

Use of Blockchain to Improve Case Studies in Food Supply

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Abstract

The current food supply is a linear economic model that directly or indirectly fulfills needs. However, this model has several weaknesses, such as the relationship between members of the supply chain or the lack of information to consumers about the origin of the product. In this paper, we propose a new supply chain model via blockchain. This new model enables the concept of a circular economy and removes many of the disadvantages of the current supply chain. A multi-agent system is created for this paper to coordinate all the transactions that occur in the food supply.

Keywords: *Blockchain Use, Improving, Food Supply*

1. Introduction

Blockchain is currently gaining interest from a wide variety of industries: finance, healthcare, other sectors, utilities, and the government sector [1]. Reasons for the increased interest: With blockchain, applications work only through trusted intermediaries. Now they can operate in a decentralized way, without the need for a verification system, and achieve the same functionality with the same level of reliability [2]. This was not possible until the blockchain was created. With the adoption of a trustless network, blockchain emerged. This is possible because, in a network that uses blockchain, you can make transfers without needing to trust other users. With fewer intermediaries, transactions become faster between users [3]. Moreover, the use of cryptography in the blockchain ensures that the information is secure. Blockchain is an accounting ledger that records all transactions made by users [4]. This has researchers and developers in the Internet of Things (IoT) looking for ways to connect IoT with the blockchain. Today the supply chain is a core area for companies concerned with the transportation of products between parties. However, the problem with this sector is that its scale can cause delays and failures in the delivery of goods as well as other problems [5]. In addition, large distributors need large volumes of workers to fulfill all the demands of the stores. All of this can lead to major delays in order processing and increase the chances of lost orders. To solve this problem, companies have automated all of their processes, contributing to a significant increase in the number of businesses and distributors in the supply chain. However, the increasing amount of digital data and the expansion of Internet companies mean that there is also a greater risk of attacks on their databases. The hacker may intend to change, steal or delete data [6].

We suggest an alternative way to solve this problem. In our case study (ie, agricultural supply chain), we will consider two different scenarios [7]. First, we provide security to the data of companies involved in the supply chain with the inclusion of blockchain. Second, a multi-agent system will be used for organizational matters. It has been proven that multi-agent

systems provide efficient solutions to a wide variety of problems. This includes, but is not limited to, the use of agents for image classification, decentralized network control, real-time troubleshooting, and Internet of Things applications. In this paper, we propose a new supply chain model. This new model enables the use of a circular economy in supply chains [8]. In addition, it coordinates everything that happens in the supply chain. In each supply chain member, an agent is defined to coordinate all operations and transactions performed by that supply chain member 2. Related work

Blockchain is a distributed data structure that is replicated and shared among network members. It was introduced with Bitcoin to solve the problem of double-spending. As a result of how the nodes in Bitcoin (which are called miners) mutually validate agreed transactions, the Bitcoin blockchain establishes owners and declares what they own [9]. Blockchain is built using cryptography. Each block is identified by its cryptographic hash and each block refers to the hash of the previous block [10]. It establishes links between blocks, forming a blockchain. For this reason, users can interact with the blockchain by using a pair of public and private keys. Miners on the blockchain need to approve transactions and the order in which they occur. Otherwise, individual copies of this blockchain can diverge resulting in forks; miners then have different views of how transactions occur, and it is not possible to save a single blockchain until the fork is not resolved [11]. To overcome this, a distributed consensus mechanism is needed in every blockchain network. Blockchain's way of solving the fork problem is that each blockchain node can connect to the next block. Only the correct random number with SHA-256 has to be found so you have the zero count expected by the blockchain [12]. Whichever node can solve this puzzle has generated what is called a proof-of-work (pow) and forms the next block of the chain. Since a one-way cryptographic hash function is involved, any other node can easily verify that the answer provided meets the requirements [13]. Note that forks may still occur on a network when two competing nodes mine blocks almost simultaneously. The fork is usually resolved automatically by the next block. With the adoption of blockchain, smart contracts are included to make transactions between different users faster and more effective. Nick Szabo introduced this concept in 1994 and defined a smart contract as "a computerized transaction protocol that enforces the terms of a contract" [14]. Szabo suggested that contractual clauses could be transferred to the code, thereby reducing the need for intermediaries in transactions between parties. In the blockchain context, smart contracts are scripts that are stored on the blockchain. Smart contracts have a unique address on the blockchain (that is, they reside in a block with a hash that identifies them) [15]. We can trigger a smart contract in a transaction by indicating an address on the blockchain. It is executed independently and automatically in a defined manner on each node in the network, according to the data contained in the transactions that are triggered. A multi-agent system is a computerized system consisting of several intelligent agents that interact with each other [16].

