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A Block Chain Management for LI-FI Based Supermarket Automation with IoT Systems

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ABSTRACT

Monitoring technology has advanced dramatically in recent years in various locations, both urban and rural. The Internet of Things (IoT) enables the remote control and collecting of data from sensors for their subsequence analysis. Thus, LiFi was proposed as an enabling technology for IoT in indoor environments. This enables the supermarket automation through the use of IoT topology. However, the absence of mutual trust can create a barrier to implementation. To conduct cryptocurrency transactions, blockchain technology has been widely employed. It has recently shown to be effective in establishing confidence in the Internet of Things (IoT) domain. This paper offered a method for integrating IoT features into supply chains. While strengthening the security of IoT-based supply chain management, our suggested architecture streamlines data sharing and decreases computational, storage, and latency needs.

Introduction

Block chain technology is widely recognized as a ground-breaking, peer-to-peer, decentralised data organization [1]. It enables the creation of decentralised monetary systems like bitcoin, smart contracts, and other online-managed resources like smart property. Nakamoto created this technique in 2008 with the goal of making cryptocurrency transactions easier [2]. Recent research has focused on how to use a blockchain to distribute ledger systems and other financial activities [2]. Blockchain technology enables diverse entities to exchange data and transactions in a matter of minutes, without the need for third-party intervention or verification. This is possible because of a shared data architecture that employs computer algorithms to generate real-time self-updates [3]. Financial transactions can also be settled using blockchain technology without the involvement of banks or other trustworthy entities. Other organisational domains, such as supply chains, are expected to be transformed by blockchain technology [4]. Furthermore, blockchain technology allows for distributed data-exchange security, which can have a significant impact on corporate governance. It can also impact how supply chain partners arrange their connections and how they trade items and data in the end [5].

Integrating blockchain technology with recent innovations like the Internet of Things (IoT) can help create permanent records that can be shared and acted on across a product supply chain [6,7]. This type of connectivity can help firms better track and monitor their products, increasing their validity and authenticity. Overall, efficiencies and the global economy would be significantly improved [8]. Several academics have recommended that organisations can employ IoT in supply chain management, including radio-frequency identification (RFID) [9], wireless sensor networks (WSNs) [10], a geographic information system (GIS) [11], and a global positioning system (GPS) [12]. Every step in the movement of shipping containers, products, and packages may be tracked using barcodes, RFID and GPS tags, sensors, and chips. Goods can be tracked reliably and securely in real time using the Internet of Things [13]. [14] has presented an interesting idea about a blockchain technology-based framework for an e-commerce cross-border supply chain. The creators of this framework devised a novel multi-chain structured paradigm based on the deployment of blockchain technology. They also introduced a wallet system that was integrated into the network's key distribution processes. A poll was also done by the authors of [15], which focused on problems, applications, and open study opportunities. Their study looked at how blockchain technology has progressed in a variety of industries, including healthcare, energy, finance, and a few others.

As a result, this paper proposes a hybrid IoT-blockchain Ethereum solution to address the issues of trust between customers and grocery owners. A blockchain provides a road to developing IoT technology that allows for the sharing of information that can be seen and trusted by all parties. Each data source is always accessible, ensuring that the shared data is safe and secure. Such integration would be advantageous if vast amounts of data had to be sent across various participants in various systems.

The benefits and advantages of blockchain technology are undeniable. It does, however, have several flaws that must be taken into account [16]. First, this technology is still in its early stages of development, particularly in terms of supply chain traceability. Second, there is still a lack of total consensus among the nodes, resulting in some functional constraints. Protocols such as delegated proof-of-stake (DPoS), proof of work (PoW), and proof of stake (PoS) are among the extant approaches to the issue of consensus, although none of them is flawless. Some of them (for example, PoW) necessitate computationally intensive machinery, and the mining process consumes a lot of energy [17]. Because the PoS protocol picks leaders based on the percentage of stakes in their ownerships, it might lead to unwanted monopolisation and centralization [18]. Similarly, the DPoS protocol weights votes based on each node's stake ownership. This means that affluent nodes can easily gain control of the entire network and establish a monopoly. Another disadvantage is that having a small number of electable block producers can increase the possibility of network centralization [19].

