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DEAGRICHAIN
Blockchain-based solution for agriculture

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Abstract

This research aims to develop a decentralized application (Dapp) for food supply chain traceability using blockchain technology. The Dapp enables consumers to track the journey of their food from the farm to their table, providing transparency and accountability to the supply chain. The Dapp is built on a blockchain platform using smart contracts to record and verify transactions between various stakeholders in the supply chain, including farmers, distributors, retailers, and consumers. Each stakeholder will have a unique identifier on the blockchain, and all transactions will be recorded in a tamper-proof and immutable manner. This work will contribute to the development of a more sustainable and trustworthy food supply chain, promoting ethical and environmentally friendly production practices. The Dapp will also provide opportunities for small-scale farmers and local producers to access larger markets and improve their profitability. Overall, this Dapp will help to create a more efficient, transparent, and accountable supply chain, benefiting all stakeholders, including suppliers, manufacturers, distributors, retailers, and consumers.

Keywords: Blockchain, Smart contract, Food supply chain, Metamask, Solidity, tracking, Agriculture

1. Introduction

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Despite the fact that nowadays there are numerous agricultural facilities available, the involvement of third party also increases. So far, most of the application cannot track the address or information of product regarding, who buy it? from where it came from? who is the producer for it? etc. When such questions arise for tracking, the blockchain technology is used to address those.

Blockchain: Blockchain is a decentralized digital ledger that records transactions and stores data in a secure and transparent way. It is a type of Distributed Ledger Technology (DLT) that uses cryptography to create a tamper-proof, immutable record of data. In a blockchain network, transactions are grouped into blocks and added to a chain of previous blocks, creating a permanent and unalterable record of all transactions that have taken place on the network. Each block contains a cartographic hash of the previous block, which links the blocks together and creates a secure and transparent ledger. One of the key features of blockchain is its decentralized architecture, which means that it is not owned or controlled by a single entity. Instead, it is maintained by a network of computers that work together to validate and verify transactions. This makes the blockchain network resistant to censorship and single-point-of-failure attacks and enables users to maintain control over their own data and assets.

DAPP: The key features of a DApp include its decentralized architecture, its use of smart contracts to automate functions, and its transparent and secure operation on a blockchain platform. One of the key benefits of DApp is that it allows users to interact directly with the blockchain network, without the need for intermediaries such as banks, governments, or other third-party service providers. This enables users to maintain control over their own data and assets, and can lead to increased privacy, security, and efficiency in various applications. Once a user submits a transaction to the blockchain, it is processed by the network of computers that make up the blockchain. The transaction is validated and added to the blockchain, and the Dapps smart contract is executed to perform the desired function. This process is decentralized, meaning that there is no single point of control or failure.

Smart Contract: Smart contracts are computer programs that run on a blockchain network. When a smart contract is created, it is stored on the blockchain, along with the terms and conditions of the contract. Once the smart contract is deployed, it is executed automatically whenever the predefined conditions are met. These conditions are typically coded into the smart contract using if-then statements, which allow the contract to react to specific inputs or

events. For example, a smart contract for a real estate transaction might contain conditions such as:

- If the buyer sends the required amount of cryptocurrencies to the smart contract address,
- If the seller transfers the property title to the buyer's name,
- If both parties confirm their agreement to the terms of the contract,
- Then the smart contract will automatically transfer the cryptocurrencies to the seller and the property title to the buyer.

Since smart contracts are executed automatically and transparently on the blockchain, they eliminate the need for intermediaries, such as lawyers or notaries, to oversee the contract execution process. This can result in faster, cheaper, and more secure contract execution, as well as increased trust and transparency between parties. Overall, smart contracts provide a way to automate and streamline contract execution, reduce transaction costs, and increase the efficiency and transparency of the contracting process.

2. Literature Review

"AgriOnBlock: Secured data harvesting for agriculture using blockchain technology" was suggested on July 13, 2021. The authors of the study Hiren Patela and Bela Shrimalib, argue that blockchain technology is a suitable substitute to address these problems and build confidence among all of its stakeholders. The distributed public ledger technology and a decentralized computing paradigm were secured. The study suggested AgriOnBlock, a blockchain-based mechanism that would connect different stakeholders by utilizing IoT devices and smart contracts in Ethereum to address the concerns described in the agriculture sector.

