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Blockchain Technology in Dairy Farm Applications for Transparency and Fair Payment

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ABSTRACT

The dairy industry in our country accounts for 4% of the country's GDP and provides a source of income and livelihood to a significant proportion of country's population. The sector currently provides income and employment to over 2 million people across the dairy value chain. The dairy farmers, who are mostly smallholder farmers, rely on local milk collection centres that manually records milk delivery transaction in some hardcopy inventory files, which are stored in their offices. These records have been susceptible to modifications and deletions by these centres to cut down on their payments to farmers. Thus, this project explores the potential use of blockchain technology in milk delivery among smallholder farmers in the rural areas in developing nations towards creating transparency, trustworthiness, and fairness in payment to these farmers. We seek to design a farmer centric blockchain based platform that ensures that farmers are protected from unscrupulous and predatory middlemen in the milk delivery chain that exploit the illiterate and the unsuspecting farmers. In general, all farmers will sell their milk to 3rd part brokers or IDA staff members, and they will record each farmer milk delivery in a manual inventory report or in computer excel or centralized server. All framers may be no or less educated so brokers may alter farmer milk deliver records and make less payment to farmers and steal money. To overcome from above issue, this work suggesting migrating such inventory to Blockchain based server where data storage is immutable which means data cannot be alter in any manner after storage. Blockchain is a decentralized network which store data in multiple nodes and if one node is down then it can retrieve data from other working nodes. Blockchain store each record as block or transaction and associate each block with hash code and before storing any new block then it will verify hash code of each old blocks and if all records verified successfully then only it will store new records. So, data alteration is impossible in Blockchain. Hence, by using Blockchain we can save farmers money stealing by brokers.

Keywords: Milk delivery platform, Blockchain technology, Fair payment.

1. INTRODUCTION

Information and Communication Technology (ICT) has made a name for itself as an important tool for producing, organizing, storing and disseminating information effectively and efficiently. To increase agricultural productivity, ICT has been used to provide farmers with timely information on issues such as weather forecasts, market information and prices, diseases and pest control, among other things. ICT, for example, is linked to increased agricultural productivity, diversification of food crops, job creation, and increased access to cash crop markets. Even in the most remote rural areas, ICT has the potential to reach the poor and promote livelihood opportunities as a means of improving agricultural productivity.

Modern blockchain-like ICTs, widely used in the commercial, industrial, and economic spheres, are among these ICTs. Blockchain is considered a distraction and a novelty. This is due to the blockchain ability to support distributed transactions built on transparent and consistent infrastructure. Blockchain operations are naturally reliable and irreversible because they rely on cryptographic hash functions in hash-chain trading (also known as blocks) on the blockchain network. Records on the blockchain cannot be changed or modified. The next block of exchanges is just added after the complex numerical problem is solved and checked by the agreement system. Each new block has a unique cryptographic key that is created because of the data from the previous block. Blockchains are regularly audited by a shared organization and are used as a loosely distributed record, where centers mostly adhere to a convention of handing over and approving new blocks. Despite the fact that blockchain records are not immutable because forks are conceivable, blockchains can be considered safe by design and represent an extended processing framework with high adaptability to non-critical failures. Most blockchain projects deal with three main features: decentralization, versatility, and security. Designers are constantly trying to adjust these angles so that no one is at risk. You can find a detailed analysis of the structure and structure of the blockchain in future studies.

The dairy industry in our country accounts for 4% of the country's GDP and provides a source of income and livelihood to a significant proportion of country's population. The sector currently provides income and employment to over 2 million people across the dairy value chain. The dairy farmers, who are mostly smallholder farmers, rely on local milk collection centres that manually records milk delivery transaction in some hardcopy inventory files, which are stored in their offices. These records have been susceptible to modifications and deletions by these centres to cut down on their payments to farmers. Thus, this project explores the potential use of blockchain technology in milk delivery among smallholder farmers in the rural areas in developing nations towards creating transparency, trustworthiness, and fairness in payment to these farmers. We seek to design a farmer centric blockchain based platform that ensures that farmers are protected from unscrupulous and predatory middlemen in the milk delivery chain that exploit the illiterate and the unsuspecting farmers.

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2. LITERATURE SURVEY

Rambim et al. explored the potential use of blockchain technology in milk delivery among smallholder farmers in the rural areas in developing nations towards creating transparency, trustworthiness, and fairness in payment to these farmers. This work seeks to design a farmer centric blockchain based platform that ensures that farmers are protected from unscrupulous and predatory middlemen in the milk delivery chain that exploit the illiterate and the unsuspecting farmers.

Vincent et al. proposed blockchain technology in the milk and dairy product supply. Despite the proposal requiring drastic changes in the milk and dairy industry, the authors believed the benefits of implementing a Blockchain platform far outweigh the challenges involved.

Varavallo et al. presented a traceability platform based on Green Blockchain with low energy consumption and costs savings applied to the Fontina PDO cheese supply chain, part of the project "Typicalp", funded by the European Union (EU). The proposed traceability system is based on Algorand Blockchain, which used the Pure Proof-of-Stake mechanism of consensus that requires minimal computational power, is highly scalable and environmentally sustainable. In addition to the environmental and financial benefits, the developed traceability platform has made it possible to digitize the entire production chain, making the data immutable and available in real-time for Fontina consortium operators and final consumers.

Khanna et al. collated the mentioned functionalities into four distinct impact dimensions: social, economic, operations, and sustainability. The proposed blockchain-enabled dairy supply chain platform combines the use of smart contracts, quick response code (QR code) technology, and IoT and has the potential to redefine the dairy supply chains on socio-economic, operational, and sustainability parameters.

Li et al. introduced the major blockchain platforms currently used in food supply chains and conduct a synthesis analysis to explore the benefits and challenges of blockchain technology in the food industry. This work demonstrated that blockchain enables unprecedented visibility at each step of the food supply chain, helps increase transaction transparency, food safety, and quality, and reduces food fraud and waste. Furthermore, it served as a digital solution for reducing operational costs and improving efficiency in food supply chains.

Niya et al. introduced "NUTRIA" as a decentralized dairy product Supply Chain Tracing (SCT) system, designed and implemented based on real-world observations of the Swiss dairy supply chain and conducted in collaboration with dairy producers. Based on these studies and to overcome deficits of traditional and centralized SCT approaches, NUTRIA enabled an automated SCT via a Blockchain-based decentralized application. NUTRIA materializes a trusted and transparent SCT, which empowers the dairy value chain.

Liyanage et al. reduced the cost of import dairy products and increase the profit of the dairy industry. IDairy: Intelligence and secure e-commerce platform for dairy production and distribution using blockchain and machine learning has been suggested as a mobile

application. Developed a mobile application for farmers to store animal data, do profit calculation, including giving business solutions through the application with location tracking service. With this IDairy application, both farmers and production companies will be able to get an idea about their future profit and will be suggesting the business solutions.