The suggested methodology intends to address many trust issues in a decentralised community by reducing the amount of energy and computational capacity required by nodes to complete blockchain activities. This project's contribution is to show how blockchain can function with IoT-based supply chains.Extensive simulation tests will be conducted to demonstrate the effectiveness and security of the suggested paradigm.

Block Chain Concept

The transaction history is stored in BC, which is a collection of blocks. It's similar to a public register. A transaction counter and transactions make up the blocks depicted in Figure 1.

The maximum number of transactions a BC can have is determined by the size of the BC and the size of a single transaction.

There are three sorts of BC: Public, Private, and Hybrid.

Everyone can participate in the consent process in Public BC. Only a small number of pre-selected nodes are allowed to participate in the consent procedure in this method, whereas Multiple organizations are involved in this Consortium type of sharing. Nodes in these organizations operate together in a structured manner, adjusting the algorithm based on their level of trust.

As a result, the BC work flow model shown in Figure 2 is explained as follows:

1. The transaction is started.
2. After transaction initialization, the receiving node verifies the received transaction using a digital signature.
3. It is appended to the list of legitimate transactions in the nodes and finds a Nonce after verification.
4. Once a valid Nonce has been found, the process is repeated to add a new block to the BC.
5. Last but not least, BC has been upgraded.

A block chain is a distributed open database. There is no single person in charge of this, and all transactions in this medium are encrypted and stored in blocks. All of the blocks are arranged in a chain-like pattern, making the system more secure. As a result, there is no requirement for a third party to protect data.

IOT and Supply Chain Management

There has been a lot of research on how IoT technologies like RFID, GPS, WSN, and GIS can be used in supply chain management [20]. Researchers have tried a variety of approaches to using traceability devices. Wang et al. [21] presented a rule-based decision system to monitor the distribution of agricultural products in real time. The author developed a model in [22] that allowed entities to track products via a supply chain. The concept was built on the assumption that it will be necessary to use blockchain and IoT devices to gather, save, and distribute data across the whole supply chain. Grunow and Piramuthu [23] developed a concept that used RFID technology to transport perishable products from the supplier to the store and ultimately to the consumer. One of the study's primary findings was that RFID technology had the ability to benefit all parties in a perishable commodities supply chain.

The authors proposed employing RFID technology to track and monitor the safety of animal food in [24]. Because active data dissemination necessitated the use of decentralised information servers, the architecture included object names and discovery services. Tian devised a solution to maintain a high degree of product safety and quality in a Chinese agrifood supply chain utilising RFID and blockchains in [9], addressing various difficulties in the existing centralised system. The movement of information in the supply chain was then tracked using a decentralised approach.

Although several trust models for supply chains based on blockchains and the Internet of Things have been presented, a lightweight approach is still required to ensure secure and efficient supply chain transaction management. Furthermore, the suggested trust model tries to address various trust issues in a decentralised manner, with nodes not wasting energy or computational power to complete blockchain transactions.

Proposed Model

Data, IoT Network, Blockchain (Ethereum blockchain), and Supply Chain System are the three core modules of our model. The first module stores data generated by sensors throughout the supply chain, as well as trading events that occur between its nodes. The supply chain has an application layer with a database for storing this raw data, while the cryptographically modified information (message digest) is sent to the blockchain layer as a transaction through the IoT module. The access control list (ACL), which determines who has the permission to write and read the data kept on the ledger, is used to log, store, and process such transactions on the blockchain.

Our suggested trust model authenticates and oversees the message and node in the next phase. Following that, a series of queries are used to interact between the blockchain and supply chain components.