"Blockchain Technology in Agriculture Product Supply Chain," in 2021, proposed by Kasa Chiranjeevi, suggested a framework solution that does away with the need for intermediaries and centralized authorities that can be trusted. It also provides records of the transactions,enhancing reliable and efficient science and safety. All transactions are registered, then recorded and kept in the immutable ledger of the blockchain with connections to a decentralized le network.

"Blockchain-based method to enhance the Supply Chain Management in Indian agriculture," in2021, proposed by V. Sudha, enhanced supply chain management with the required characteristics, including checkpoints at every level of the supply chain management and verification of the condition of the items by both farmers and governmentauthorities. A method was put forth for achieving transparency regarding the state of the items that result in a more positive interaction between the producer and the consumer.

"Blockchain technology in existing agricultural systems: from approaches to applications" in 2021, proposed by Lai hung yak, presented a study that uses blockchain technology to showhow they might be used. To demonstrate how professionals utilize them to create these agricultural applications, popular platforms and smart contracts were also presented. Thirdly, the attempts and potential solutions being made to address the major issues that many future agricultural systems face to address these issues, were explored. "Macroblock: Blockchain-based Solution for Agriculture," released on May 5, 2021, proposed by Vanitha Sadananda Rai, establishes a blockchain-based framework for the agriculture industry.

3. Involvements in Agricultural Supply Chain

A supply chain is a network of individuals, organizations, activities, information, and resources involved in creating and delivering a product or service to the end customer. It includes all the activities that take place from the raw materials stage to the final product delivery to the customer, including sourcing raw materials, manufacturing, logistics, warehousing, and distribution. The traditional food supply chain involves the roles such as farmer, distributer, retailer and the consumer for delivering goods participated in it.

Farmer: A farmer is a person who is involved in agriculture, which is the practice of cultivating land, raising animals, and producing food, fiber, and other products. Farmers can work on small or large-scale farms, and they may grow crops such as corn, wheat, and vegetables, or raise livestock such as cattle, pigs, or poultry.

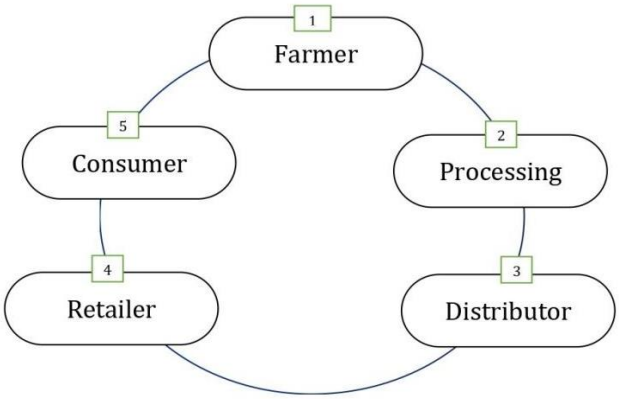

Figure 1. Involvements in agricultural supply chain

Processing: Food processing refers to the methods and techniques used to transform raw ingredients into food products that are safe to eat, have a longer shelf life, and are more convenient to store, transport, and use. The process typically involves a series of steps such as cleaning, sorting, cutting, grinding, heating, cooling, packaging, and preserving.

Distribution: The distribution of food products refers to the process of getting food from the point of production to the point of consumption. It involves a series of activities, such as transportation, storage, handling, and delivery of food products. The distribution of food products requires a complex network of logistics and supply chain management. It involves coordinating transportation, storage, and handling of products to ensure that they reach their destination in good condition and on time.

Retailer: Retailers play a critical role in the economy as they facilitate the distribution of goods and services from manufacturers to consumers. They provide convenience to consumers by offering a wide range of products in one place, and they add value to products through services such as customer support, warranties, and promotions

Consumer: A consumer is an individual or entity that purchases goods or services for personal or household use. Consumers are the end-users of products and services and can be individuals, families, businesses, or organizations. Consumers play a crucial role in the economy as they drive demand for goods and services, which, in turn, stimulates production and employment. Consumer spending accounts for a significant portion of economic activity in many countries, making it an essential indicator of economic growth.

4. WORKFLOW

The management of agricultural supply chain logistics and the expansion of farming goods are critical for ensuring product safety. The article on food safety and the possibility of contamination has reemphasized the need for supply chain traceability.

