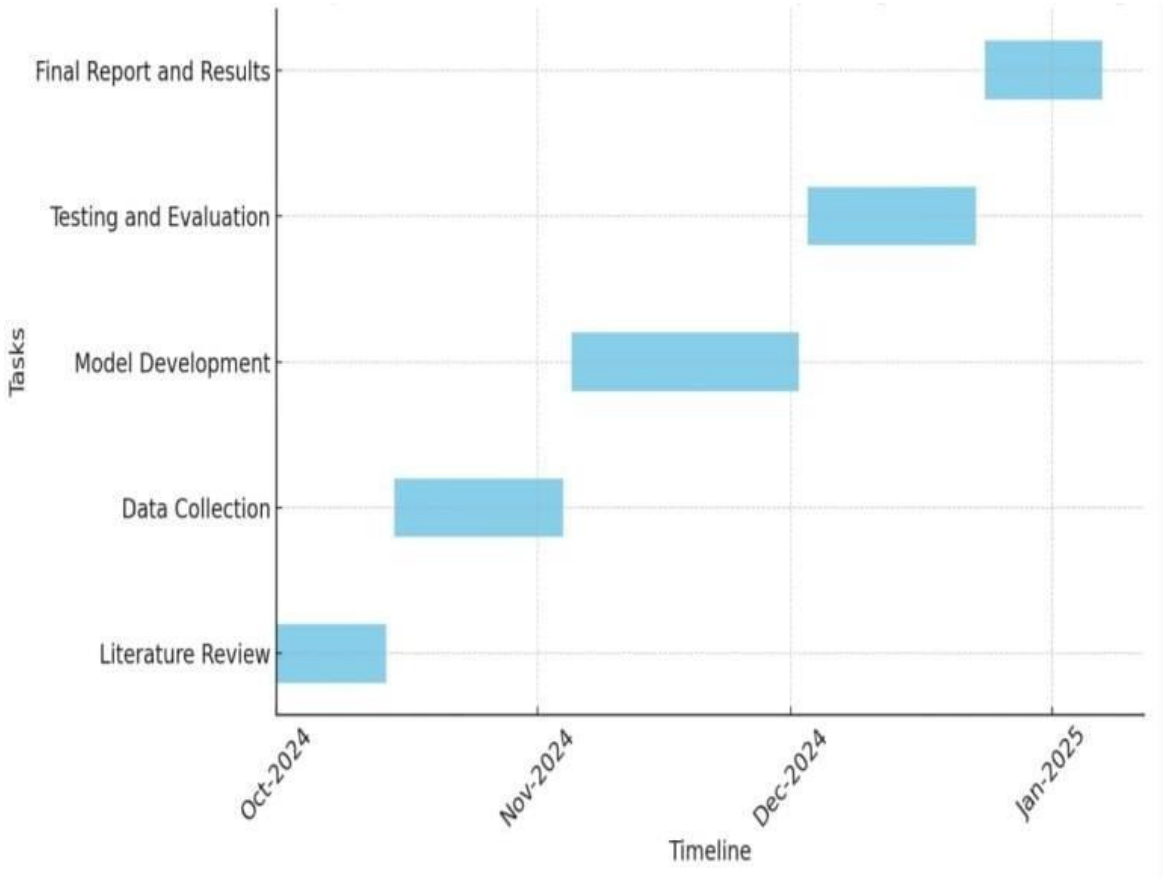


Fig 6 Gantt Chart

CHAPTER - 8
OUTCOMES

The "Subsidy Chain: Ensuring Transparency and Integrity in Government Fund Distribution" project aims to achieve multiple key outcomes, impacting both the operational efficiency of government subsidy programs and the overall experience of beneficiaries. The system's implementation will create measurable benefits in several areas:

1. Enhanced Accountability in Government Transactions

The introduction of blockchain technology ensures that every subsidy transaction is recorded on a secure, immutable ledger. This fosters accountability, making it difficult for errors or fraud to go unnoticed. As a result, government agencies are encouraged to maintain high standards of integrity in managing public funds.

2. Increased Public Confidence

By providing a transparent, secure, and automated subsidy distribution system, the project aims to improve public trust in government schemes. Citizens can be confident that they will receive the benefits they are entitled to, with minimal delay or interference, strengthening the overall reputation of government welfare programs.