Multi-agent systems are used to solve complex problems with excellent results. Multiagent systems are used in a variety of applications. The author presents a multi-agent system for the smart use of electricity in the Smart home and thereby, increasing its energy efficiency. Another problem that multi-agent systems have solved effectively is voice monitoring in various situations. Implementation of a multi-agent system [17].

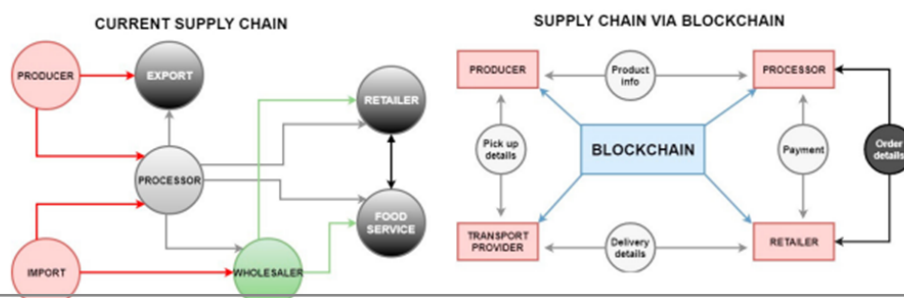


Figure 1. Supply Models

This is a linear model from producers and imports to retailers and food services. Through the inclusion of the blockchain, the supply chain is now decentralized and all transactions are placed on the blockchain [18]. Each member of the supply chain can write their transactions on the blockchain. However, supply chain members can only read blockchain blocks they have a direct connection with [19]. logistics is not a new problem, a multi-agent system is proposed to provide solutions to logistics problems. In addition, another successful application of multi-agent systems is the problem of distributed computing. Therefore, several proposals that we found in the literature combine the advantages of blockchain and multi-agent systems [20]. The various systems that integrate blockchain and multi-agent systems work are worth mentioning. This work proposes to use both technologies to increase security and privacy in decentralized energy networks. The authors propose a model that employs agents and blockchain for a ride-sharing system [21]. Apart from that, there are other applications of blockchain and multi-agent systems. The authors propose an innovative blockchain model for IoT. However, after seeing its sophistication, we believe that the current model of blockchain and multi-agent systems have some drawbacks. We propose a new model that utilizes smart contracts and a multi-agent system, which aims to improve efficiency in the management of the logistics system. This paper describes a case study that verifies the proposed model, focusing specifically on the agricultural supply chain sector [22].

