AGRI-FOOD TRACEABILITY: AUTOMATIC GENERATION OF ETHEREUM BLOCKCHAIN CONTRACTS

[#1]SAINI ASHWINI, *Department of MCA,*
[#2]B.ANVESH KUMAR, *Assistant Professor,*
[#3]Dr.V.BAPUJI, *Associate Professor& HOD,*
Department of Master of Computer Applications,
VAAGESWARI COLLEGE OF ENGINEERING, KARIMNAGAR, TELANGANA

ABSTRACT: Transparency in the agri-food supply chain is becoming increasingly important to customers and governments alike. Because of the inherent trust and inalterability given by this technology, the adoption of block chain technology to enable safe traceability for the management of the agri-food chain, provide information such as the provenance of a food product, and prevent food fraud is growing rapidly. However, creating the appropriate smart contracts for these use cases is significantly more difficult than for other organizations. Several agri-food chain management systems based on blockchain technology and smart contracts have been proposed, but they are all ad hoc and difficult to generalize for a specific product or manufacturing process. In this work, we describe a novel approach for rapidly customizing and building general Ethereum-based smart contracts for the agri-food industrial domain, which allows us to reuse code and modules and automate the process to reduce development times while maintaining safety and dependability. Starting with the actual production process, we want to construct both the smart contracts that govern the system and the user interfaces that interact with them automatically, resulting in a semi-automatic system. We also include a case study on honey production to demonstrate how our method works. Future work will first broaden the scope of the technique to other supply chains; also, while Ethereum is presently being used, our approach will be easily convertible to other block chain platforms in the future.

Keywords: Block chain technology, Network node, RFID technology and SC programming languages.

1. INTRODUCTION

Block chain technology is a unique distributed, decentralized, and immutable ledger database that ensures data integrity and immutability without the need for a trusted third party. This is one reason why this technology is expected to solve problems in industries like the agri-food industry, which rely on the cooperation of a huge number of shady players. Bitcoin is a decentralized digital currency that was first described in a white paper [1] written in 2008 by an unknown programmer(s) under the alias Satoshi Nakamoto. Because it is built on a block chain, it may be transferred from one person to another without the need for an intermediary or centralized authority. The data in a block chain, which is a distributed database, is immutable and secure, and its history can be viewed by anyone with access to the network. Users can join the P2P network anonymously through encrypted transactions, making use of the underlying technological protocol that enables data transmission with other parties within the P2P network. Each transaction must be validated by a group of users via a consensus method before it can be added to the immutable chain of blocks comprising the transactions stored in every node of the network and recorded in the ledger. We are witnessing a meteoric rise in ideas and applications due to the widespread adoption of blockchain technology by both established businesses and innovative new ventures.

2.LITERATURE SURVEY

BLOCKCHAIN IN AGRICULTURE TRACEABILITY SYSTEMS: A REVIEW

There is no denying the significance of food, both as an individual necessity and in the larger context of human cultures everywhere. It is generally accepted that the food and agriculture sectors contribute significantly to global employment levels. Farmers, distributors, retailers, and consumers are just some of the various types of stakeholders involved in the agricultural supply chain, all of whom add complexity to its administration. The complexity of the agricultural goods supply chain makes it difficult to create global solutions to improve transparency and traceability. This article offers an in-depth analysis

of how blockchain technology has been applied to date food and agricultural production. The essay begins with a brief introduction to traceability, including its definition, levels of application, tools, and benefits. Following this, a brief summary of the features and advantages of blockchain technology is presented. The next step is to conduct a thorough analysis of the published research on the topic of blockchain technology's potential application in traceability systems. The paper then moves on to an analysis of related existing commercial implementations, focusing on the difficulties those projects have faced. In addition, it gives a survey of the ways in which blockchain technology may be used in the near future to improve the agricultural and food supply chain.