3. Efficiency in Subsidy Distribution

Traditional subsidy processing systems often face delays due to manual checks and intermediaries. The blockchain solution automates key processes via smart contracts, enabling faster subsidy distribution and reducing the time between application and disbursement.

4.Elimination of Middlemen

Blockchain technology removes the need for intermediaries in the subsidy distribution process, reducing administrative overhead and potential points of
failure. This contributes to a more direct and cost-effective subsidy transfer system, where beneficiaries receive the full subsidy amount without deductions.

5.Improved Coordination Among Government Departments

The decentralized and transparent nature of blockchain facilitates seamless collaboration between different governmental agencies involved in subsidy distribution. Shared access to real-time data allows for more coordinated and efficient operation, minimizing potential for errors or duplication.

6.Environmental Benefits

By digitizing processes and eliminating the need for paper-based records, the project contributes to sustainability. The reduction in paperwork and administrative tasks helps lower the carbon footprint of the subsidy system, aligning with broader environmental goals.

7.Adaptability for Future Technological Integration

The blockchain-based solution is built to be flexible, allowing easy integration with emerging technologies like mobile applications, IoT devices, and Artificial Intelligence. This ensures the system remains adaptable as new tools and technologies are developed.

8.Scalability for Broader Use

While initially focusing on the PMKisan program, the blockchain platform is scalable, allowing its use for other government schemes. This opens the possibility of applying the system to a wide range of public welfare initiatives, making it a valuable tool for future government projects.

9.Real-Time Monitoring for Beneficiaries

The system will provide beneficiaries with real-time updates regarding their subsidy status, allowing them to track payments and better manage their finances. This transparency reduces uncertainty and helps people plan their financial activities with greater confidence.

10. Robust Data Security and Privacy Protection

Blockchain ensures the confidentiality and security of beneficiary data through advanced encryption and access control. Only authorized parties can access sensitive information, ensuring that privacy is maintained while still allowing necessary transparency.

11. Cost Savings for Government Operations

The elimination of intermediaries, automation through smart contracts, and streamlining of processes all contribute to significant cost savings for government agencies. These savings could be reinvested into other public programs or initiatives to further enhance the government's efficiency.

12. Empowerment of Farmers and Rural Communities

For agricultural subsidy programs like PMKisan, blockchain ensures that subsidies reach farmers without delays or manipulation. This gives rural communities greater access to timely financial support, helping to stabilize their livelihoods and support agricultural growth.

CHAPTER - 9

RESULTS AND DISCUSSIONS

The **"Subsidy Chain: Ensuring Transparency and Integrity in Government Fund Distribution"** project illustrates the practical application of blockchain technology in improving the efficiency and reliability of government subsidy systems. Below is an overview of the key findings and analyses based on the implementation and performance of the system.

1. System Performance

Transaction Speed: The system demonstrated faster processing times compared to conventional subsidy distribution methods. Using smart contracts on the Polygon blockchain network streamlined the process, reducing the delays commonly seen with intermediaries and manual verification.

Efficient Record Management: The decentralized structure of the blockchain allowed for seamless updating and management of records, providing transparent access to stakeholders involved, such as government bodies and recipients.

2. Security and Data Integrity

Enhanced Security: The blockchain system provided a high level of security for sensitive information. By leveraging encryption and permissioned blockchain mechanisms, data protection was assured, safeguarding beneficiaries' details from unauthorized access.

Immutability and Audibility: Once recorded on the blockchain, transaction records were immutable. This feature ensured that the data could not be altered, preventing fraud and maintaining the integrity of the subsidy distribution process.

Fraud Reduction: The system’s decentralized nature and the use of smart contracts reduced the need for middlemen, minimizing the risk of fraud. Furthermore, automated

validation through smart contracts ensured that transactions were legitimate and verifiable.

3. Cost Efficiency

Reduction in Operational Costs: By eliminating intermediaries and automating the subsidy process, the blockchain system reduced the administrative costs traditionally associated with subsidy distribution programs.

Decreased Fraud Costs: With enhanced transparency and fraud prevention measures, the cost of investigating and rectifying fraudulent transactions was minimized, further improving the cost-effectiveness of the system.