2. Method

A new model for farm tracking is presented in this paper. The proposed model involves blockchain, a smart contract, to coordinate food tracking in agricultural supply chains [23]. Through the implementation of this new model, the agricultural supply chain is currently experiencing improvements based on the addition of the blockchain. Figure.1 is the current supply chain and supply chain architecture via blockchain. Both models are described below, including the advantages provided by the new supply chain model. 1) Current supply chain: The current model starts with manufacturers and imports [24]. These two members of the supply chain transmit their products and data to the next layer of the supply chain. On the next layer are exports, processors, and wholesalers. It is the middle layer that processes the basic products that are received by the supply chain. Finally, in the last layer are retailers and food services that sell products [25]. The main disadvantage of this model is that data is centralized in each element of the supply chain and other elements cannot see transactions. The main implication of this loss is that consumers have no way of verifying the source of the food to be purchased. In addition, there is no way to ensure that consumer data is reliable. 2) Supply chain via blockchain: The model changes with the addition of blockchain to the agricultural supply chain. Now all members of the supply chain store all their transactions on the blockchain. This allows for higher security in transactions. In addition, the new model corrects current supply chain weaknesses. The data is decentralized and each member can read data essential for their operations on the blockchain. For example, a manufacturer can view a processor's product info and a transportation provider's pick-up details. there is no way to ensure that consumer data is reliable. 2) Supply chain via blockchain: The model changes with the addition of blockchain to the agricultural supply chain. Now all members of the supply chain store all their transactions on the blockchain.

3. Results and Discussion

This allows for higher security in transactions. In addition, the new model corrects current supply chain weaknesses. The data is decentralized and each member can read data essential for their operations on the blockchain. For example, a manufacturer can view a processor's product info and a transportation provider's pick-up details. there is no way to

ensure that consumer data is reliable. 2) Supply chain via blockchain: The model changes with the addition of blockchain to the agricultural supply chain. Now all members of the supply chain store all their transactions on the blockchain. This allows for higher security in transactions. In addition, this new model corrects current supply chain weaknesses. The data is decentralized and each member can read data essential for their operations on the blockchain. For example, a manufacturer can view a processor's product info and a transportation provider's pick-up details. This allows for higher security in transactions. In addition, the new model corrects current supply chain weaknesses. The data is decentralized and each member can read data essential for their operations on the blockchain. For example, a manufacturer can view a processor's product info and a transportation provider's pick-up details. This new model is available via the blockchain. Coordinate all members of the supply chain.

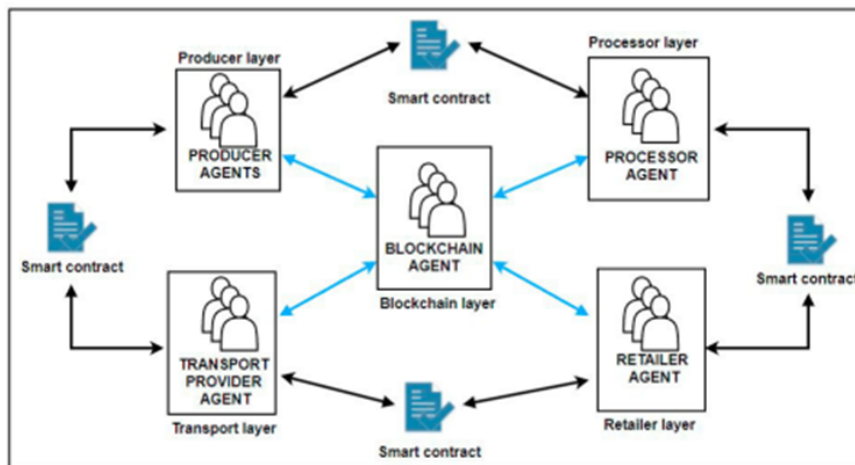


Figure 2. Supply chain via blockchain architecture.

Each layer sends data from its transactions to the blockchain. In addition, the layers that govern articles communicate with each other with smart contracts. These smart contracts are for buying and selling goods.