Experiment Settings

Using virtual machines generated on a personal computer, we created a prototype model to show the functionality of the suggested concept. Other standard consensus defensive protocols, including as proof of work (PoW), proof of stake (PoS), and delegated proof-of-stake, were used to analyse the model (DPoS).

Each contributing node generated 1 k transactions, which were stored in the nodes' memory pool. In each scenario, the proportion of rogue nodes changes. In each scenario, the number of false transactions in the 1000 transactions is increased from 100 to 900. There is only one transaction per block.

Figure 3 shows a scenario in which all nodes are protected. In this scenario, we assumed that each node had a different number of transactions. The results demonstrated that, regardless of the amount of rogue transactions in the nodes' local memory pool, the trust model added the correct transactions to the blockchain ledger. This is due to the fact that the model assigned trust scores to each transaction based on where it originated. It only included transactions that reached a particular level of trustworthiness (at least 80 percen). The model was able to filter out any fraudulent transactions and only add authentic ones to the blockchain ledger in this way. Figure 3 shows a comparison of the performance of our suggested trust model and the performance of alternative models. Each of the various protocols struggled to distinguish genuine transactions from false ones, as shown in this diagram. The DPoS consensus algorithm takes advantage of transaction similarity, which means that if it meets a higher number of incorrect transactions, the checks are more likely to pass. As a result, the ledger fills up with bogus blocks over time.

We compare the performance of our model to the PoW consensus in this section of the study. To analyse the required computational power, processing time, and memory requirements, we set the difficulty level to four. The processing power required by the two consensuses is depicted in Figure 4. Large RAM requirements will slow down the mining process and cause delays, even if the algorithm makes it look that CPU power is more significant than memory. Our proposed model has a reduced rate of memory increase, 0.41 percent each block, which will improve the block verification process.

Figure 6 shows how long it takes for a consensus algorithm to add blocks to the ledger. Our model is used to evaluate the PoW's delay. When shown in the diagram, as more blocks are added to the chain, the PoW algorithm slows down. The algorithm took 4.2 seconds to create 10 blocks, but our model took only 0.58 seconds.

Conclusion

A blockchain-based supply chain system using IoT devices does not require trusted intermediates and instead develops confidence between transacting entities using a different approach. A system like this can track, trace, and manage products all the way through a supply chain. As a result, data can be safely transferred between entities that might otherwise have questioned the accuracy of each other's data. IoT devices are often small, which presents a hurdle when it comes to blockchain processing, which necessitates a lot of computing power.

The trust model provided in this paper uses blockchain technology to foster an open and traceable system utilising a lightweight approach. Our proposed model can reduce storage, latency, and computing needs. When compared to established consensus methodologies, the results of our simulation confirm the proposed model's security and efficiency.