4. Scalability and Adaptability

System Expansion: The blockchain framework is scalable, meaning it can be extended to other government schemes beyond PMKisan. This adaptability allows the system to serve various subsidy programs in different sectors, such as healthcare, education, or social welfare.

Integration Potential: The system was designed with interoperability in mind, ensuring it could connect with existing government systems and databases, thus enabling a smoother transition from legacy systems.

5. Beneficiary Experience

Transparency for Beneficiaries: One of the most notable improvements for beneficiaries was the enhanced transparency. Through the blockchain, beneficiaries could track the status of their subsidies, ensuring they received the funds they were entitled to without unnecessary delays.

Direct Fund Transfers: Subsidies were transferred directly to the recipients without involving intermediaries, thus ensuring the full amount was received by the beneficiaries. This direct transfer mechanism improved efficiency and trust in the process.

User-Friendly Interface: The system's interface was designed to be easy to navigate, even for beneficiaries who might not be familiar with technology. This ensured that users could easily check the status of their subsidies without any technical barriers.

6. Challenges Encountered

System Integration: A major challenge faced during the implementation was the integration of the blockchain-based solution with existing government databases. However, this was addressed by developing a flexible architecture that allowed seamless compatibility.

User Adoption: Despite the system's advantages, some beneficiaries, particularly in rural areas, faced difficulties adopting the new system. Efforts were made to provide educational resources and assistance to help users transition to the new platform.

Regulatory and Legal Issues: As blockchain technology is still evolving, there were challenges related to adapting existing regulatory frameworks to incorporate blockchain-based systems. Ongoing discussions with policymakers were essential in addressing these challenges.

7. Impact on Society

Wider Access to Subsidies: The blockchain system ensured that more beneficiaries, particularly small-scale farmers, received direct access to subsidies in a more timely manner, helping improve their economic stability.

Empowerment of Rural Communities: By reducing delays and ensuring that subsidies reached their intended recipients, the project helped empower rural communities, enabling them to better support agricultural activities.

Increased Trust in Government Systems: The system improved public trust in government services by providing greater transparency and reducing the potential for corruption or fraud. This fostered confidence in the government's ability to manage and distribute subsidy.

8.Opportunities for Future Enhancements

Integration with IoT: Future iterations of the system could incorporate Internet of Things (IoT) technology to gather real-time data on agricultural activities, enabling more personalized and efficient subsidy distribution.

Incorporation of AI: Artificial intelligence (AI) could be utilized to analyze data patterns and predict the needs of beneficiaries. This would allow for more targeted and efficient allocation of subsidies.

Greater Automation: There is potential for further automating aspects of the system, including eligibility verification and subsidy calculations, which could reduce delays and human errors.

Security Requirement	Blockchain-based System	Traditional System
Data Integrity	Immutability and transparency	Centralized control, prone to tampering
Authentication	Decentralized Identity lined to Aadhaar	Centralized Identity Validation
Fraud Prevention	Transparent transactions and audit trails on blockchain	Prone to identify fraud and data manipulation
Access Control	Cryptographic verification	Centralized access control
Privacy	Data Stored as hashes, no sensitive data stored on-chain	Sensitive data is often centrally stored

Table 1: Security Requirements Comparison

CHAPTER - 10
CONCLUSION

The "Subsidy Chain" project demonstrates how blockchain technology can revolutionize the distribution of government subsidies by addressing inefficiencies and ensuring fairness. Through its use of smart contracts on the Polygon blockchain, the system achieves secure, automated, and tamper-proof transactions, minimizing delays and eliminating intermediaries. The project effectively tackles challenges like fraud and administrative overhead, fostering transparency and trust among all stakeholders. While obstacles such as integrating with existing systems and improving digital literacy in rural areas presented initial difficulties, these were overcome through strategic efforts, including collaboration with government agencies and targeted training programs.

The future potential of this solution is vast, with opportunities for scaling and innovation. Integrating technologies like IoT could enable real-time activity monitoring, while AI could improve the precision of subsidy allocation. Automating verification and allocation processes could further streamline operations. By setting a benchmark for integrity and efficiency in public sector programs, this initiative paves the way for a more accountable and equitable approach to resource distribution, offering a scalable model for modernizing welfare systems globally.