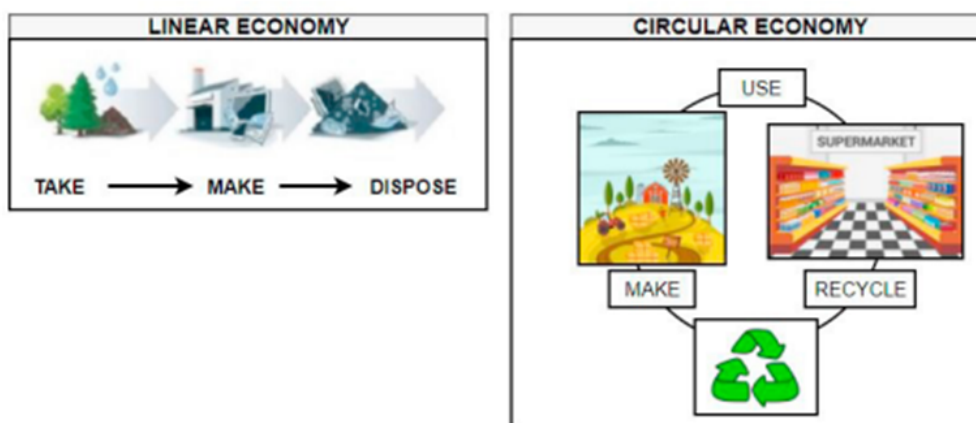


Figure 3. The figure shows the concept of the linear and circular economy.

This change in the market model is made possible by the inclusion of the blockchain. This model has 5 layers: 1) On the layer the manufacturer is the manufacturer's agent. This agent coordinates all the operations that producers have to perform (e.g. buying materials, selling products, etc.). 2) At the processor layer is the processor agent. This agent coordinates all the tasks performed at this layer (e.g. buying key materials, selling products, contracting transportation providers, etc.). 3) In the transport layer are the transport-providing agents. This agent coordinates all transportation between other members of the supply chain. 4) At the retail layer is the retail agent. These agents coordinate the purchase of materials from processors and sales to consumers. Lastly, 5) at the blockchain layer is the blockchain agent. This new supply chain via the blockchain enables a new market model called the circular economy. You can find the changing market model in picture.3. Meanwhile, the current supply chain follows the Take – Make – Dispose of the model.

With the supply chain via the blockchain, the circular economy model is enabled. This new market model follows the Make - Use -Recycle model. This new model allows for a self-sufficient economy. With the use of blockchain, all products can be traced from their origin to their sale and subsequent recycling. The advantage of this model over a linear economy is that all products are tracked with the blockchain and with this traceability it is possible to give the final consumer confidence about the origin of the product, whether it is recycled, whether it is used for the first time, etc.

5. Conclusions

This research presents a new blockchain approach to improve the current supply chain. The novelty of this paper lies in the blockchain for storing all transaction information in the supply chain of the proposed case study. In addition, multi-agent systems use smart contracts to manage the entire supply chain process more efficiently, this eliminates the middleman and enables a circular economy market.

Our model can be used to improve any supply chain. The case studies were undertaken in this proposal focus on the agricultural sector. Our model has increased security and efficiency because it is automated by the agent system. By combining the blockchain we provide an agricultural system with solid security features. Shipments can be tracked, origin and destination authenticated, and proof of all transactions can be stored and not manipulated. Another novelty of this paper is the agent verifying that both parties comply with the smart contract terms. If the agent detects that one of the parties does not meet the conditions set, a penalty is imposed and the agent keeps the money in the control entity until the agreed conditions are met. This makes our model more efficient than the current model. In addition, it can track and authenticate orders. In addition, a rating and reward system is introduced in the supply chain via blockchain to recognize and reward the most fulfilling members of this new supply chain model. Future research lines include enhancing the multi-agent system by introducing new agents for monitoring procedures. In addition, our model can be enhanced by integrating a case-based reasoning (CBR) system.