Mangla et al. evaluated the societal impacts of blockchain technology on farmers, the community and animals using parameters such as local embedding, rural development, decreasing food fraud, animal health and welfare, proximity to food markets, food security, educating and promoting people towards healthy eating, assisting food access and social acceptability for transparency. Moreover, the critical traceability points of a milk supply chain are evaluated with the blockchain adoption. This will help achieved the sustainable development goals (SDGs) of providing safe food, promoting good health and better well-being for everyone.

Latif et al. suggested a commodity traceability network focused on blockchain technologies, which permanently stores all commodity history in a global database by way of smart contracts and creates a chain that can trace back to the source of goods. This framework built an incident response system to check the parties' identity and ensure the legitimacy of the transaction. And all events are stored permanently in the form of logs to manage disputes and track accountable entities.

Ahmed et al. presented a scoping review on the application of integrated LSS and blockchain technology in the manufacturing and healthcare sector. Further, the authors examined existing blockchain-based solutions on a variety of dimensions, including application area, technical approach, methodology, application scenario, various blockchain platforms, purpose, and monitoring parameters. The authors studied LSS approaches in detail, as well as the key benefits that blockchain technology can enable. Finally, the authors discussed significant research problems to be addressed to develop a highly efficient, resilient, and secure quality management framework using blockchain technology.

3. PROPOSED SYSTEM

To overcome from the issue arisen in existing system, this work suggesting migrating such inventory to Blockchain based server where data storage is immutable which means data cannot be alter in any manner after storage. Blockchain is a decentralized network which store data in multiple nodes and if one node is down then it can retrieve data from other working nodes. Blockchain store each record as block or transaction and associate each block with hash code and before storing any new block then it will verify hash code of each old blocks and if all records verified successfully then only it will store new records. So, data alteration is impossible in Blockchain. Hence, by using Blockchain we can save farmers money stealing by brokers.

To implement this project, we have designed following modules:

- **Admin:** admin can login to application by using username as admin and password as admin and then can add new farmer details who supply milk and add new NADAFA staff members. Admin can view all staff and farmer details.

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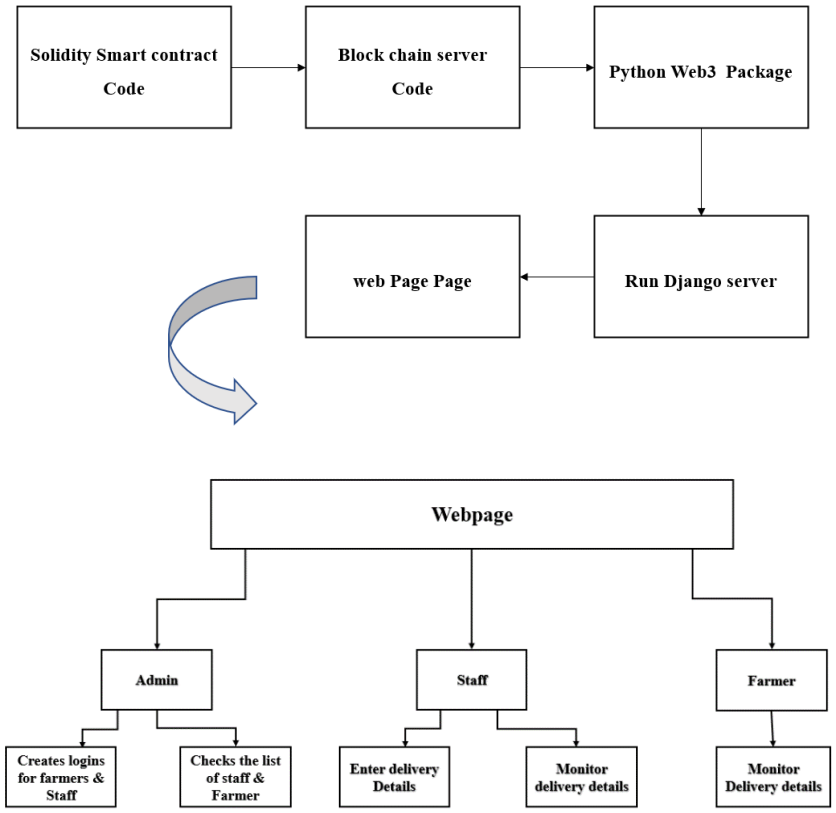
- **IDA Staff Login:** staff can login to application by using username and password given by admin and then record all milk deliveries done by farmer and all this delivery details will be saved in Blockchain.
- **Farmer Login:** The application allows farmers to log in using a username and password provided by the administrator. Once logged in, farmers can view the quantity of milk that has been delivered and the corresponding amount of money they will receive for their delivery. It is important to note that farmers are only able to view the details entered by the staff and are not able to edit any information on the portal. This ensures that the data remains accurate and up-to-date, and prevents any potential errors or discrepancies in the records. Overall, the application provides a convenient and secure platform for farmers to manage their milk deliveries and payments.

To store record in Blockchain we need to design SOLIDITY Smart Contract code and this code contains all functions to store farmer and staff details and then this contract will be deployed on Blockchain Ethereum tool. After deployment we can call this contract to read and store data by using PYTHON WEB3 package.



3.1 Ethereum

Ethereum is a decentralized blockchain platform that allows developers to build decentralized applications (dApps) and execute smart contracts. It was launched in 2015 by Vitalik Buterin and quickly became one of the most popular blockchain platforms in the world, second only to Bitcoin in terms of market capitalization.

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Ethereum's main innovation is the ability to create smart contracts, which are self-executing contracts with the terms of the agreement between buyer and seller being directly written into lines of code. These smart contracts are executed on the Ethereum Virtual Machine (EVM), which is a decentralized, Turing-complete virtual machine that runs on the Ethereum network.

The Ethereum network also has its own cryptocurrency called Ether (ETH), which is used to pay for transaction fees and computational services on the network. ETH is also used as a store of value and traded on cryptocurrency exchanges.

Overall, Ethereum provides a flexible platform for developers to build decentralized applications and execute complex smart contracts in a secure, transparent, and decentralized manner.

3.2 Advantages of Ethereum

Ethereum provides several advantages over other blockchain platforms and traditional systems. Here are some of the main advantages of Ethereum:

Smart Contracts: Ethereum's main innovation is the ability to create smart contracts, which are self-executing contracts with the terms of the agreement between buyer and seller being directly written into lines of code. This allows for secure and automated execution of complex agreements without the need for intermediaries or third parties.

Decentralization: Ethereum is a decentralized platform, which means that it is not controlled by any single entity or organization. This provides a level of trust and transparency, as there is no single point of failure or vulnerability.

Interoperability: Ethereum's blockchain is open-source and allows for interoperability with other blockchain platforms, making it easier to integrate with existing systems and applications.

Programmable: Ethereum's blockchain is programmable, which means that developers can create custom applications and smart contracts that meet their specific needs. This allows for more flexibility and customization than traditional systems.