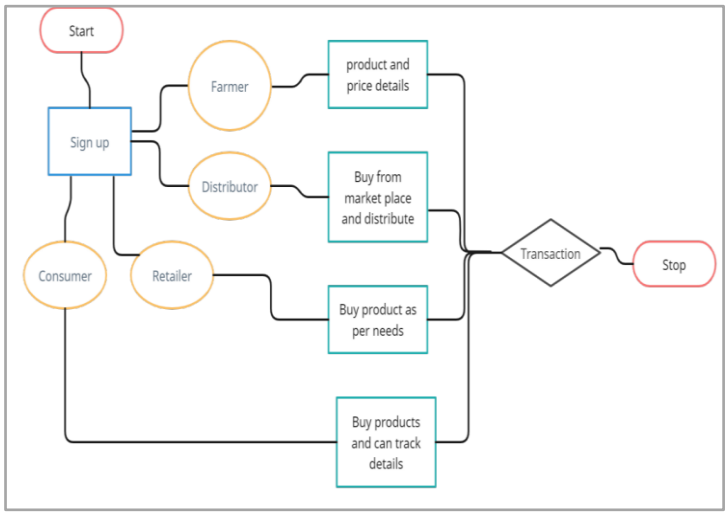

Figure 2. Workflow of agricultural supply chain

Farmer -> Distributor -> Retailer

Farmer will add the product information or list the information, and the ownership of the product will remain with the farmer until someone takes the product.

Now main idea is:

- Farmer should get profit; hence, when distributor is buying a product, he has to pay 20% higher price of the product so that farmer gets some profit. For example, if the farmer has listed his product price to be 100rs, then when the distributor purchases, the amount of the product will rise to 20% of original price, that is 120rs; hence, 20rs will reach the farmer's hand as his profit income.
- After the distributor purchases the product from the farmer, he adds the product in inventory as well as in the product's more sections (s_productdistributor).
- Finally, the retailer takes the product.

The product ownership changes as it is passed from one seller to another; therefore, the product owner information should be changed time to time while selling.

ListItem (Farmer will add the item to list)

- Check if price is less than 0, if it is, then give error.
- Add product in Farmers inventory.
- Assign the ownership of the product to the sender's address, that is the farmer emits or calls 'ItemListed' to list the product.

BuyItem (From farmer to distributor)

- Take unique ID of the product and fetch the product details.
- Increase the price of the product such that the farmer will profit.
- Add product in the distributor inventory.
- Delete the product from Farmer inventory.
- Store the info of the product in product distributor.
- At last, call 'ItemBought' so that it will pass info to the front-end.

PurchaseItem

- Based on the token ID of the product, fetch the product name.
- Check if the price is worth the product or not.
- Now the owner is changed. Hence, delete the product information from the distributor inventory and the variables which store information of the previous owner of product.
- At last, emit 'ItemPurchased' so that this updated information is passed to web UI.

5. Tools and Software Used

Vs-code: VS Code is a free, open-source code editor developed by Microsoft. It has become one of the most popular code editors among developers due to its user-friendly interface, numerous extensions and plugins, and its ability to work with multiple programming languages.

Remix IDE: It is a web-based Integrated Development Environment (IDE) for building and testing smart contracts on the Ethereum blockchain. It provides a user-friendly interface and simplifies the process of developing, testing, and deploying smart contracts on Ethereum. Some of the key features of Remix IDE include its ability to connect to various Ethereum networks, a built-in code editor, debugging tools, and automated contract testing. Additionally, it supports a range of programming languages such as Solidity, Vyper, and Yul. Remix IDE also includes a library of pre-built contracts, which can be used to deploy smart contracts quickly and easily. Furthermore, it has a plugin system that allows developers to add functionality to the IDE as needed.

Solidity: It is a high-level programming language that is used for writing smart contracts on the Ethereum blockchain. Solidity is similar to JavaScript in its syntax, and it supports object-oriented programming concepts such as inheritance and polymorphism. It also includes features such as libraries, events, and modifiers, which allow developers to write more complex and robust smart contracts.

Metamask: It is a popular web3 wallet and browser extension that allows users to interact with decentralized applications (DApp) on the Ethereum blockchain. It is a non-custodial wallet, which means that users are in full control of their private keys and funds. In this research, the web -based technology is used since anyone can use a mobile, also a farmer, and the Mobile wallet is the best option. For the purpose of access, metamask is needed and balance should be available. For the testing purpose, the testnet is used.