References

- [1] U. Rahardja, "Meningkatkan Kualitas Sumber Daya Manusia Dengan Sistem Pengembangan Fundamental Agile," *ADI Bisnis Digit. Interdisiplin J.*, vol. 3, no. 1, pp. 63–68, 2022.
- [2] R. Yunita, M. S. Shihab, D. Jonas, H. Haryani, and Y. A. Terah, "Analysis of The Effect of Servicescape and Service Quality on Customer Satisfaction at Post Shop Coffee Toffee in Bogor

- City,” *Aptisi Trans. Technopreneursh.*, vol. 4, no. 1, pp. 66–74, 2022.
- [3] D. Rustiana, J. D. Pratama, T. Mudabbir, and M. A. Fahmi, “Adoption Computerized Certificate Transparency And Confidentiality,” *Int. J. Cyber IT Serv. Manag.*, vol. 2, no. 1, pp. 1–10, 2022.
- [4] S. Azizah and B. P. K. Bintoro, “Determining Factors of Continuance Intention to Use QR Code Mobile Payment on Urban Millennials in Indonesia Empirical Study on Mobile Payment Funds,” *ADI J. Recent Innov.*, vol. 3, no. 2, pp. 121–138, 2022.
- [5] L. A. Faza, P. M. Agustini, S. Maesaroh, A. C. Purnomo, and E. A. Nabila, “Motives For Purchase of Skin Care Product Users (Phenomenology Study on Women in DKI Jakarta),” *ADI J. Recent Innov.*, vol. 3, no. 2, pp. 139–152, 2022.
- [6] C. S. Bangun and N. A. Santoso, “Inovasi Pengembangan Kartu Ujian Online pada Web Portal dengan Metode Waterfall,” *J. MENTARI Manajemen, Pendidik. dan Teknol. Inf.*, vol. 1, no. 1, pp. 1–8, 2022.
- [7] H. Purwantih, Z. F. Rahayu, W. Amelia, R. Dwi, and H. M. Bilqis, “Rancang Bangun Sistem Seleksi Rekrutmen Karyawan Dan Guru Berbasis Website Pada Sekolah Citra Bangsa Tangerang,” *ADI Bisnis Digit. Interdisiplin J.*, vol. 1, no. 2, pp. 60–70, 2020.
- [8] N. Lutfiani, F. P. Oganda, C. Lukita, Q. Aini, and U. Rahardja, “Desain dan Metodologi Teknologi Blockchain Untuk Monitoring Manajemen Rantai Pasokan Makanan yang Terdesentralisasi,” *InfoTekJar J. Nas. Inform. dan Teknol. Jar.*, vol. 5, no. 1, pp. 18–25, 2020.
- [9] F. P. Oganda, M. Hardini, and T. Ramadhan, “Pengaruh Penggunaan kontrak cerdas pada Cyberpreneurship Sebagai Media Pemasaran dalam Dunia Bisnis,” *ADI Bisnis Digit. Interdisiplin J.*, vol. 2, no. 1, pp. 55–64, 2021.
- [10] A. C. Purnomo, B. Pramono, and F. P. Oganda, “Design of Information System in Admission of New Students Based on Web in SMK Al Amanah,” *Aptisi Trans. Manag.*, vol. 3, no. 2, pp. 159–167, 2019.
- [11] B. Mardisentosa, U. Rahardja, K. Zelina, F. P. Oganda, and M. Hardini, “Sustainable Learning Micro-Credential using Blockchain for Student Achievement Records,” in *2021 Sixth International Conference on Informatics and Computing (ICIC)*, 2021, pp. 1–6.
- [12] F. P. Oganda, “PEMANFAATAN SISTEM IJC (iLearning Journal Center) SEBAGAI MEDIA E-JOURNAL PADA PERGURUAN TINGGI DAN ASOSIASI,” *CSRID (Computer Sci. Res. Its Dev. Journal)*, vol. 11, no. 1, pp. 23–33, 2020.
- [13] T. Ramadhan, Q. Aini, S. Santoso, A. Badrianto, and R. Supriati, “Analysis of the potential context of Blockchain on the usability of Gamification with Game-Based Learning,” *Int. J. Cyber IT Serv. Manag.*, vol. 1, no. 1, pp. 84–100, 2021.
- [14] A. G. Prawiyogi, A. S. Anwar, M. Yusup, N. Lutfiani, and T. Ramadhan, “Pengembangan Program Studi Bisnis digital bagi pengusaha dengan perangkat lunak lean,” *ADI Bisnis Digit. Interdisiplin J.*, vol. 2, no. 2, pp. 52–59, 2021.
- [15] T. Ramadhan and R. D. Destiani, “Pengetahuan Manajemen Keuangan Bisnis Terhadap Niat Mahasiswa Bisnis Digital dalam Berwirausaha,” *ADI Bisnis Digit. Interdisiplin J.*, vol. 3, no. 1, pp. 59–62, 2022.
- [16] D. Apriani, T. Ramadhan, and E. Astriyani, “Kerja Lapangan Berbasis Website Untuk Sistem Informasi Manajemen Praktek (Studi Sistem Informasi Program Studi Kasus Merdeka Belajar Kampus Merdeka (MBKM) Universitas Raharja),” *ADI Bisnis Digit. Interdisiplin J.*, vol. 3, no. 1, pp. 24–29, 2022.
- [17] Q. Aini, U. Rahardja, and A. Khoirunisa, “Blockchain Technology into Gamification on Education,” *IJCCS (Indonesian J. Comput. Cybern. Syst.)*, vol. 14, no. 2, pp. 1–10, 2020, doi: 10.22146/ijccs.53221.
- [18] N. Sari, W. A. Gunawan, P. K. Sari, I. Zikri, and A. Syahputra, “Analisis Algoritma Bubble Sort Secara Ascending Dan Descending Serta Implementasinya Dengan Menggunakan Bahasa Pemrograman Java,” *ADI Bisnis Digit. Interdisiplin J.*, vol. 3, no. 1, pp. 16–23, 2022.
- [19] D. Rifai, S. Fitri, and I. N. Ramadhan, “Perkembangan Ekonomi Digital Mengenai Perilaku Pengguna Media Sosial Dalam Melakukan Transaksi,” *ADI Bisnis Digit. Interdisiplin J.*, vol. 3, no. 1, pp. 49–52, 2022.