A REVIEW ON AGRI-FOOD SUPPLY CHAIN TRACEABILITY BY MEANS OF RFIDTECHNOLOGY

Radio-frequency identification (RFID) technology holds great potential for improving agri-food supply chain security and streamlining information administration. With the mandatory introduction of food item traceability systems, several countries today place a premium on the critical importance of guaranteeing food safety. Therefore, it is crucial to employ technical solutions that improve food and agricultural traceability. The primary purpose of this research is to analyze recent progress made by the RFID industry in the food and agriculture sectors. To do this, an operational framework will be used to categorize the current literature, making it easier to conduct a brief content analysis and, in turn, identify promising new lines of inquiry. Despite widespread agreement on RFID's potential benefits, widespread adoption has yet to occur due to a number of obstacles. The results of this survey may help readers comprehend the opportunities and challenges associated with RFID's widespread adoption. The major goal of this analysis is to give a state-of-the-art evaluation of developments in RFID technology for various product types in the agri-food industry. Furthermore, the paper intends to investigate the feasibility of implementing RFID technology at various points in the manufacturing and distribution chain in order to improve technological and logistical capacities. RFID implementations are growing rapidly in the agri-food sector, as was previously indicated, and technological advances are converging with the possibility for practical usage. However, there are numerous technical and financial hurdles that prevent RFID technologies from being used in real-world applications at this time.

A FOOD TRACEABILITY SYSTEM BASED ON BLOCKCHAIN AND RADIO FREQUENCY IDENTIFICATION TECHNOLOGIES

Consumers' knowledge and sensitivity has been raised as a result of the prevalence of food safety accidents around the world. Food safety measures and consumer confidence could both benefit greatly from the implementation of a food traceability system. Current food traceability systems rarely think about how the environment affects the quality of food at any point in the supply chain. Another major obstacle is making sure the information you get through traceability is correct. The purpose of this initiative was to use blockchain and RFID to create a standard for tracking the whereabouts of food along the supply chain. The architecture incorporated a centralized database and a blockchain for data storage, with a focus on maintaining the transparency of environmental data at every stage of the food production process. In contrast to the lot identifying information that was collected at various points in the supply chain, environmental data were recorded utilizing blockchain technology. This guaranteed that the data used for traceability was correct and complete. Traceability of trial temperature data was achieved by simulating the model's block chain in an Ethereum test environment.

A REVIEW ON BLOCKCHAIN APPLICATIONS IN THE AGRI-FOOD SECTOR

Transparency, low transaction costs, and the ability to put this technology to use right away are just a few of the reasons why food security is beneficial. A blockchain is a distributed,

encrypted ledger of all the individual blocks of data that make up a transaction or digital event that has taken place between parties and can be verified at any time in the future. Blockchain's strong and decentralized character makes it ideal for use in global financial systems, but the technology can also be easily extended to cover contractual agreements and procedures like monitoring the global supply chain. To further expand the utility of ICT, a blockchain infrastructure can be used to support innovative farm systems and e-agricultural endeavors in the field of precision agriculture.

INTELLIGENT SMART CONTRACTS FOR INNOVATIVE SUPPLY CHAIN MANAGEMENT

We propose using blockchains and smart contracts as enabling technologies for a new approach to supply chain management in order to improve cooperation between companies in the supply chain, resulting in greater profitability and economic well-being for the enterprises involved. Most current blockchain supply chain efforts are focused on utilizing decentralized blockchain networks for tracking the origin and delivery of commodities. However, our idea goes beyond these narrow confines. To address these issues of trust and coordination, which have been shown to be major roadblocks in the efficient operation of supply chains, we present a new class of intelligent contracts. Solving the trust problem calls for the ability to quickly and cheaply form contractual alliances based on common commercial needs among previously untested partners worried about being taken advantage of. Establishing a cost-effective management system that can steer the supply chain's overarching goals toward a greater collective benefit is essential for solving the coordination problem. This is in contrast to the current situation, wherein participants' narrow self-interests have prevailed over the interests of society as a whole. In order to alleviate these issues, innovative supply chain management has begun using smart contracts in place of human coordinators. This removes a significant barrier to efficiently addressing these issues: the need to have faith in the coordinator. As an added bonus, the supply chain saves money on managerial costs by automating the coordinating process. By automating the execution of contracts and the management of costs and compensations for supply chain players, these systems can take the place of human coordinators. Thus, the term "intelligent smart contracts" is used. In this paper, we describe a cutting-edge framework for managing supply chains that is powered by decentralized, self-executing smart contracts. We will investigate the complex computational approaches that underpin the decision-making processes of these contracts and examine the broader socioeconomic ramifications that our approach provides.