Ether: It is used to pay for the execution of smart contracts on the Ethereum network. Smart contracts are self-executing contracts that can automatically execute when certain conditions are met, without the need for intermediaries. They can be used to automate a wide range of business processes and operations, from supply chain management to decentralized finance applications.

Testnet: Goerli is a testnet for the Ethereum blockchain that is used for testing and developing applications before deploying them on the main net. To obtain test Ether (Goerli ETH) on the Goerli testnet, a faucet may be used. A faucet is a web application that can send a small amount of test Ether to the testnet address. The Goerli testnet has several faucets available that can be used to obtain test Ether.

Here are the steps to obtain test Ether from the Goerli faucet:

Navigate to a Goerli faucet website, such as *https://goerli-faucet.slock.it/ or https://faucet.goerli.mudit.blog/*. Enter the Goerli testnet address in the appropriate field on the faucet website. Complete any additional verification steps required by the faucet website, such as solving a captcha or completing a social media task. Click on the "Request" or "Send me test Ether" button on the faucet website. Wait for the test Ether to be sent to the Goerli testnet address. This process may take a few minutes, depending on network congestion. Once test Ether is received from the Goerli faucet, it can be used to test and develop Ethereum applications on the Goerli testnet. It is to be note that test Ether obtained from a faucet is not real Ether and has no monetary value, so it cannot be used on the Ethereum mainnet.

ReactJS: ReactJS is an open-source JavaScript library for building user interfaces. It was developed by Facebook and is widely used for building web applications and single-page applications.

NodeJS: Node.js is a powerful and flexible tool for building server-side applications with JavaScript, and it has become an essential tool for many developers and companies.

6. Implementation

When an application is logged in for logging, metamask connection is required. During the sign-up process, the role such as farmer, distributor, or retailer must be chosen. If logged in as farmer, the UI is given as below in which the list items are created by the farmer. The product details like who was the product’s farmer or the distributor or the retailer of it can be traced. Anyone can get this information by tracing the information using the wallet address. This builds trustworthy chain among the roles involved and also the third party are avoided. The main point is that the Government cannot take part in this transaction.

1] Connection of Metamask wallet to the application:

The first step when an application is run, is to connect the metamask wallet to the Deagrichain application. For connection, its mandatory to have ether in the wallet. The welcome page displays the page for connecting the wallet; when the button is turned on, the metamask opens automatically.

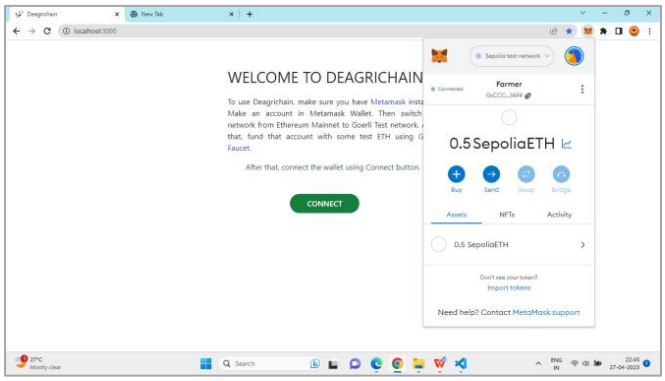

Figure 3. Connecting Metamask

2] Adding Ether (Test net Ether):

As application needs ether, testnet and its ether are available for adding. The testnet such as Georeil, Mumbai, and sepoil are available freely. For adding, the site is visited, and the wallet adders of the account are added, and the ether will be sent to the wallet.

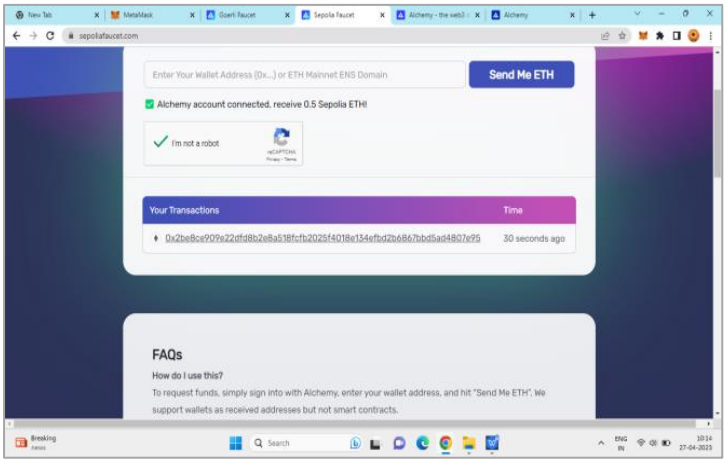

Figure 4. Adding Ether

3] Example when logged in as a farmer in the application:

After connecting the wallet, the sign-up page occurs in which the role as farmer, distributor, retailer or consumer is selected. For example, the farmer role has rights to edit the list in the inventory, for adding product details and its price.