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APPENDIX-A

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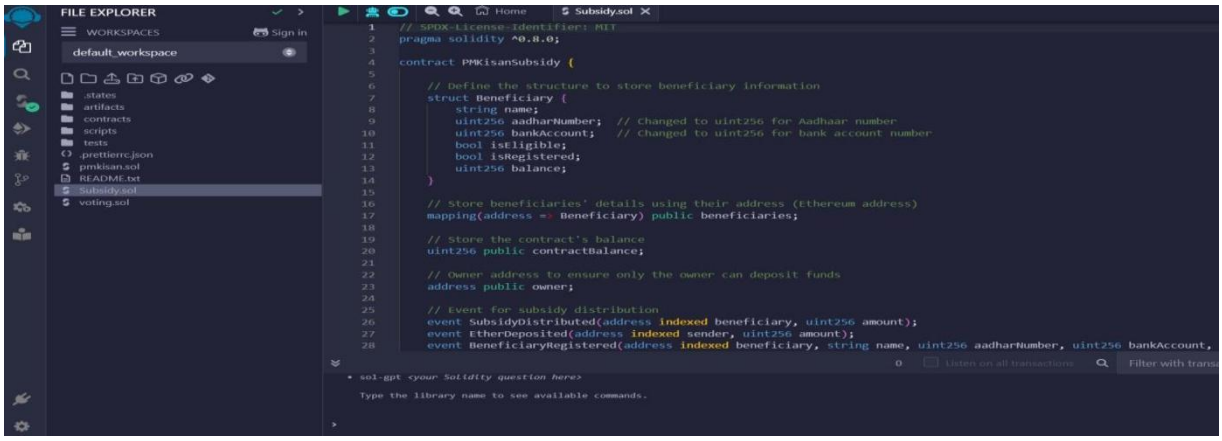