Security: Ethereum's blockchain is secured through cryptographic algorithms and consensus mechanisms, making it resistant to hacking and fraud. Additionally, smart contracts on the platform are auditable and transparent, which helps to reduce the risk of fraud and corruption.

Tokenization: Ethereum enables the creation and exchange of tokens, which can represent assets, securities, or other digital assets. This makes it possible to create new business models and revenue streams that were previously not possible.

Overall, Ethereum provides a powerful and flexible platform for developers to build decentralized applications and execute complex smart contracts in a secure, transparent, and decentralized manner.

3.3 WEB3 Python Package

web3.py is a Python library that provides a simple and easy-to-use API for interacting with Ethereum networks using JSON-RPC. It allows developers to easily interact with smart contracts, send transactions, and access blockchain data.

Some of the key features of web3.py include:

Contract interaction: web3.py provides an API for interacting with smart contracts on the Ethereum network. This includes functions for deploying contracts, calling contract functions, and reading contract data.

Transaction management: web3.py makes it easy to send transactions to the Ethereum network, including specifying gas prices and gas limits.

Event listening: web3.py allows developers to listen for events emitted by smart contracts on the Ethereum network, making it easy to build real-time applications that react to blockchain data.

Blockchain data access: web3.py provides functions for accessing blockchain data like account balances, transaction history, and block data.

Integration with popular wallets: web3.py integrates with popular Ethereum wallets like Metamask and Geth, making it easy to manage accounts and interact with the network. Overall, web3.py is a powerful tool for building decentralized applications on the Ethereum network using Python.

3.4 Blockchain

Blockchain is a decentralized, digital ledger technology that is used to record and store data in a secure and transparent manner. It is a distributed ledger, meaning that it is maintained by a network of computers, rather than being controlled by a single entity. Each block in the chain contains a set of transactions, and once a block is added to the chain, it cannot be altered or deleted. This makes blockchain an immutable and tamper-resistant technology that is particularly well-suited for storing and transmitting sensitive data.

Blockchain technology is perhaps best known for its use in cryptocurrencies like Bitcoin and Ethereum, but it has a wide range of other potential applications as well. These include supply chain management, identity verification, voting systems, and more. The decentralized nature of blockchain means that it has the potential to disrupt a variety of industries and business models by enabling trust and transparency in transactions and data exchange.

Concepts

There are several key concepts that are important to understand when it comes to blockchain technology:

Decentralization: Blockchain is a decentralized technology, meaning that it is not controlled by any single entity, but rather maintained by a network of participants. This increases transparency, security, and resilience.

Distributed ledger: Blockchain technology uses a distributed ledger to record and store data. Each block in the chain contains a set of transactions, and once a block is added to the chain, it cannot be altered or deleted.

Cryptography: Blockchain technology uses advanced cryptographic algorithms to secure transactions and data exchange, making it highly resistant to hacking and cyber attacks.

Consensus mechanism: In a blockchain network, participants must agree on the validity of transactions before they are recorded on the blockchain. Different blockchain networks use different consensus mechanisms to achieve this, such as Proof of Work or Proof of Stake.

Smart contracts: Smart contracts are self-executing contracts with the terms of the agreement directly written into code. They can be used to automate complex transactions and ensure that all parties involved in a transaction adhere to the terms of the contract.

Tokenization: Blockchain technology enables the creation of digital tokens that can be used to represent a variety of assets, such as currencies, commodities, or even real estate.

3.4.1 Applications of Blockchain

Blockchain technology has a wide range of potential applications across various industries. Some examples of how blockchain is currently being used, or has the potential to be used, include:

Cryptocurrencies: Blockchain technology is the foundation of cryptocurrencies like Bitcoin and Ethereum, which use blockchain to enable peer-to-peer transactions without the need for a centralized intermediary.

Supply chain management: Blockchain technology can be used to create transparent and secure supply chain systems, allowing participants to track and verify the origin and authenticity of products.

Identity verification: Blockchain technology can be used to create secure and tamper-proof digital identity systems, allowing individuals to prove their identity without the need for a centralized authority.

Voting systems: Blockchain technology can be used to create secure and transparent voting systems, ensuring the accuracy and legitimacy of election results.

Healthcare: Blockchain technology can be used to create secure and transparent healthcare systems, enabling secure sharing of patient data and facilitating drug traceability.

Finance: Blockchain technology can be used to create more efficient and secure financial systems, allowing for faster and cheaper transactions while reducing the risk of fraud and corruption.

Real estate: Blockchain technology can be used to create more transparent and secure real estate transactions, allowing for faster and more efficient transfer of ownership.

These are just a few examples of how blockchain technology is being used, and there are many other potential applications that are currently being explored.

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4. RESULTS AND DISCUSSION

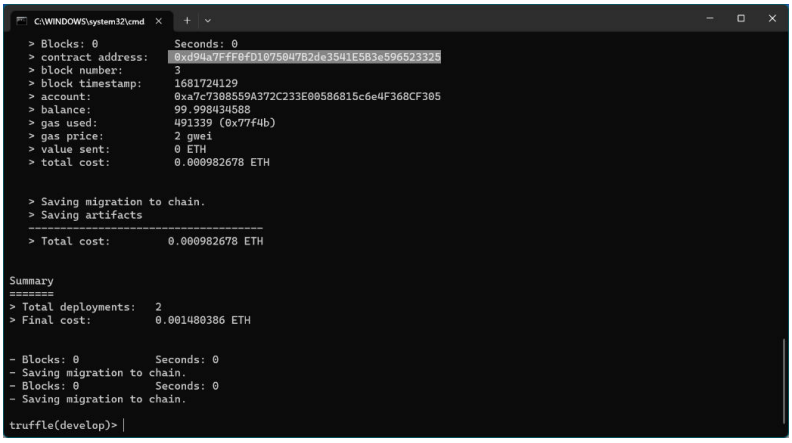
To store record in Blockchain we need to design SOLIDITY Smart Contract code and this code contains all functions to store farmer and staff details and then this contract will be deployed on Blockchain Ethereum tool. After deployment we can call this contract to read and store data by using PYTHON WEB3 package. Below screen showing solidity code

```
pragma solidity >= 0.8.11 <= 0.8.11;

contract MilkContract {
    string public nadafa_users;
    string public farmer_milk_delivery;

    function addNadafaStaff(string memory ns) public {
        nadafa_users = ns;
    }

    function getNadafaStaff() public view returns (string memory) {
        return nadafa_users;
    }

    function addMilkDelivery(string memory fm) public {
        farmer_milk_delivery = fm;
    }

    function getMilkDelivery() public view returns (string memory) {
        return farmer_milk_delivery;
    }

    constructor() public {
        nadafa_users = "empty";
        farmer_milk_delivery = "empty";
```