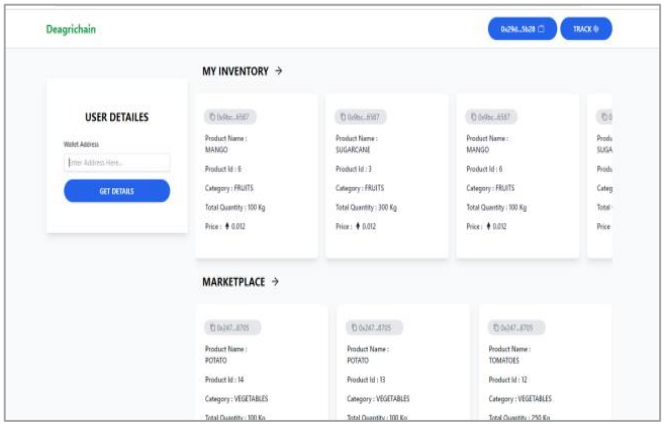

Figure 5. Example of Farmer

4] Tracking product details using smart contract functionality:

This system's main aim is to track the owner of the product and the details of that product, which will build the trustworthy chain and avoid the third party.

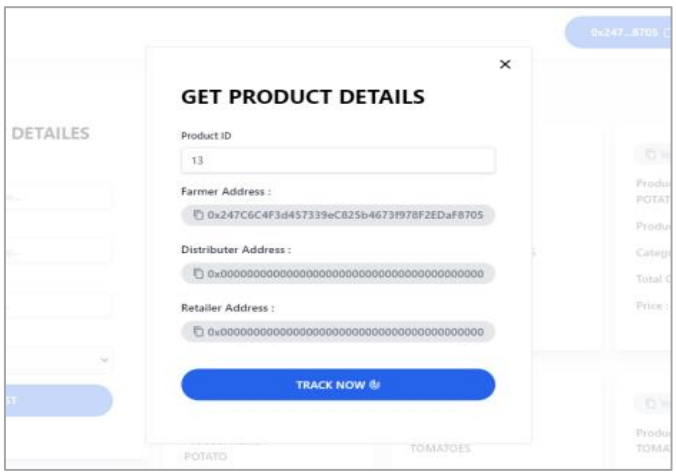

Figure 6. Tracking the product detail

7. Result

The result of a Deagrichain project and some outcomes that are achieved include:

A functional and user-friendly Dapp platform: The primary outcome of a Dapp platform is a functional and user-friendly platform that enables users to execute transactions, interact with smart contracts, and engage with other users in a decentralized environment.

Improved user experience: Through the use of modern development tools and technologies, such as React.js and CSS tailwind, a Dapp project can result in an improved user experience that is responsive, intuitive, and visually appealing.

Enhanced security: By leveraging blockchain technology and implementing robust security protocols, a Dapp platform can provide enhanced security features, such as secured storage of user data and secured execution of transactions.

Increased adoption: A successful Dapp platform can result in an increased adoption and usage by users, leading to a larger user base and more transactions on the platform.

Revenue generation: Depending on the business model and revenue streams of the Dapp platform, it may be possible to generate revenue through transaction fees, advertising, or other means.

Overall, the result of a Dapp project can be a highly functional, secure, and user-friendly platform that provides a new level of decentralization and user ownership. This can lead to increased adoption, revenue generation, and innovation in the blockchain space.

8. Discussion

Dapp can provide a number of benefits to users and developers alike, including increased security, transparency, accessibility, and innovation. Through the use of modern development tools and technologies such as React.js, CSS tailwind, and blockchain technology, it is possible to create a highly functional and user-friendly Dapp platform that provides a new level of decentralization and user ownership. By leveraging the power of blockchain technology, a Dapp platform can offer users a more secure and transparent environment for executing transactions, interacting with smart contracts, and engaging with other users in a decentralized network. With the increasing adoption of blockchain technology and the growing demand for decentralized applications, Dapp platforms have the potential to revolutionize the way people interact with each other and conduct business online.