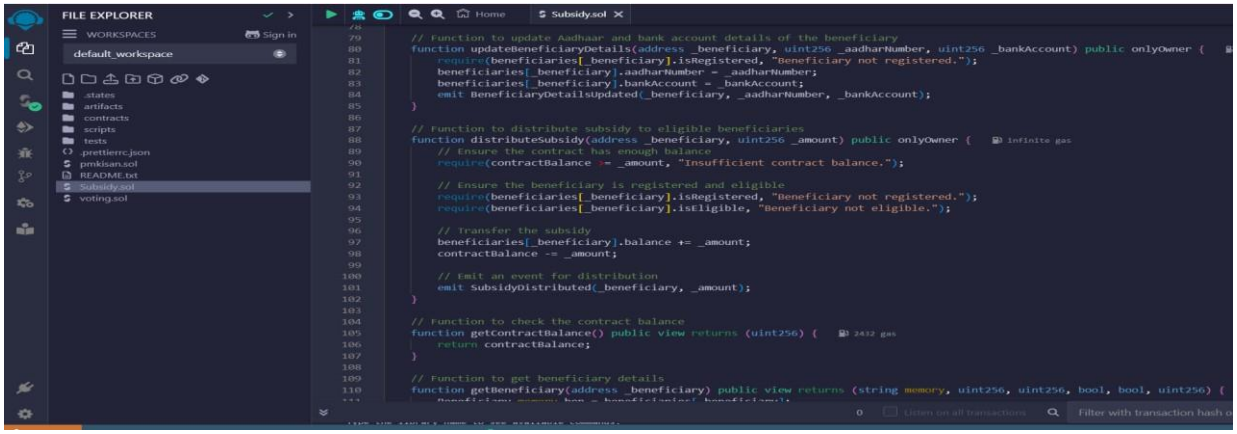

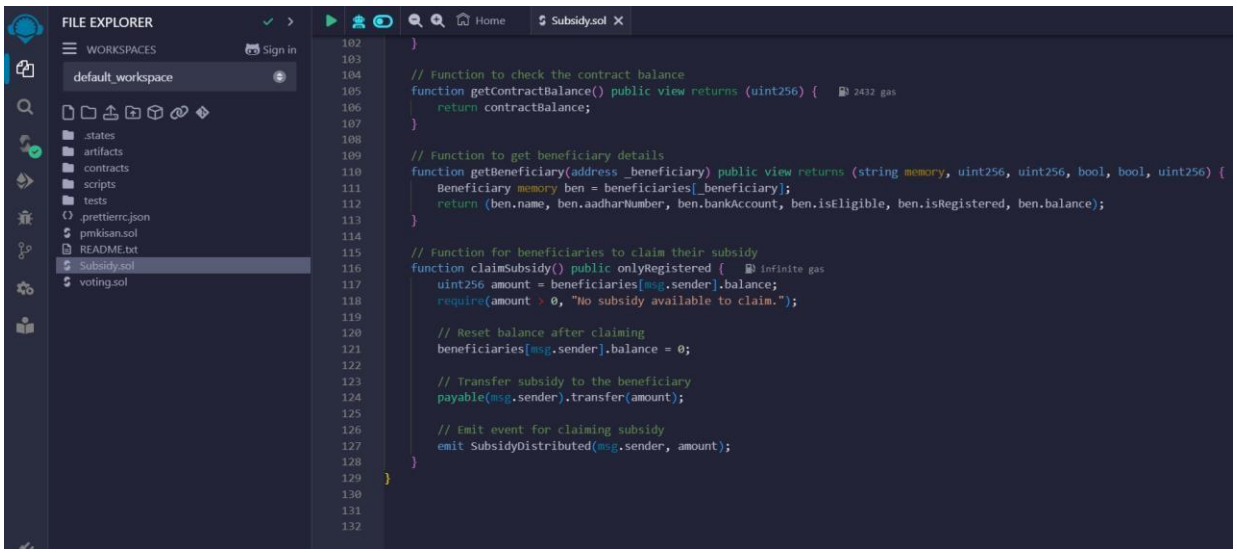

APPENDIX-B
SCREENSHOTS

Fig 7: Home page

This is an image of PM kisan Yojna which is for empowering farmers and to provide government schemes to display for farmers to provide subsidy.

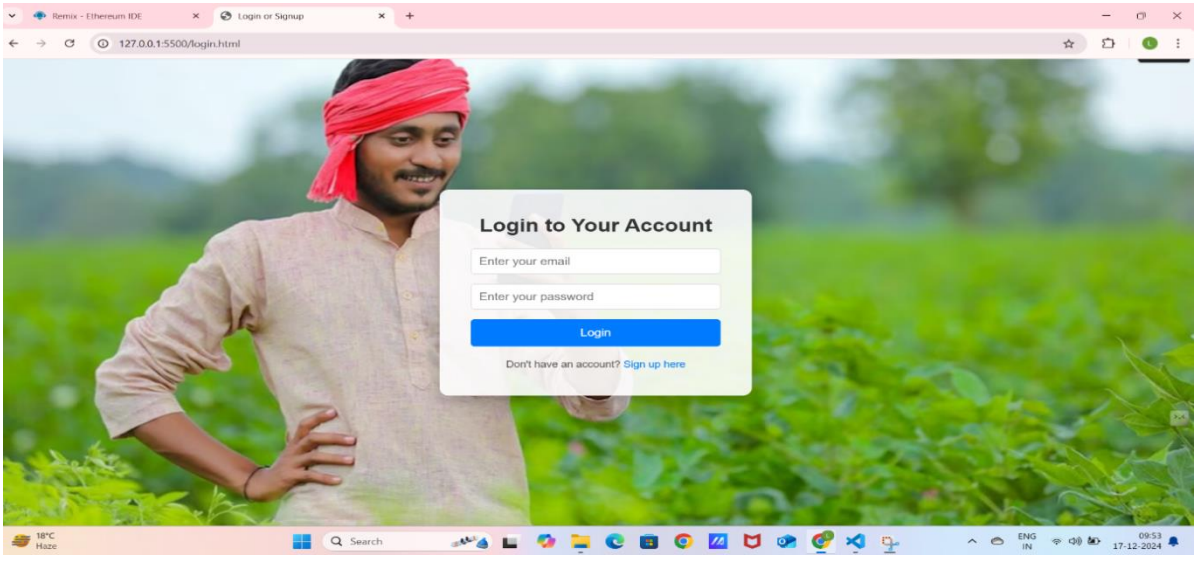

Fig 8: Login Page

The image displays a login interface for a web-based platform associated with "Remix Ethereum IDE," used for development activities, for farmers welfare registration.