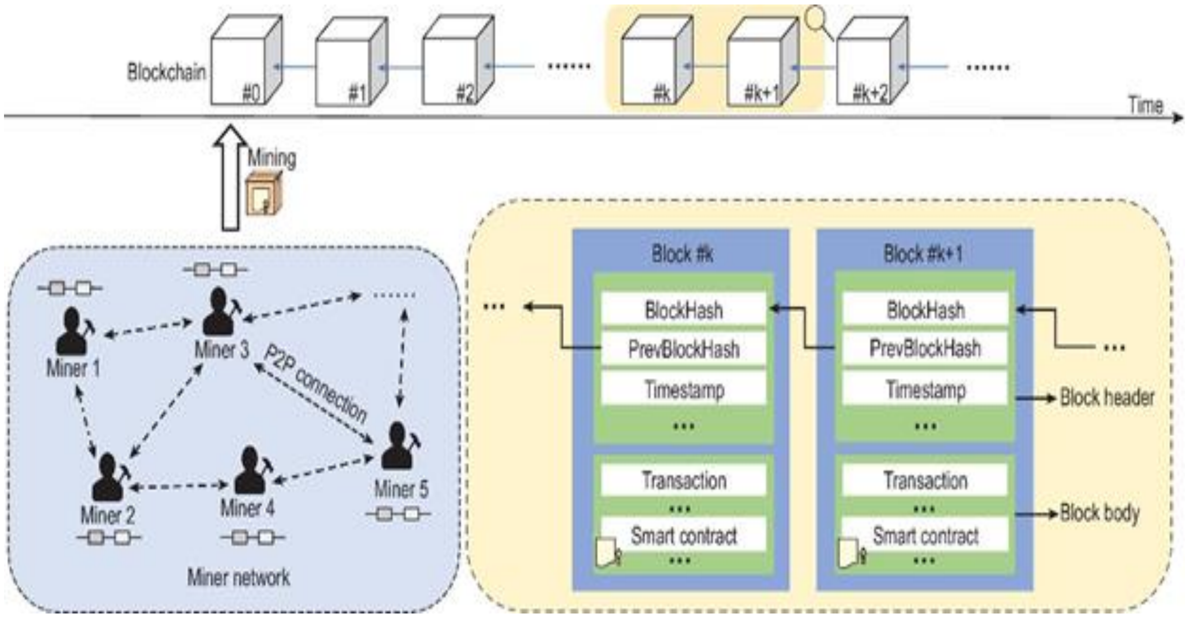

Figure 1. Architecture of BC

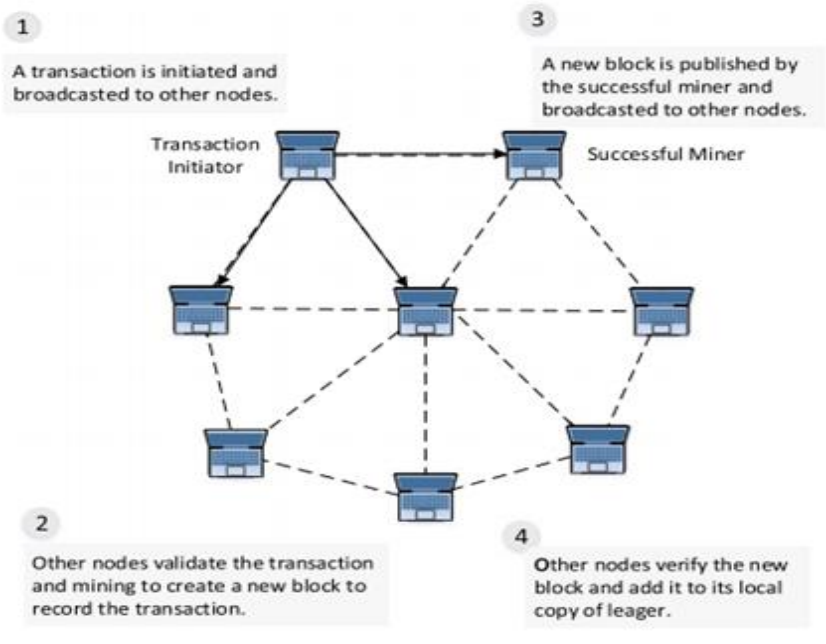

Figure 2. The work flow of a BC network

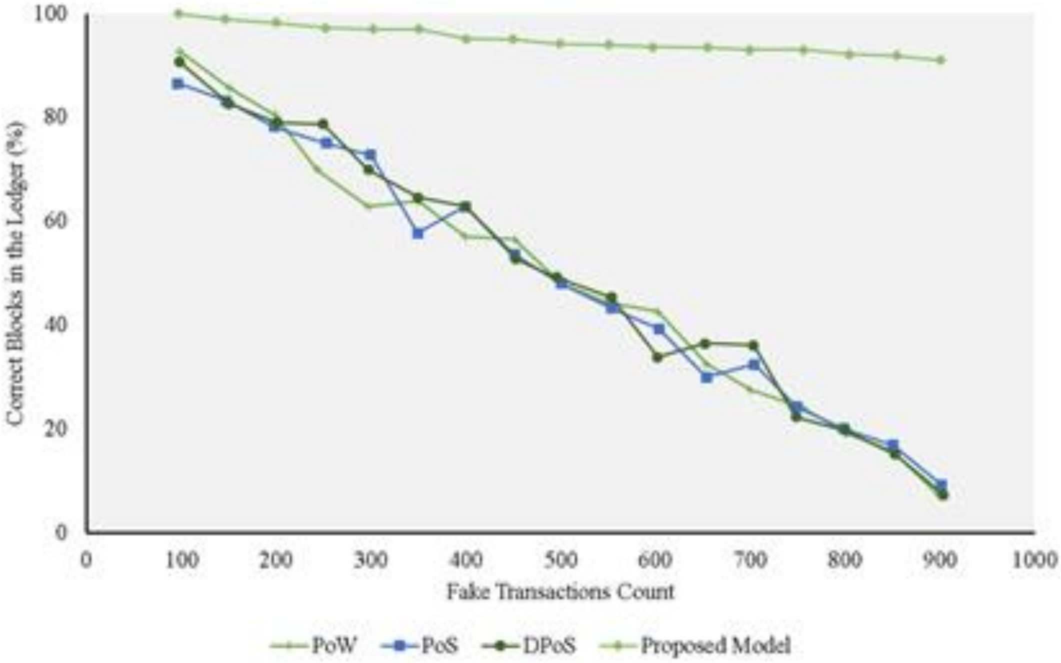