- [20] P. Rashi, A. S. Bist, A. Asmawati, M. Budiarto, and W. Y. Prihastiwi, "Influence Of Post Covid Change In Consumer Behaviour Of Millennials On Advertising Techniques And Practices," *Aptisi Trans. Technopreneursh.*, vol. 3, no. 2, pp. 85–92, 2021.
- [21] M. F. Elkarimah and U. Sutisna, "Pendampingan pengajaran Metode Iqro' untuk guru-guru di TPA Hayatinnur Tambun Selatan Bekasi," *ABSYARA J. Pengabd. Pada Masy.*, vol. 2, no. 2, pp. 178–184, 2021.
- [22] P. Edastama, S. Purnama, R. Widayanti, L. Meria, and D. Rivelino, "The Potential Blockchain Technology in Higher Education Learning Innovations in Era 4.0," *Blockchain Front. Technol.*, vol. 1, no. 01, pp. 104–113, 2021.
- [23] T. Wahyuningsih, F. P. Oganda, and M. Anggraeni, "Design and Implementation of Digital Education Resources Blockchain-Based Authentication System," *Blockchain Front. Technol.*, vol. 1, no. 01, pp. 74–86, 2021.
- [24] T. Ayuninggati, E. P. Harahap, and R. Junior, "Supply Chain Management, Certificate Management at the Transportation Layer Security in Charge of Security," *Blockchain Front. Technol.*, vol. 1, no. 01, pp. 1–12, 2021.
- [25] N. Lutfiani, E. P. Harahap, Q. Aini, A. D. A. R. Ahmad, and U. Rahardja, "Inovasi Manajemen Proyek I-Learning Menggunakan Metode Agile Scrumban," *InfoTekJar J. Nas. Inform. dan Teknol. Jar.*, vol. 5, no. 1, pp. 96–101, 2020.