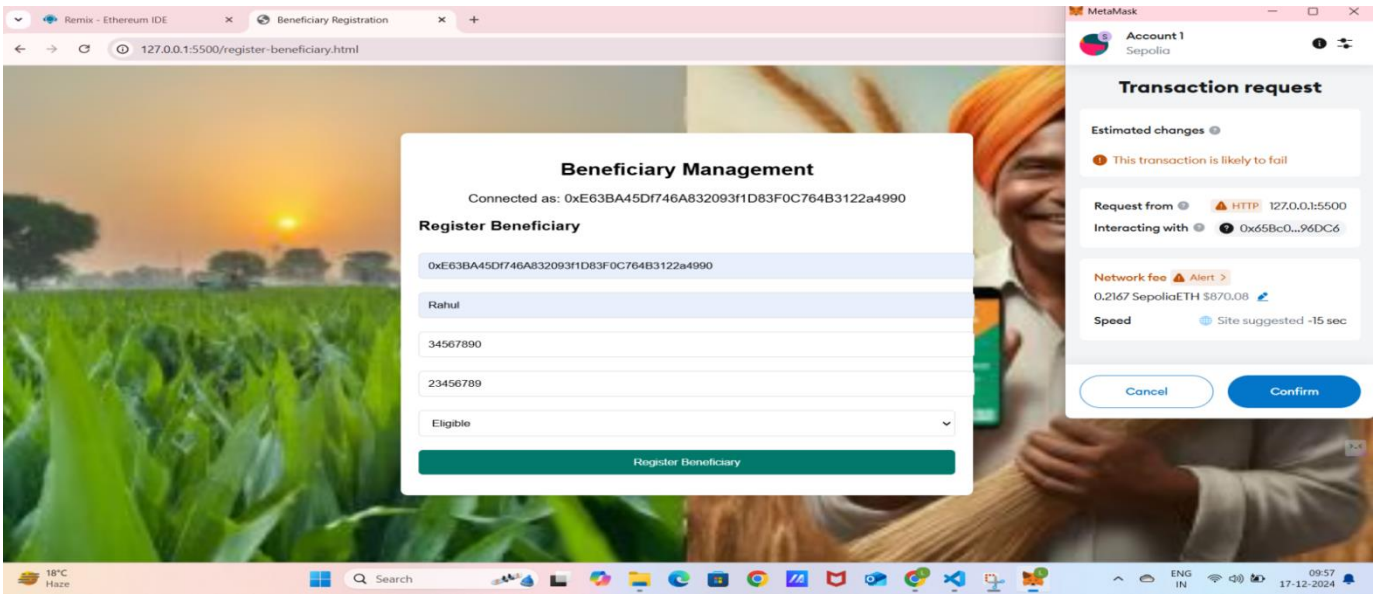

Fig 9: Beneficiary Management

The image displays a Beneficiary Management interface for updating details, with a MetaMask transaction on the Sepolia testnet. The background features a farming scene.