Overall, a Dapp platform requires a solid understanding of blockchain technology, modern development tools, and a clear vision of what the platform should achieve.

9. Advantages

1. **User privacy:** The personal information that users share with the application or that the application collects from users are protected. It includes any data that can be used to identify an individual, such as name, address, phone number, email address, or any other sensitive information.

2. **Open source:** Benefit of open-source software is that it can be more secure and reliable than proprietary software. Because the source code is available to anyone, developers can identify and fix security vulnerabilities and other issues more quickly, and the community can work together to ensure that the software is stable and reliable.

3. **Fault tolerance:** The ability of a system to continue functioning properly in the event of a failure or error is fault tolerance. In other words, a fault-tolerant system is designed to continue working even if one or more components of the system fail.

4. **Decentralized storage:** It is a type of data storage system that relies on a network of computers and nodes to store and retrieve data instead of a centralized server or data center. In a decentralized storage system, data is stored across multiple devices or nodes, which can be located in different geographic locations.

5. **Security:** Decentralized storage can be more secure than centralized storage because it eliminates the risk of a single point of failure or attack. If one node is compromised, the data can still be retrieved from other nodes.

6. **Transparency:** It is transparent because all transactions and activities on the network are publicly visible on the blockchain. This makes it easier to verify the integrity of the data and to identify and prevent fraud.

10. Benefits

1. **Integration with other blockchain networks:** One area of future work for a Dapp platform could be to integrate with other blockchain networks, such as Ethereum,

Binance Smart Chain, or Polygon. This could provide users with more options for executing transactions and interacting with smart contracts.

2. **Development of additional features:** Dapp could continue to be developed by adding new features and functionality to the platform. For example, it could support additional cryptocurrencies or allow for the creation of custom tokens.

3. **Improvement of user experience:** Future work could include improve the user experience of the Dapp platform by making it more user-friendly, adding more intuitive interfaces, or improving performance and speed.

4. **Security and scalability improvements:** As the Dapp platform grows and scales, it is important to ensure that security and scalability are maintained. Future work could focus on improving security protocols, testing for vulnerabilities, and optimizing performance to ensure that the platform can handle increased usage.

5. **Community engagement and adoption:** Future work could involve engaging with the community to increase adoption of the Dapp platform. This could involve marketing and outreach efforts, educational resources, or incentive's user participation through rewards or other means.

11. Application

Decentralized applications (Dapps) can have a significant impact on agriculture and food supply chain by providing a more transparent and secure way to track products and goods as they move through the supply chain. Here are some potential applications of Dapps in this area:

Traceability: Dapps can be used to create a secure and transparent record of the entire supply chain, from farm to table. This can help to track the origin and movement of food products and ensure that they are produced and distributed in compliance with relevant regulations.

Smart contracts: Dapps can leverage smart contract technology to automate the process of verifying compliance with food safety standards, as well as to manage payments and settlements between different parties in the supply chain.

Quality control: Dapps can be used to monitor the quality of agricultural products, from seed to harvest. This can help to ensure that crops are grown and harvested in accordance with best practices and relevant regulations.

Farmer participation: Dapps can provide farmers with a way to participate in the supply chain, by giving them direct access to buyers and markets. This can help to eliminate intermediaries, reduce transaction costs, and ensure that farmers receive fair prices for their products.

Consumer engagement: Dapps can be used to provide consumers with more information about the products they are buying, including information about the origin, production methods, and quality of the product. This can help to increase consumer trust and engagement with the food supply chain.

12. Conclusion

In conclusion, a Dapp platform can provide a number of benefits to users and developers alike, including increased security, transparency, accessibility, and innovation. Through the use of modern development tools and technologies such as React.js, CSS tailwind, and blockchain technology, it is possible to create a highly functional and user-friendly Dapp platform that provides a new level of decentralization and user ownership. By leveraging the power of blockchain technology, a Dapp platform can offer users a more secure and transparent environment for executing transactions, interacting with smart contracts, and engaging with other users in a decentralized network. With the increasing adoption of blockchain technology and the growing demand for decentralized applications, Dapp projects have the potential to revolutionize the way people interact with each other and conduct business online. Overall, a Dapp project requires a solid understanding of blockchain technology, modern development tools, and a clear vision of what the platform should achieve. With careful planning, thorough testing, and a commitment to ongoing development and improvement, a Dapp project can provide a highly valuable and innovative solution for users and developers alike.

