Research Article / Review Article FUPRE JOURNAL 7(2): 81-90 (2023)

FUPRE Journal

of

Scientific and Industrial Research

ISSN: 2579-1184(Print) ISSN: 2578-1129 (Online)

http://fupre.edu.ng/journal

Application of Blockchain Technology Model in Food Palliative Distribution in Developing Countries

AKAZUE, M. [1,*], *EDEKI, E. J.* [2] *OGEH, C. O.* [3] *UFIOFIO, E.* [4]

[1]*Department of Computer Science, Delta State University, Nigeria*

ARTICLE INFO

Received: 11/12/2022
Accepted:14/02/2023

Keywords

Blockchain, Food security, Palliative, Distribution system

ABSTRACT

COVID-19 pandemic brought negative effects on the global economy, which led to food shortage. Also, the prevention of online food loss throughout the supply chain, including donors and manufacturers, has become a major challenge for a number of organizations. In the light of these challenges, there is a concern in the production, processing, demand, and distribution of food. To address this issue, there is need for reliable and robust tools that traces food throughout the supply chain from the donor to the consumer, thus, ensuring transparency. This study investigates the existing system method of food distribution in Nigerian, and proposed a model for food distribution using blockchain technology. The result showed that blockchain technology can be adopted in food chain distribution.

1. INTRODUCTION

Food shortage in the supply chain leads to food diversion. The prevention of food diversion throughout the supply chain, including donors and manufacturers, has become a major challenge for several organizations. In addition, consumers are also increasingly interested in the authenticity of online food to ensure that they receive the right quality of products or online food shared. To address this issue, there is a need for reliable and robust tools to be available to trace food throughout the supply chain from the donor through processing until it reaches the consumer and, thus, ensures transparency. Food diversion is often described as a "farm-to-fork" damage problem (Aung and Chang 2019). Food diversion is a global challenge in developing and developed countries (de-Lange and Nahman, 2018). In a food supply chain, diversion can lead to loss. Loss can be classified into five categories: agricultural loss, postharvest loss, processing loss, distribution loss, and consumption loss (Kummu et al., 2020). Most food loss occurs throughout the food system starting at the point of production and ending at households

The food tracking system enables the supply chain to measure the level of safety of perishable food products, tracing the journey from where they are grown, handled, or stored and under what conditions they are transported or processed, thus leading to the

*Corresponding author, e-mail: akazue@delsu.edu.ng, ufiofioemmanuel@gmail.com
DIO

development of a transparent and authentic chain of records of the food ecosystem (Godsiff, 2016; Akazue et al., 2023). In the food industry, the provenance and traceability of information help to improve the quality as well as the safety of food (Saberi et al., 2019). In addition, the evolution of technologies in this era has the potential to prevent unnecessary waste and reduce the economic burden of product recalls, outbreaks, and cross-contamination. However, many unknown impediments related to people, processes, technology, and performance can creep into the food supply chain and so need further investigation. Online palliative distribution is how food or items is shared out among a group of people or spread over an area from a website or other application. In this context, the product has not been specially prepared for direct consumption.

The COVID-19 pandemic has caused uncertainty about food security around the whole world. Following the country's lockdown in March 2020 due to the COVID-19 pandemic, the presidency made a campaign for food distribution and other relief materials, that is, palliative to those who are in need and to the vulnerable to cushion the shortage of food effect in the country. But, in developing countries, the food supply chain faces several challenges, such as the need for confidence among stakeholders which often correlated with the credibility and traceability required by the end-users, and the difficulty of managing risks, delays, or disruptions is often occurred due to insufficient information (Kittipanya-Ngamand Tan, 2020; Sabir et al., 2021, Akazue et al., 2023).

The motivation of the study resulted from the problems encountered in a developing country during food distribution such as

- Lack of traceability. A lack of traceability and transparency, can create blind spots in your supply chain and expose you to unnecessary risk (Jad, 2018).
- Lack of trust
- Lack of accountability
- Lack of transparency in the storage and transmission of information about food products distribution through the stage of the food supply chain to facilitate the good control of food products distribution quality and safety. Lack of transparency can result in quality and safety issues in food supply chain management (Vu et al, 2021).

Blockchain technology provides a way to achieve the immutable storage of data that can reduce the need for third-party verifications (Lin & Liao 2017). Non-involvement of third-party engagement will be helpful for businesses and consumers in the contemporary complex supply chains in this era (Perboli et al., 2018).