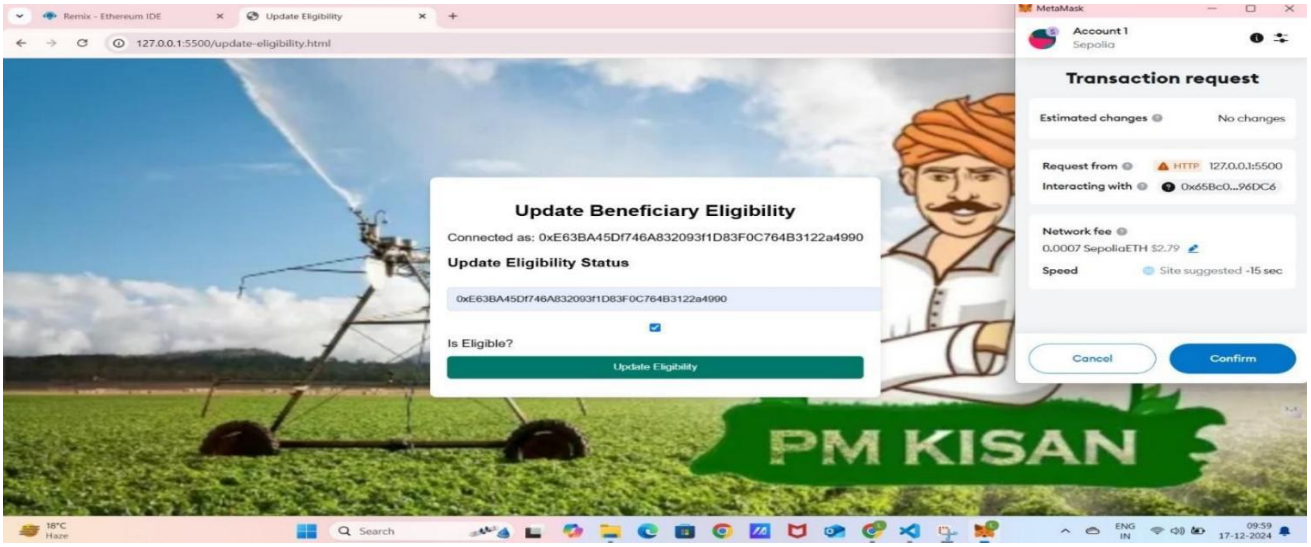

Fig 10: Update Beneficiary

This image displays a blockchain application on the Sepolia test network for updating beneficiary eligibility. A MetaMask transaction with a 0.0007 SepoliaETH fee awaits confirmation.

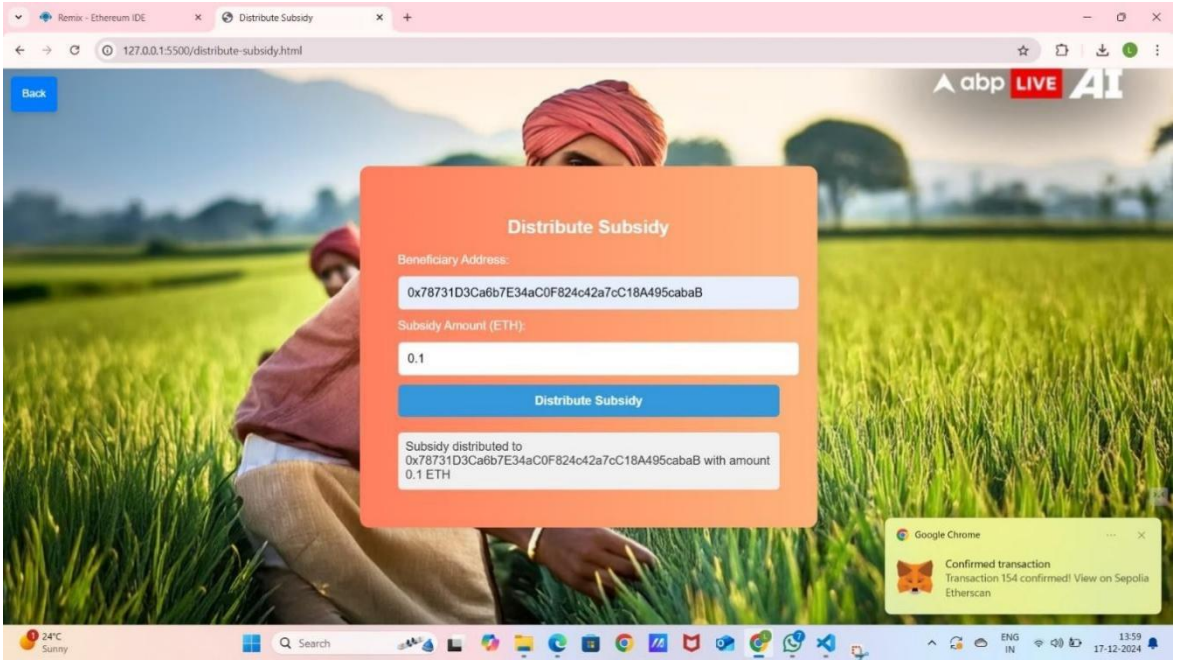

Fig 11: Distribute Subsidy

This image displays a blockchain application for subsidy distribution. A beneficiary address (0x7873...cabaB) and an amount (0.1 ETH) are entered. The transaction is successfully confirmed on the Sepolia testnet, as shown in the notification.