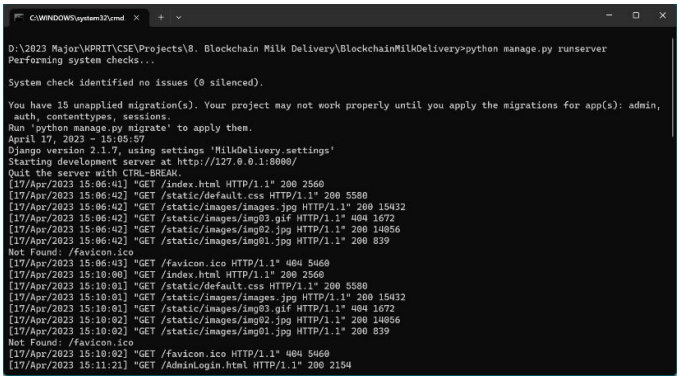
In above screen we have designed two functions where one is used to store staff details and other function is used to store and retrieve milk delivery details. Now to deploy this contract in Blockchain just go inside 'hello-eth/node_modules/.bin' folder and then double click on 'runBlockchain.bat' file to get below screen.

```
C:\WINDOWS\system32\cmd.

D:\2023 Major\KPRIT\CSE\Projects\8. Blockchain Milk Delivery\hello-eth\node_modules\.bin>truffle develop
Truffle Develop started at http://127.0.0.1:9545/

Accounts:
(0) 0xa7c7308559a372c233e00586815c6e4f368cf305
(1) 0x35f9a0cbebfcb69a09246271917afc351c7865cd
(2) 0x54e0a4d8a0e9cee7783208e2dc0e9521b50711e4
(3) 0x314bde5ca3eb430819d20cab13cd0325e2be92d1
(4) 0x2a18dd5dd260b588f8f7bc7d076ae5c23cd29170
(5) 0x99bba2e243a75de1c9d81d290fbd18fb030624f1
(6) 0x32e2681978fd566c30ed9e2028a75e5406c12426
(7) 0x267865136f3697604 0aea870f546ae867561957a
(8) 0xd59b991e3b4aee13ffc3e1f71cb7cc2aac2c35ad
(9) 0xf17260a07a1c8992d252d071accc623818d754d5

Private Keys:
(0) 4f3dc93e0278d0a4810ff232de637e917ac24b50d22cc933fb7200790b3ffd47
(1) 8bf4b412f7ce291831935643aae76d1fe26794f985454586f06bb9febd7fd13b9
(2) 7e18501a8c7aad5730890a815c53a53c67af9729bc37d9e1122eab6d2b5af089
(3) c9b6394108fc5555abfc4159f7f464e218e04f31ae38ce70653ecb92bdd83cec
(4) a71eca97b0864cda036f7da96717a720287f5b0fe07af9589f564aade66f22b1
(5) 87919bc80bdc56698bc2c9f9977f02e0355d5942eace040c2a4228adab808da1
(6) c7fd5a018a2a2bce07ed0ab123ee489274f1de4fc883aaeb8628c4325bf02a2c
(7) a2eeb4c2ffa2ffe3c48744c935b843e37f8f2e5f8e2ed3586f6f8398293c306b
(8) 9eaae7b877945ede7002107816a44a522109bc280ab849f9b49897a35f520da7
(9) 0b4b959e55feb28bfab8e135f7892f8d3f97846c3209e2a17e10151c9d3bbfb3

Mnemonic: venue must inhale zebra over squeeze pull foam hurt drift movie topple
```

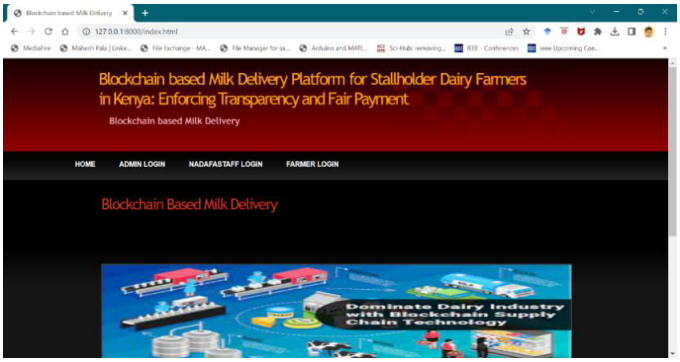
In above screen Blockchain generate some default accounts and keys and now in same console type "truffle migrate" and press enter key to deploy contract to Blockchain and get below output



In above screen in grey colour text, we can see MILK contract deployed and we have to specify that contract address in python code to access this Blockchain function and below is the python code. Now start DJANGO server like below screen



In above screen python DJANGO server started and now open browser and enter URL as http://127.0.0.1:8000/index.html and press enter key to get below screen



In above screen click on 'Admin Login' link to get below login screen

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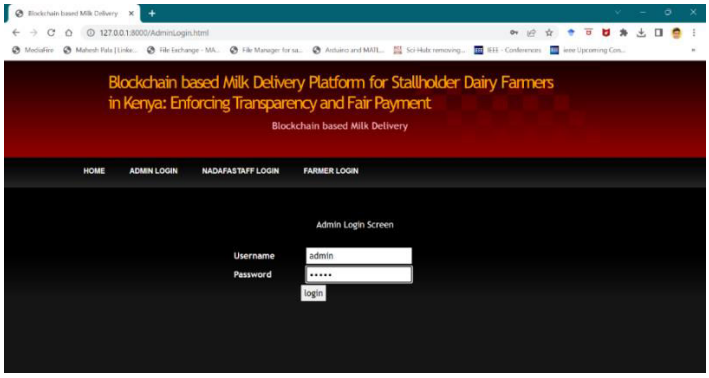
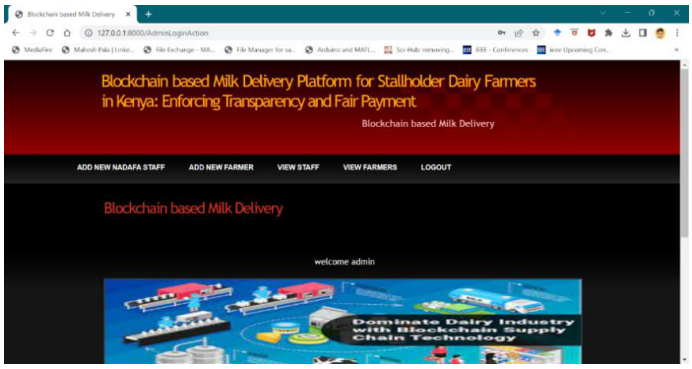
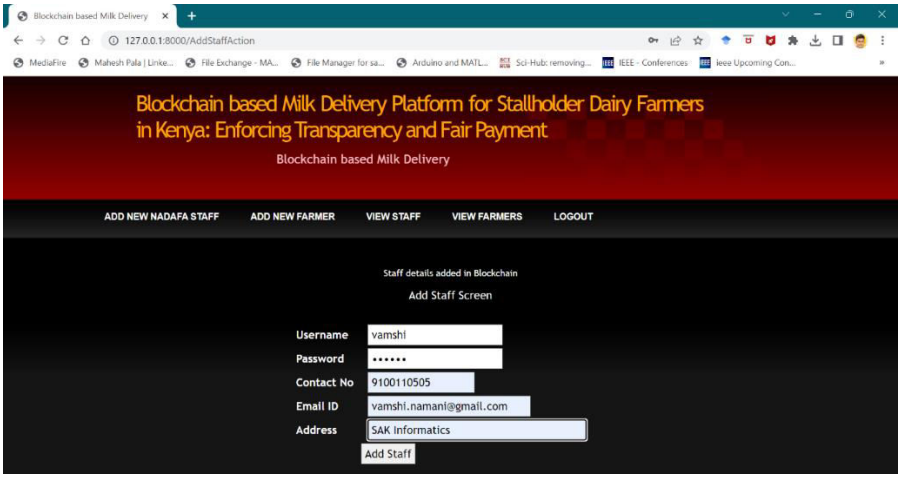