3. EXISTING SYSTEM

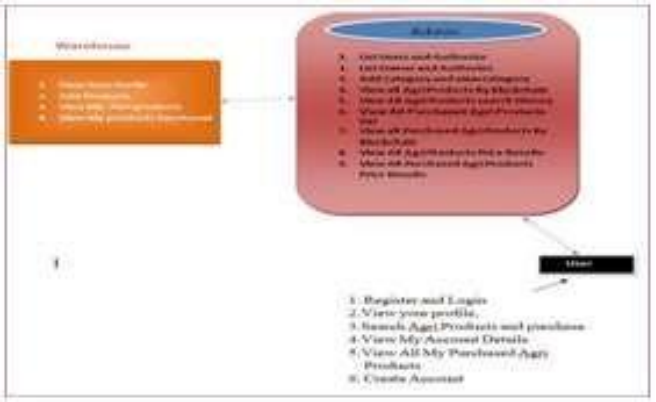
There are four obstacles that Alharby and Van Moorsel (2015) have identified that developers may encounter when writing smart contracts. First, there is the challenge of writing foolproof contracts. Second, a contract cannot be modified or revoked after it has been deployed. Third, there is a paucity of efficient contract identification tools and methods. Finally, the programming languages used to create smart contracts can be difficult to learn and master. An empirical study was undertaken by Zou et al. [16], focusing on the Ethereum blockchain, to investigate potential difficulties encountered by developers while creating smart contracts. Some significant difficulties were highlighted by the poll. The current crop of SC development tools is notable for its lack of sophistication. Since the blockchain and the code it contains are immutable, after a smart contract has been implemented, the process of programming it is different from writing in normal programming languages. In order to better incorporate unique blockchain concepts or

interfaces into existing software modeling notations, Rocha and Ducasse [17] offered a thorough suggestion. The authors suggest that modeling is essential to the software development process, and their preliminary work introduces the idea of specialized modeling notations for dApps. Entity-Relationship Model (ERM), Unified Modeling Language (UML), and Business Process Model and Notation (BPMN) are the three modeling notations proposed by the authors. Finally, the researchers apply these ideas to a deep examination of a single application of software, dubbed block chain oriented software (BOS). In order to carry out specific business logic within the blockchain architecture, this program makes use of smart contracts (SCs).

4. PROPOSED SYSTEM

Finally, we suggest a new method to make it easier to modify and assemble agrifood-specific smart contracts (SCs) built on the Ethereum blockchain. This method allows for the process to be automated, shortening the development time while still adhering to security and reliability standards. This research is the first attempt in the agri-food industry to create a semi-automated configurable system that can support all supply chains. Initially developed for the agricultural sector, this method has broad applicability in any industry where components are assembled and processed via many transformational steps. An improved and all-encompassing food production framework is being developed, tailored for field traceability systems driven by blockchain technology. One step in this direction is the creation of a modular system that can be simply adjusted to establish round-the-clock monitoring of the agricultural and food supply chains. Both global supply chains and user interface apps are part of this system. Additional security and fuel efficiency checks were performed on the supply chains (SCs). The first step in the methodical approach was to describe the food production process with the use of preset tables. This method simplifies the configuration of these modules and the generation of the final system for developers with limited expertise of blockchain technology. In addition, a cutting-edge case study was developed with honey production as the focus to show how this tactic works.

5. SYSTEM ARCHITECTURE DIAGRAM



USER

Buying is the process of getting an item from a seller. The person is usually not given an address. The following actions are carried out by consumers who shop for agricultural products and services from internet retailers who specialize in these areas: The topic at hand relates to the account at hand. Looking for food and farming supplies. Please create an account to get started with the signup procedure. Please check your account details for a full rundown of the agricultural items that have been purchased.

WAREHOUSE

The majority of Warehouse's sales efforts have been directed at online consumers. When doing business with a trustworthy organization, it is in the best interest of both parties for customers to have easy access to the seller's contact information so that they may learn more about the company before making any purchases. It's also crucial to keep track of information on consumer products, such as how many people buy or use the product. Recommendations from people you know who have used your services like "Add Products," "View All Agri Products," and "View Purchased Products" are great indicators of a quality business. Warehouses are places where items can be received, stored, and sent out. Users have the option of purchasing tokens representing the target item outright or merely registering the tokens'

physical presence in cold storage without really transferring ownership.