References

[1] IEEE Conference Publication | IEEE Explore. “Analysis of Agricultural Supply Chain Management for Trace-ability of Food Products Using Blockchain-Ethereum Technology,” October 30, 2020. https://ieeexplore.ieee.org/document/9278029.

[2] IEEE Conference Publication | IEEE Explore. “Blockchain 2.O: A Smart Contract,” December 1, 2021. https://ieeexplore.ieee.org/document/9752021.

[3] IEEE Conference Publication | IEEE Explore. “Blockchain Smart Contract for Calculable Data Sharing in IoT: A Case Study of Smart Agriculture,” December 12,2020. https://ieeexplore.ieee.org/document/9345874.

[4] Demestichas, Konstantinos, Nikolaos Peppes, Theodoros Alexakis, and Evgenia Adamopoulou. “Blockchain in Agriculture Traceability Systems: A Review.” Applied Sciences 10, no. 12 (June 15, 2020): 4113. https://doi.org/10.3390/app10124113.

[5] Kamble, Sachin S., Angappa Gunasekaran, and Rohit Sharma. “Modeling the Blockchain Enabled Traceability in Agriculture Supply Chain.” International Journal of Information Management 52 (June1,2020):101967. https://doi.org/10.1016/j.ijinfomgt.2019.05.023.

[6] Kamilaris, Andreas, Agusti Fonts, and Francesc X. Prenafeta-Boldú. “The Rise of Blockchain Technology in Agriculture and Food Supply Chains.” Trends in Food Science and Technology 91 (July 30, 2019): 640–52. https://doi.org/10.1016/j.tifs.2019.07.034.

[7] Leng, Kaijun, Ya Bi, Linbo Jing, Han-Chi Fu, and Inneke Van Nieuwenhuyse. “Research on Agricultural Supply Chain System with Double Chain Architecture Based on Blockchain Technology.” Future Generation Computer Systems 86 (September 1, 2018): 641–49. https://doi.org/10.1016/j.future.2018.04.061.

[8] Mirabelli, Giovanni, and Vittorio Solina. “Blockchain and Agricultural Supply Chains Traceability: Research Trends and Future Challenges.” Procedia Manufacturing 42 (January 1, 2020): 414–21. https://doi.org/10.1016/j.promfg.2020.02.054.

[9] Patel, Hiren D., and Bela Shrimali. “AgriOnBlock: Secured Data Harvesting for Agriculture Sector Using Blockchain Technology.” ICT Express, July 28, 2021. https://doi.org/10.1016/j.icte.2021.07.003.

[10] Queiroz, Maciel M., Renato Telles, and Silvia H. Bonilla. “Blockchain and Supply Chain Management Integration: A Systematic Review of the Literature.” Supply Chain Management 25, no. 2 (February 12, 2019): 241–54. https://doi.org/10.1108/scm-03-2018-0143.

[11] Saberi, Sara, Mahtab Kouhizadeh, Joseph Sarkis, and Lejia Shen. “Blockchain Technology and Its Relationships to Sustainable Supply Chain Management.” International Journal of Production Research 57, no. 7 (April 3, 2019): 2117–35. https://doi.org/10.1080/00207543.2018.1533261.

[12] Schmidt, Christoph M., and Stephan Wagner. “Blockchain and Supply Chain Relations: A Transaction Cost Theory Perspective.” Journal of Purchasing and Supply Management 25, no. 4 (October 1, 2019): 100552. https://doi.org/10.1016/j.pursup.2019.100552.

[13] IEEE Journals & Magazine | IEEE Xplore. “Smart Contract-Based Agricultural Food Supply Chain Traceability,” 2021. https://ieeexplore.ieee.org/document/9317793.

[14] IEEE Conference Publication | IEEE Xplore. “Using Blockchain and Smart Contract for Traceability in Agricultural Products Supply Chain,” November 27, 2020. https://ieeexplore.ieee.org/document/9312315.

[15] Yu, Chun-Tang, Yongzhao Zhan, and Zhi-Yuan Li. Using Blockchain and Smart Contract for Traceability in Agricultural Products Supply Chain. The Internet of Things, 2020. https://doi.org/10.1109/itia50152.2020.9312315.