In above screen admin is login and after login will get below screen



In above screen 'admin' can click on 'Add New NADAFA staff' link to add staff details and get below output



In above screen admin is entering staff details and then press 'Add Staff' button to get below output

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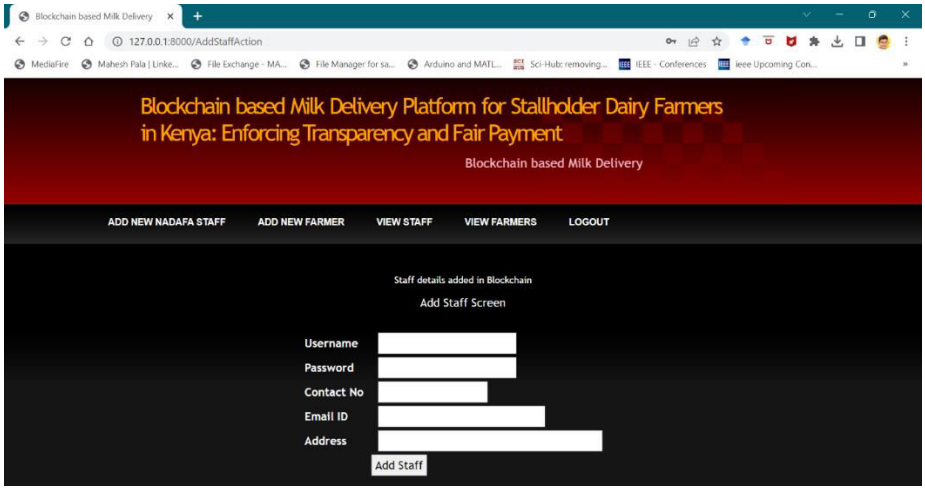
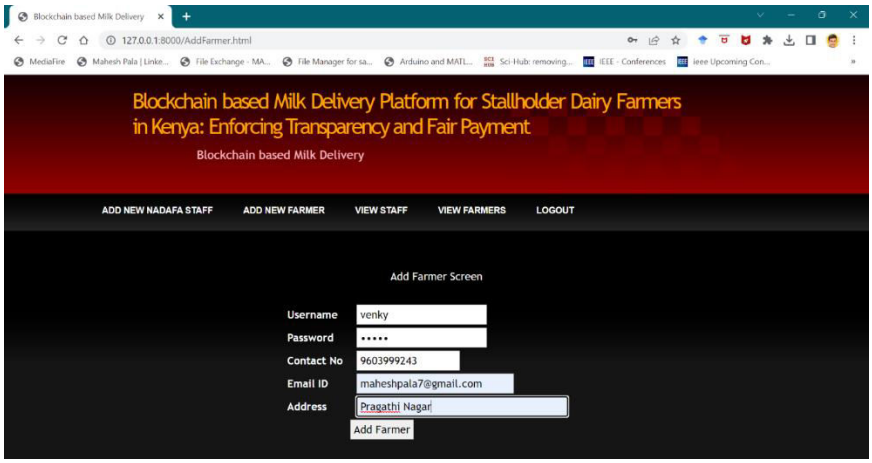
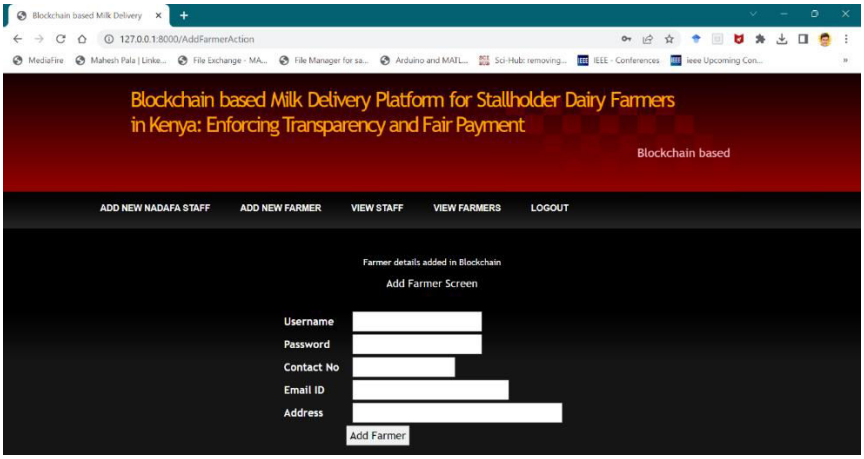


In above screen staff details added in Blockchain and now click on 'Add New Farmer' link to add farmer details



In above screen admin adding Farmer details and then press button to get below output



In above screen farmer details added and now click on 'View Staff' link to view all staff details saved in Blockchain