ADMIN

The software system efficiently manages and supervises other actors' read/write permissions and access levels. This feature is available in the vast majority of BPM systems. In order to do actions like approving, Observe all users, the administrator must provide permission to both users and warehouse sellers. All categories of agricultural products can be viewed, as well as individual agricultural products, agricultural products categorized by blockchain technology, agricultural products purchased using blockchain technology, agricultural product price results, and agricultural product price trend results.

6. CONCLUSION

Consumers today want to know that the food they are buying is free of harmful ingredients and can be tracked back to its original source to verify its authenticity and nutritional content. Therefore, people are likely to invest in non-tangible benefits like secure traceability and country-of-origin labels. In addition, they are demanding that stringent food safety standards be applied throughout the whole food distribution system. The importance of food traceability systems in ensuring product safety and reducing food fraud across the industry is well-established. Unscrupulous manufacturers could take advantage of loopholes in the current traceability processes, which would have a negative effect on consumers. The deployment of a traceability system is made possible by the combination of blockchain technology, smart contracts, and the Internet of Things. With this setup, manufacturers can pool their resources and take on the duty of providing product details. Also, unbiased third parties can verify the authenticity of the information provided about the products' quality and provenance. With this method, customers are more likely to trust the data offered to them. We offer a methodology that simplifies the design of traceability systems for the agri-food industry for programmers, removing the need for them to have an in-depth understanding of the technical complexities of supply chain development. It can't be emphasized enough how much of a departure this method makes from the norm in the software industry. This goal was reached by creating software that could mechanically produce a tracing system's system components (SCs) and user interface (UI). The system was developed to accurately depict the problem space, which the proposed method was determined to be able to handle.

The first step in the technique is to sketch out the whole scope of the required supply chain, including all of the stakeholders, producers, resources, items, events, and data. Following is an explanation communicated using a series of spreadsheet pages, a user-friendly tool available to both domain specialists and non-computer scientists. This process of converting HTML5 pages to.csv files then yields the UI of the decentralized application (dApp) and the ability to interact with users. All participants in the supply chain can use this technology to record and verify important events in a permanent ledger. Furthermore, it is possible to positively identify the people accountable for recording the aforementioned occurrences. In comparison to traditional systems, where certification is simply dependent on the producer's claims, this occurrence inspires a greatly enhanced degree of confidence in the validity of product information because each stage of the production process can be duly confirmed.

REFERENCES

[1] S. Nakamoto, ``Bitcoin: A peer-to-peer electronic cash system," Manubot, Tech. Rep., 2008.

[2] K. Demestichas, N. Peppes, T. Alexakis, and E. Adamopoulou, ``Blockchain in agriculture traceabilitysystems: A review," Appl. Sci., vol. 10, no. 12, pp. 122, 2020.

[3] C. Costa, F. Antonucci, F. Pallottino, J. Aguzzi, D. Sarriá, and P. Menesatti, ``A review on agri-food supply chain traceability by means of RFID technology," Food Bioprocess Technol., vol. 6, no. 2, pp. 353366, Feb. 2013.

[4] F. Tian, ``An agri-food supply chain traceability system for China based on RFID &

blockchain technology," in Proc. 13th Int. Conf. Service Syst. Service Manage. (ICSSSM), Jun. 2016, pp. 16.

[5] F. Antonucci, S. Figorilli, C. Costa, F. Pallottino, L. Raso, and P. Menesatti, ``A review on blockchain applications in the agri-food sector," J. Sci. Food Agricult., vol. 99, no. 14, pp. 61296138, Nov. 2019.

[6] P. Bottoni, N. Gessa, G. Massa, R. Pareschi, H. Selim, and E. Arcuri, ``Intelligent smart contracts for innovative supply chain management," Frontiers Blockchain, vol. 3, p. 52, Nov. 2020.

[7] J. F. Galvez, J. C. Mejuto, and J. Simal-Gandara, ``Future challenges on the use of blockchain for food traceability analysis," TrAC Trends Anal. Chem., vol. 107, pp. 222232, Oct. 2018.

[8] C. Dalvit, M. De Marchi, and M. Cassandro, ``Genetic traceability of livestock products: A review," Meat Sci., vol. 77, no. 4, pp. 437449, Dec. 2007.