Blockchain technology was harnessed as a credit evaluation system to strengthen the effectiveness of supervision and management in the food supply chain. (Andreas et al., 2019). Blockchain technology has helped improve the food industry. Hence, a blockchain can be used in the food distribution so that every party along the length of the supply chain (producers, processors, and distributors), can provide traceability information about their particular role and for each batch of the product (dates, places, farm buildings, distribution channels, potential treatments). The reason is because blockchain is a specific type of database, which stores data in blocks and then chained them together. As new data comes in, it is entered into a fresh block and once the block is filled up with data, it is chained onto the previous block, which makes the data chained together in chronological order.

According to Aileen (2022), Blockchain consists of three components which include;

- Blocks: A block is a place in a blockchain where information is stored and encrypted. Every chain consists of multiple blocks and each block has three basic elements (i) The data in the block (ii) A 32-bit whole number called Nonce (iii) The hash which is a 256bit number joined to the nonce and it must begin with a huge number of zeroes.
- Nodes: Any kind of electronic device that maintains copies of the blockchain and keeps the network functioning.
- Miners: It creates new blocks on the chain through a process called Mining.

1.1 Types of Blockchain

Tiscini et al., (2020), Blockchain technology integrated with other artificial intelligence (AI) technologies can potentially mitigate issues surrounding trust, traceability, and collaboration in a supply chain. The cryptocurrency technology is also used by different applications, such as VeChain, for certification Waltonchain for apparel supply chains, Ambrosus for food and medicine supply chains, and Modum exclusively for pharma supply chains. Currently, there are four main types of blockchain technology, name**ly;** Public Blockchain, Private Blockchain, Hybrid Blockchain and Consortium Blockchain.

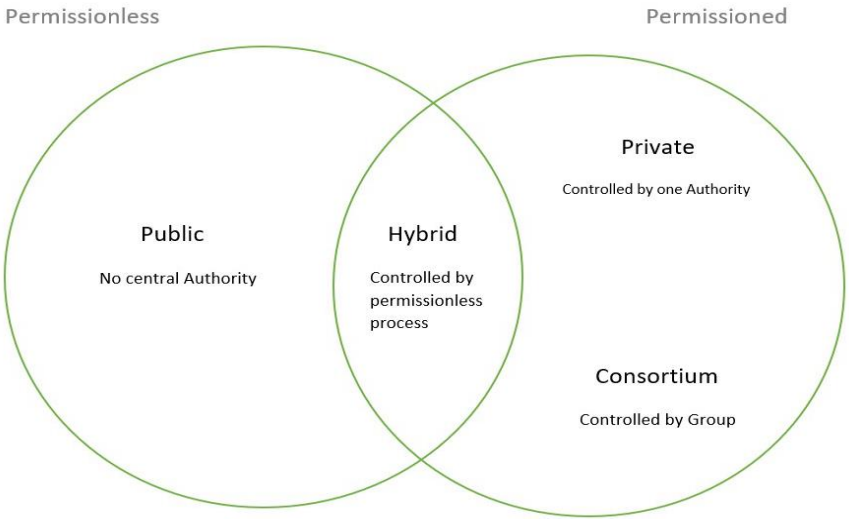

Figure 1: Types of Blockchain (Tiscini et al., 2020)

1.1.1 Public Blockchain

All block chains have their merit and demerits. Tiscini et al., (2020) listed the merits or advantages of public blockchain to include:

- Trustable: There are algorithms to detect no fraud. Participants need not worry about the other nodes in the network
- Secure: This blockchain is large in size as it is open to the public. In a large size, there is greater distribution of records
- Anonymous Nature: It is a secure platform to make your transaction

properly at the same time, you are not required to reveal your name and identity to participate and

- Decentralized: There is no single platform that maintains the network, instead every user has a copy of the ledger.

The following are the disadvantages or demerits that research have revealed over the years; these include;

- Processing: The rate of the transaction process is very slow, due to its large size. Verification of each node is a very time-consuming process.
- Energy Consumption: Proof of work is high energy-consuming. It requires good computer hardware to participate in the network
- Acceptance: No central authority is there so governments are facing the issue to implement the technology faster.

1.1.2 Private Blockchain

These blockchains are not as decentralized as the public blockchain. Only selected nodes can participate in the process, making it more secure than the others.