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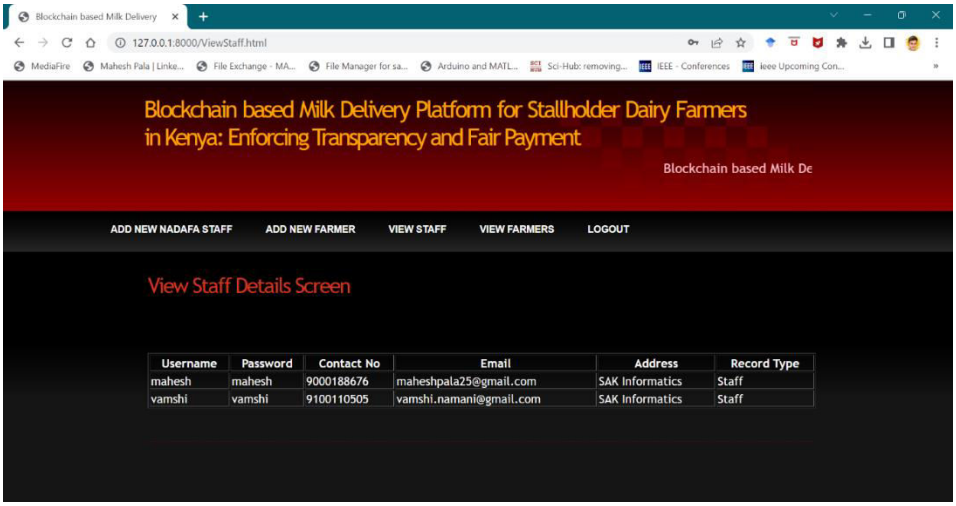
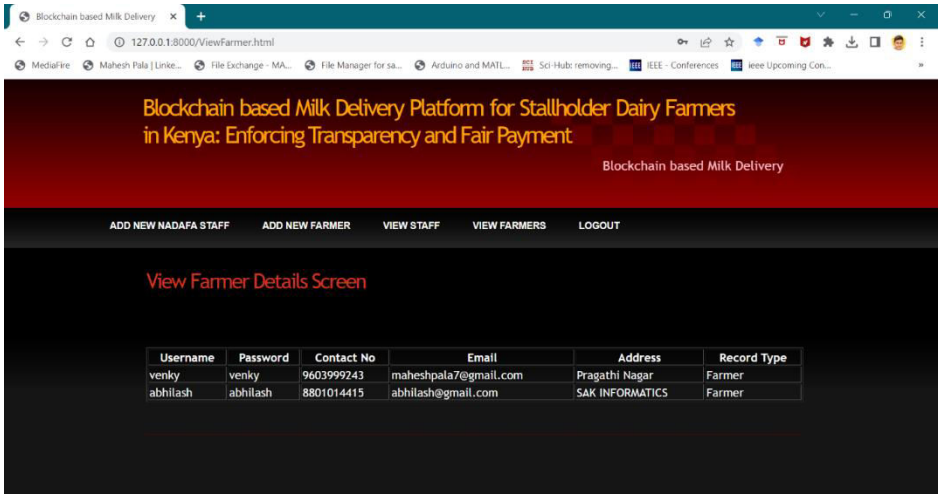
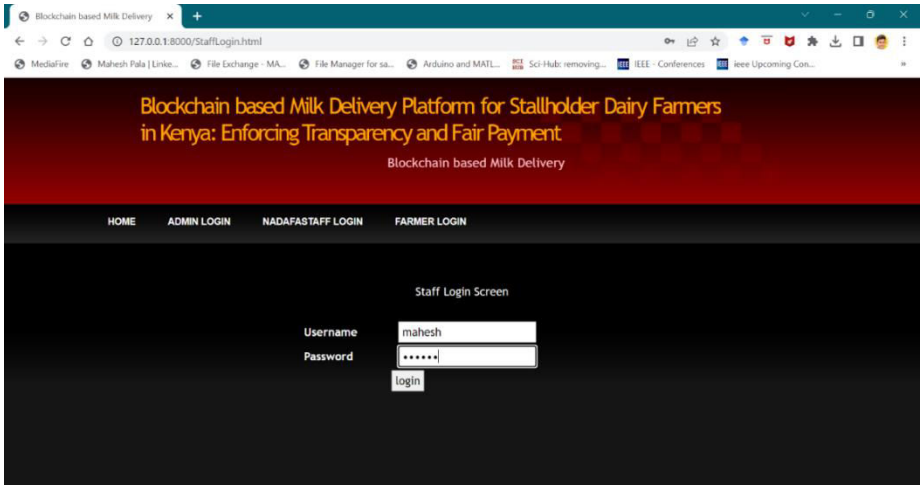


In above screen admin can view all staff details and similarly you can click on 'View Farmers' link to view all registered farmers



In above screen admin can view all farmer details and now logout and login as 'Staff Members'



In above screen staff member is login and after login will get below output

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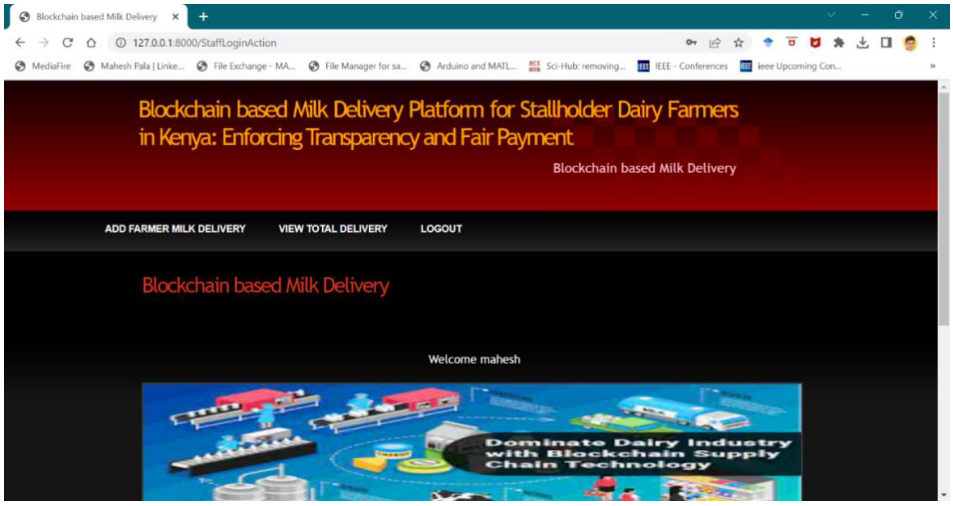
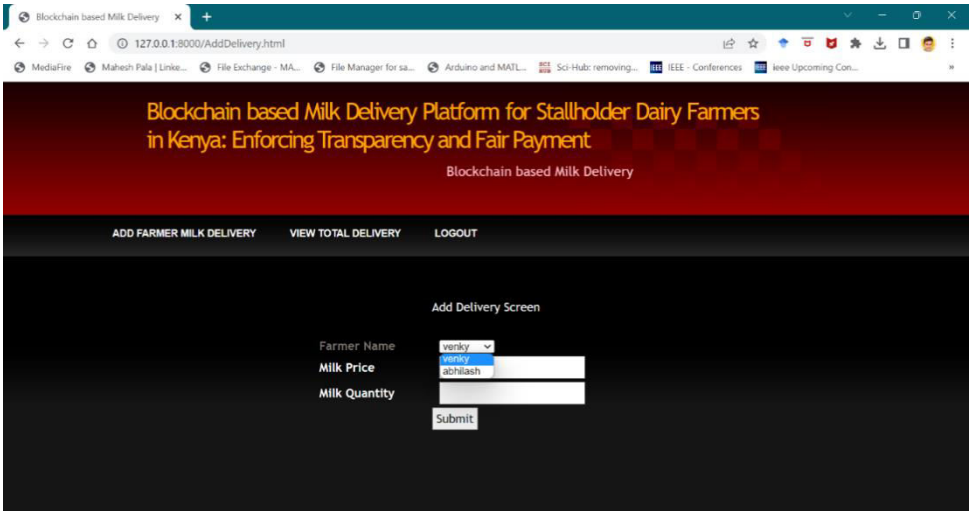
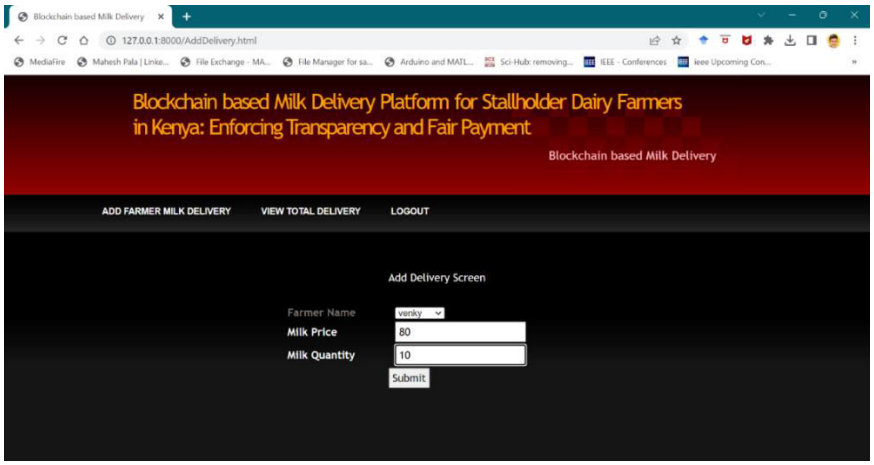