[9] E. Commission. General Food Law. Accessed: Feb. 20, 2022. [Online]. Available: https://ec.europa.eu/food/horizontal-topics/general-foodlaw_ En

[10] M. M. Aung and Y. S. Chang, ``Traceability in a food supply chain: Safety and quality perspectives," Food Control, vol. 39, pp. 172184, May 2014.[Online]. Available: https://www.sciencedirect. com/science/article/pii/S0956713513005811

[11] L. Cocco and K. Mannaro, ``Blockchain in agri-food traceability systems: A model proposal for a typical Italian food product," in Proc. IEEE Int. Conf. Softw. Anal., Evol. Reeng. (SANER), Mar. 2021, pp. 669678.

[12] L. Cocco, K. Mannaro, R. Tonelli, L. Mariani, M. B. Lodi, A. Melis, M. Simone, and A. Fanti, ``A blockchain-based traceability system in agrifood SME: Case study of a traditional bakery," IEEE Access, vol. 9, pp. 6289962915, 2021.

[13] L. Marchesi, K. Mannaro, and R. Porcu, ``Automatic generation of blockchain agri-food traceability systems," in Proc. IEEE/ACM 4th Int. Workshop Emerg. Trends Softw. Eng. Blockchain (WETSEB), May 2021, pp. 4148, doi: 10.1109/wetseb52558.2021.00013.

[14] C. D. Clack, V. A. Bakshi, and L. Braine, ``Smart contract templates: Foundations, design landscape and research directions," 2016, arXiv:1608.00771.

[15] M. Alharby and A. van Moorsel, ``Blockchain-based smart contracts: A systematic mapping study," 2017, arXiv:1710.06372.

[16] W. Zou, D. Lo, P. S. Kochhar, X.-B.-D. Le, X. Xia, Y. Feng, Z. Chen, and B. Xu, ``Smart contract development: Challenges and opportunities," IEEE Trans. Softw. Eng., vol. 47, no. 10, pp. 20842106, Oct.2021.

[17] H. Rocha and S. Ducasse, ``Preliminary steps towards modeling blockchain oriented software," in Proc. 1st Int. Workshop Emerg. Trends Softw. Eng. Blockchain, May 2018, pp. 5257.

[18] M. Jurgelaitis, R. Butkiene, E. Vai£iukynas, V. Drungilas, and L. *ƒ* eponiene, ``Modelling principles for blockchain-based implementation of business or scientic processes," CEUR Workshop Proc., vol. 2470, pp. 4347, Apr. 2019.

[19] A. B. Tran, Q. Lu, and I. Weber, ``Lorikeet: A model-driven engineering tool for blockchain-based business process execution and asset management," in Proc. 16th Int. Conf., BPM. Sydney, NSW, Australia: Springer, Sep. 2018.

[20] Q. Lu, A. Binh Tran, I.Weber, H. O'Connor, P. Rimba, X. Xu, M. Staples, L. Zhu, and R. Jeffery, ``Integrated model-driven engineering of blockchain applications for business processes and asset management," Softw., Pract. Exper., vol. 51, no. 5, pp. 10591079, May 2021.

[21] C. Udokwu and A. Norta, ``Deriving and formalizing requirements of decentralized applications for inter-organizational collaborations on blockchain," Arabian J. Sci. Eng., vol. 46, no. 9, pp. 83978414, Sep.2021.

[22] C. Udokwu, P. Brandtner, A. Norta, A. Kormiltsyn, and R. Matulevi£ius, ``Implementation and evaluation of the DAOMframework and support tool for designing blockchain decentralized applications," Int. J. Inf. Technol., vol. 13, no. 6, pp. 22452263, Dec. 2021.

[23] C. K. Frantz and M. Nowostawski, ``From institutions to code: Towards automated generation of smart contracts," in Proc. IEEE 1st Int.Workshops Found. Appl. Self Syst. (FAS*W), Sep. 2016, pp. 210215.

[24] V. A. de Sousa, C. Burnay, and M. Snoeck, ``B-MERODE: A model-driven engineering and artifact- centric approach to generate smart contracts," in Proc. Conf. Adv. Inf. Syst. Eng., Cham, Switzerland: Springer, 2020, pp. 115.

[25] M. Marchesi, L. Marchesi, and R. Tonelli, ``An agile software engineering method to design blockchain applications," in Proc. 14th Central Eastern Eur. Softw. Eng. Conf. Russia ZZZ (CEE-SECR), 2018, pp. 18.