Figure 3. Experiments for different protocols on the fake transaction dataset (0% malicious nodes) Compared with the proposed model.

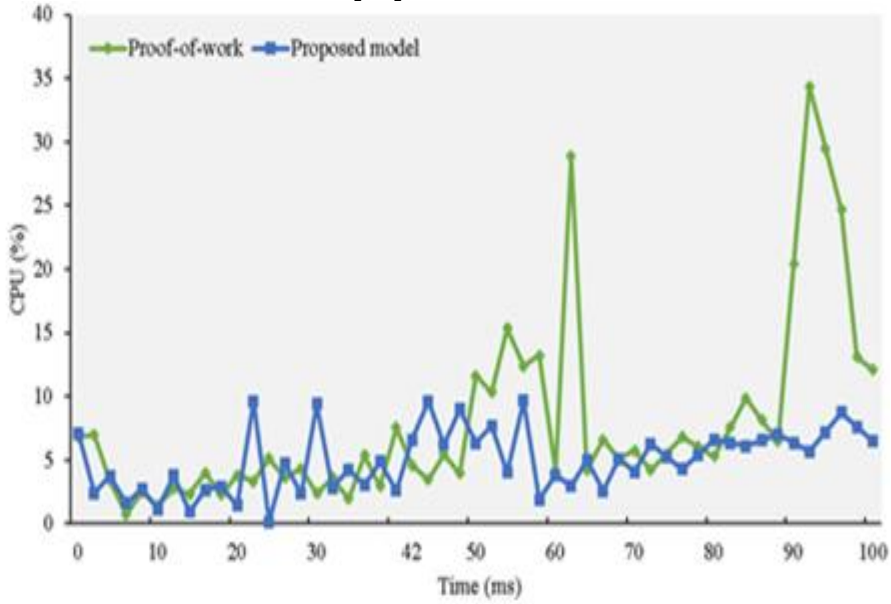

Figure 4. Computational power experiment.