In above scree screen staff member can click on 'Add Farmer Milk Delivery' link to add farmer milk deliver details



In above screen staff member will select farmer name from drop down box and collect milk from farmer



In above screen staff member selected farmer name and entre milk price and quantity and then press button to store milk delivery details in Blockchain and get below output

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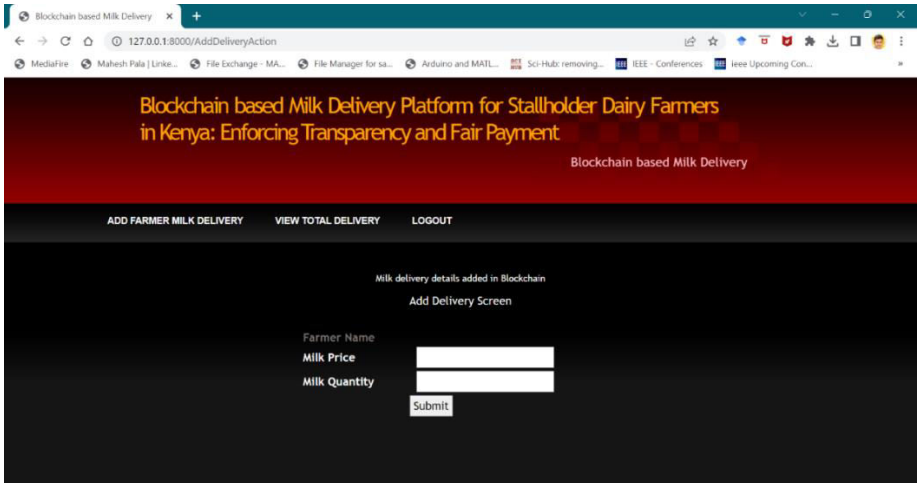
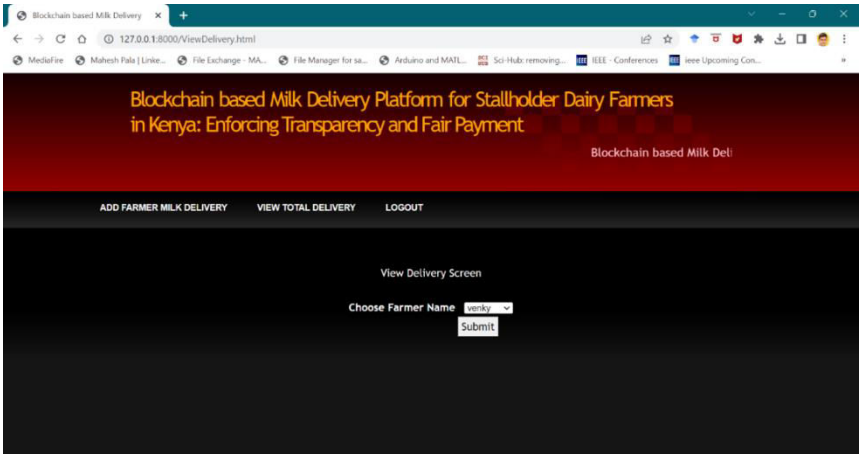
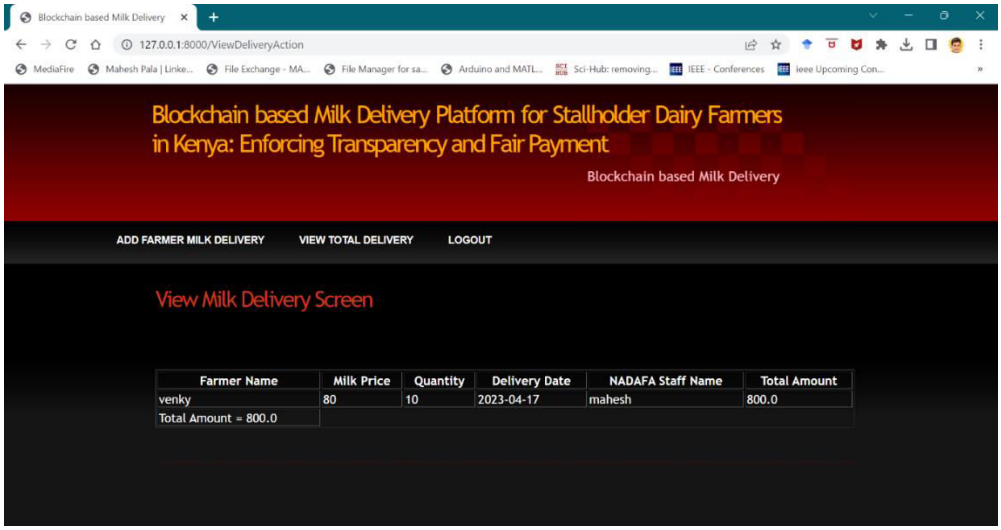


In above screen we can see milk delivery details added and now click on 'View Total Delivery' link to view all deliveries from farmers



In above screen select farmer name and then press button to view all his deliveries like below screen