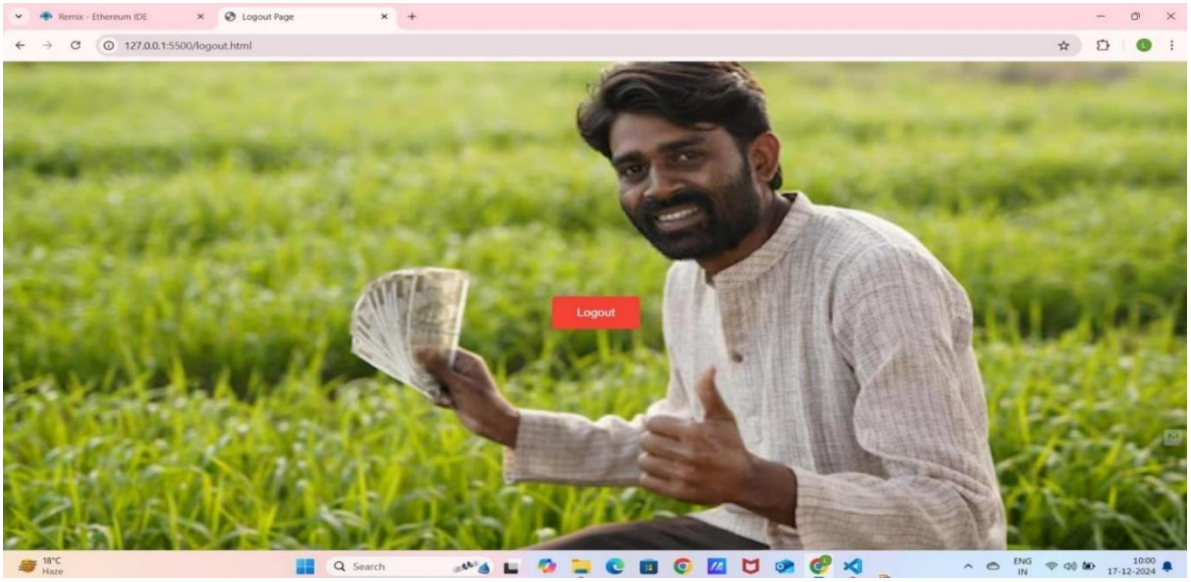

Fig 12: Logout

This image displays logout page

APPENDIX-C

ENCLOSURE

Goal 16: Peace, Justice and Strong Institutions:

Our project fosters transparency, accountability, and good governance through direct delivery of subsidies to rightful beneficiaries using blockchain technology. It will ensure the secure and tamper-proof system will not be misused for stealing funds and thereby strengthen the institutions and public trust.

Microsoft CMT <email@msr-cmt.org> Fri 3 Jan, 12:34 (11 days ago)

to me ▾

Hello,

The following submission has been edited.

Track Name: Blockchain Technology

Paper ID: 389

Paper Title: Subsidy-Chain: A Secure Blockchain-based Architecture for Subsidy Management and Tracking

Abstract:
This paper proposes a secure blockchain-based architecture for managing and tracking government subsidy distribution, with a focus on the PM Kisan Yojana scheme in India. The proposed system leverages decentralized identity (DID) technology on the Polygon public blockchain to streamline beneficiary registration, subsidy eligibility verification, and distribution. Farmers, as beneficiaries, are registered using Aadhaar credentials and their bank details, ensuring secure and trans- parent access to government subsidies. Smart contracts deployed
on the blockchain manage various processes, including eligibility
checks, real-time subsidy distribution, and claims between the
Government of India and farmers. This system enhances transparency, reduces fraud, and ensures seamless subsidy tracking. The architecture utilizes blockchain's immutable and transparent features to ensure accountability and traceability throughout the subsidy process, offering a scalable and efficient solution for public sector financial management.

Arshiya Lubna - Subsidy final reports (1)

ORIGINALITY REPORT

16%	10%	9%	9%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Presidency University Student Paper	4%
2	Submitted to City University Student Paper	3%
3	fastercapital.com Internet Source	1%
4	A M Viswa Bharathy, Dac-Nhuong Le, P. Karthikeyan. "Applications of Blockchain and Artificial Intelligence in Finance and Governance", CRC Press, 2024 Publication	1%
5	Fatima Zahra Fakir, Erdem Baydeniz. "The Future of Blockchain in Tourism and Hospitality - Global Insights", Routledge, 2024 Publication	<1%
6	Ramchandra Sharad Mangrulkar, Pallavi Vijay Chavan. "Blockchain Essentials", Springer Science and Business Media LLC, 2024 Publication	<1%