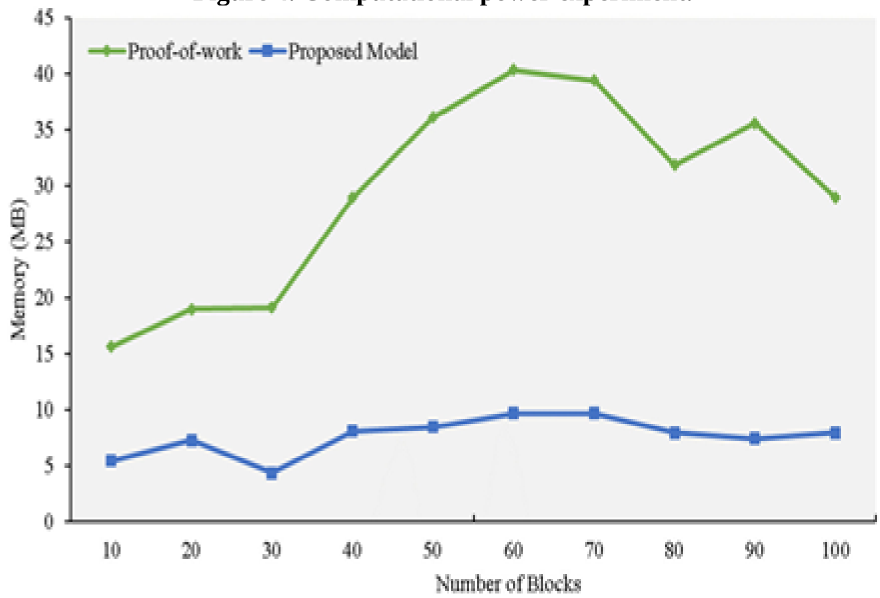

Figure 5. Memory evaluation experiment.

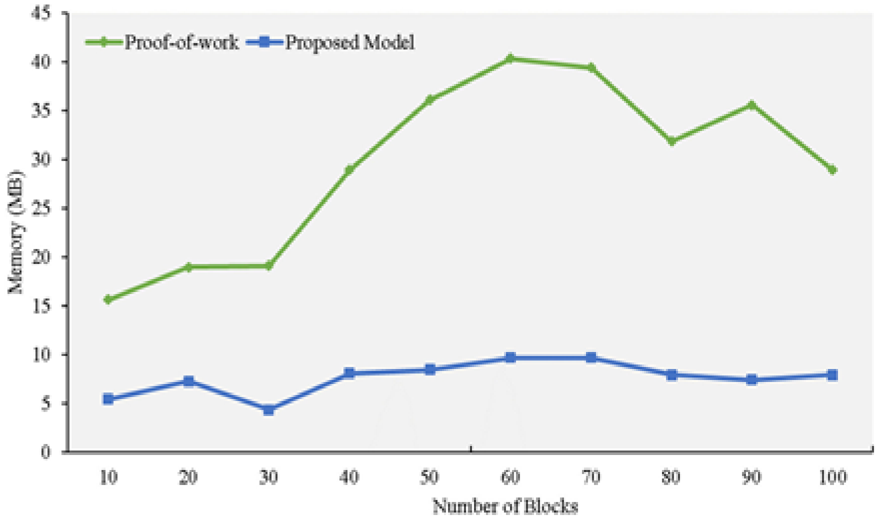

Figure 6. Delay evaluation experiment

References

1. Liu, M.; Jiang, X.; Zhao, F.; Feng, X.; Wang, R.A Fast Adaptive Blockchain Consensus Algorithm via Wlan Mesh Network. J.Internet Technol. 2020, 21, 523–533.

2. Zhang, J.; Zhong, S.; Wang, T.; Chao, H.-C.; Wang, J. Blockchain-based systems and applications: A survey. J. Internet Technol.2020, 21, 1–14.

3. Li, X.; Jiang, P.; Chen, T.; Luo, X.;Wen, Q.A survey on the security of blockchain systems.Future Gener. Comput. Syst.2020, 107,841–853.

4. Saberi, S.; Kouhizadeh, M.; Sarkis, J.; Shen, L. Blockchain technology and its relationships to sustainable supply chain management. Int. J. Prod. Res. 2019, 57, 2117–2135.

5. Min, H. Blockchain technology for enhancing supply chain resilience. Bus. Horiz. 2019, 62, 35–45.

6. Banerjee, A. Blockchain with IOT: Applications and use cases for a new paradigm of supply chain driving efficiency and cost.Adv. Comput. 2019, 115, 259–292.