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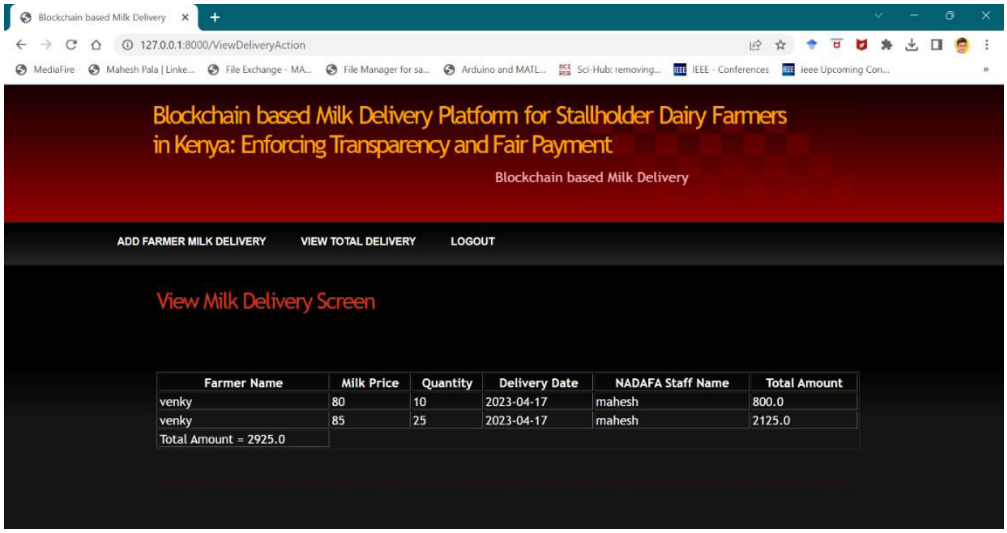
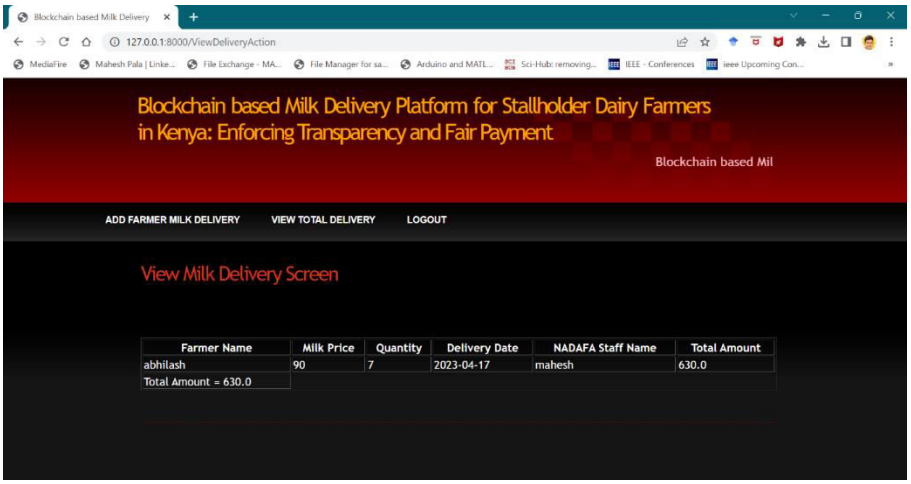
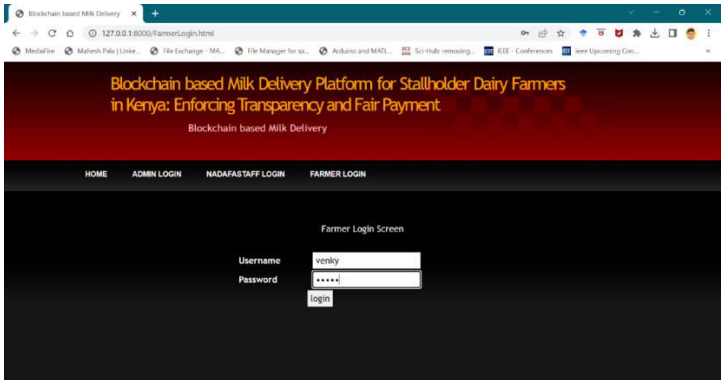
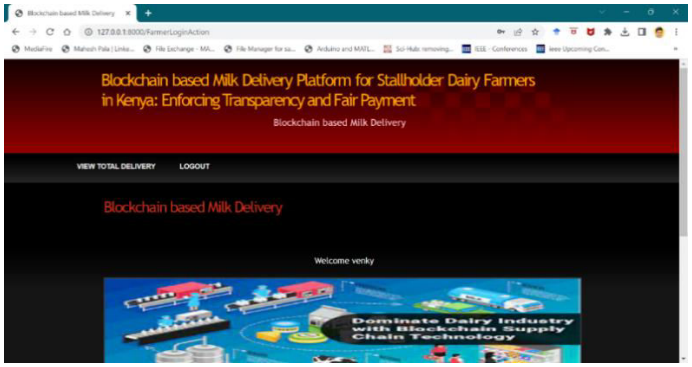


In above screen staff member can view how much delivery done by farmer and how much amount is balanced. Similarly, you can add any number users and then collect milk and store details in Blockchain.

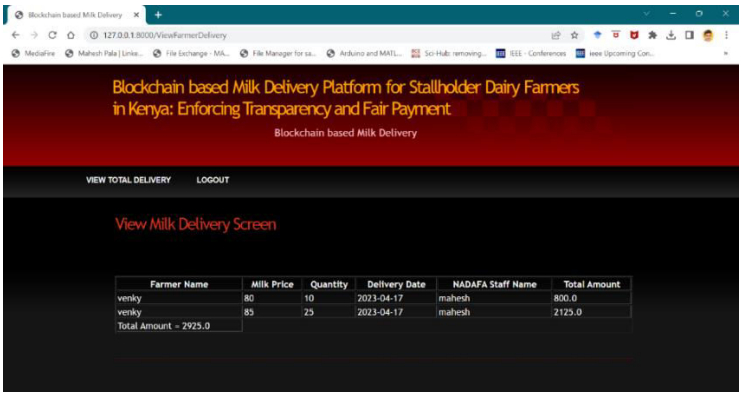




In above screen farmer is login and this username and password will be provided by 'admin' and after login will get below screen.



In above screen farmer can click on 'View Total Delivery' link to view all deliveries did by him.



In above screen farmer can view all his milk deliveries with quantity and date wise. These details will be added by NADAF staff. Similarly, you can add any number of farmer and staff and run code.

5. CONCLUSION

This project implemented the blockchain technology in the dairy industry can address the issue of manipulation and fraud in milk delivery transactions, thereby providing transparency, trustworthiness, and fairness in payments to smallholder farmers. The current system of manual record-keeping is prone to modifications and deletions, leading to farmers being exploited by unscrupulous middlemen. By migrating the inventory records to a blockchain-based platform, the data becomes immutable and decentralized, ensuring that records cannot be altered after storage. This technology provides a solution to the problem of altering farmer milk delivery records, resulting in fairer payments and protecting farmers from exploitation. The use of blockchain in this context has the potential to benefit the livelihoods and incomes of farmers in the dairy industry, contributing to the country's GDP and supporting a significant portion of the population.

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