7. Sodhro, A.H.; Sangaiah, A.K.; Sodhro, G.H.; Lohano, S.; Pirbhulal, S. An energy-efficient algorithm for wearable electrocardiogram signal processing in ubiquitous healthcare applications.Sensors 2018, 18, 923.

8. Sodhro, A.H.; Pirbhulal,S.;Muzammal,M.;Zongwei, L. Towards blockchain-enabled security technique for industrial internet of things based decentralized applications. J. Grid Comput. 2020, 18, 615–628.

9. Tian, F. An agri-food supply chain traceability system for China based on RFID & blockchain technology. In Proceedings of the 2016 13th International Conference on Service Systems and Service Management (ICSSSM), Kunming, China, 24–26 June 2016; pp. 1–6.

10. Huang, S.; Chang, H. Energy-aware supply route data collecting methods using wireless sensor networks. Wirel. Commun. Mob. Comput. 2016, 16, 872–883.

11. Zhang, F.; Wang, J.; Liu, S.; Zhang, S.; Sutherland, J.W. Integrating GIS with optimization method for a biofuel feedstock supply chain. Biomass Bioenergy 2017, 98, 194–205.

12. Lam, C.Y.; Ip, W.H.An integrated logistics routing and scheduling network model with RFID-GPS data for supply chain management. Wirel. Pers. Commun. 2019, 105, 803–817.

13. Tu, M.An exploratory study of Internet of Things (IoT) adoption intention in logistics and supply chain management. Int. J. Logist. Manag. 2018, 29, 131–151.

14. Liu, Z.; Li, Z. A blockchain-based framework of cross-border e-commerce supply chain. Int. J. Inf. Manag. 2020, 52, 102059.

15. Dutta, P.; Choi, T.-M.; Somani, S.; Butala, R. Blockchain technology in supply chain operations: Applications, challenges and research opportunities.Transp. Res. Part E Logist. Transp. Rev. 2020, 142, 102067.

16. Golosova, J.; Romanovs, A.The advantages and disadvantages of the blockchain technology. In Proceedings of the 2018 IEEE 6th Workshop on Advances in Information, Electronic and Electrical Engineering (AIEEE), Vilnius, Lithuania, 8–10 November 2018; pp. 1–6.

17. Nakamoto, S. Bitcoin: A Peer-to-Peer Electronic Cash System. Available online: http://www.bitcoin.org/bitcoin.pdf (accessed on 15 January 2021).

18. King, S.; Nadal, S. Ppcoin: Peer-to-Peer Crypto-Currency with Proof-of-Stake. Available online: https://decred.org/research/

19. Snider, M.; Samani, K.; Jain, T. Delegated Proof of Stake: Features & Tradeoffs. Available online: https://multicoin.capital/2018/03/02/delegated-proof-stake-features-tradeoffs/

20. Tian, F. An Information System for Food Safety Monitoring in Supply Chains Based on HACCP, Blockchain and Internet of Things; WU Vienna University of Economics and Business: Vienna, Austria, 2018.

21. Wang, L.; Kwok, S.K.; Ip,W.H.A radio frequency identification and sensor-based system for the transportation of food. J. Food Eng. 2010, 101, 120–129.

22. Tian, F.A supply chain traceability system for food safety based on HACCP, blockchain & Internet of things. In Proceedings of the 2017 International Conference on Service Systems and Service Management, Dalian, China, 16–18 June 2017; pp. 1–6.

23. Grunow, M.; Piramuthu, S. RFID in highly perishable food supply chains–Remaining shelf life to supplant expiry date? Int. J. Prod. Econ. 2013, 146, 717–727.

24. Cao,W.; Zheng, L.; Zhu, H.;Wu, P. General framework for animal food safety traceability using GS1 and RFID. In Proceedings of the International Conference on Computer and Computing Technologies in Agriculture, Beijing, China, 14–17 October 2009; pp. 297–304.