- These are not as open as a public blockchain.
- They are open to some authorized users only.
- These blockchains are operated in a closed network.
- In this few people are allowed to participate in a network within a company/organization.

Advantages:

- Speed: The rate of the transaction is high, due to its small size. Verification of each node is less time-consuming.
- Scalability: We can modify the scalability. The size of the network can be decided manually.
- Privacy: It has increased the level of privacy for confidentiality reasons as the businesses required.
- Balanced: It is more balanced as only some user has the access to the transaction which improves the performance of the network.

Disadvantages:

- Security- The number of nodes in this type is limited so chances of manipulation are there. These blockchains are more vulnerable.
- Centralized- Trust building is one of the main disadvantages due to its central nature. Organizations can use this for malpractices.
- Count- Since there are few nodes if nodes go offline the entire system of blockchain can be endangered.

1.1.3 Hybrid Blockchain

It is the mixed content of the private and public blockchain, where some part is controlled by some organization and other makes are made visible as a public blockchain.

- It combines public and private blockchain technologies.
- Systems with and without permission are employed.
- Users can access data through smart contracts
- Even if a principal entity owns a hybrid blockchain, the transaction cannot be changed.

Advantages:

- Ecosystem: Most advantageous thing about this blockchain is its hybrid nature. It cannot be hacked as 51% of users don't have access to the network

- Cost: Transactions are cheap as only a few nodes verify the transaction. All the nodes don't carry the verification hence less computational cost.
- Architecture: It is highly customizable and still maintains integrity, security, and transparency.
- Operations: It can choose the participants in the blockchain and decide which transaction can be made public.

Disadvantages:

- Efficiency: Not everyone is in a position to implement a hybrid Blockchain. The organization also faces some difficulty in terms of efficiency in maintenance.
- Transparency: There is a possibility that someone can hide information from the user. If someone wants to get access through a hybrid blockchain it depends on the organization whether they will give it or not.
- Ecosystem: Due to its closed ecosystem this blockchain lacks the incentives for network participation.

1.1.4 *Consortium Blockchain:* It is a creative approach that solves the needs of the organization. This blockchain validates the transaction and also initiates or receives transactions.

- Also known as Federated Blockchain.
- This is an innovative method to solve the organization's needs.
- Some part is public and some part is private.
- In this type, more than one organization manages the blockchain.

Advantages:

- Speed: A limited number of users make verification fast. The high speed makes this more usable for organizations.
- Authority: Multiple organizations can take part and make it decentralized at every level. Decentralized authority, makes it more secure.
- Privacy: The information of the checked blocks is unknown to the public view. but any member belonging to the blockchain can access it.
- Flexible: There is much divergence in the flexibility of the blockchain. Since it is not a very large decision can be taken faster.

Disadvantages:

- Approval: All the members approve of the protocol making it less flexible. Since one or more organizations are involved, there can be differences in the vision of interest.
- Transparency: It can be hacked if the organization becomes corrupt. Organizations may hide information from the users.
- Vulnerability: If a few nodes are getting compromised there is a greater chance of vulnerability in this blockchain.

Numerous studies have examined blockchain technology. Sawamir (2019) conducted a study to ascertain the significance of blockchain technology in managing the food supply chain. A helpful application of the chosen research goal was to demonstrate the value of blockchain technology in fostering trust among those involved in the food supply chain. According to research, blockchain technology has many advantages that can be used to address the system's flaws and problems today. Its primary added value is a marked improvement in operational transparency among all stakeholders using big data throughout the entire food chain.

Tanwar et al., (2022), provide a comprehensive analysis of contemporary methods for managing the supply chain, tracing food, and maintaining industrial security. In addition, we offer a

decentralized and secure blockchain-based food industry architecture to address privacy and security concerns and present a thorough solution taxonomy for a blockchain-based food business. Then, a comparison of the pros and cons of the available ways is offered, allowing the end-user to choose an option based on its advantages over others in terms of scalability, latency, and food quality. Finally, we conclude with some observations on the unresolved problems and the difficulties in the research.

Hui et al., (2021), gives a survey to research the methods and uses of blockchain technology in the agricultural industry. First, the technical features, including data structure, cryptographic algorithms, and consensus procedures are presented in detail. To show how to apply blockchain technology, the current agricultural blockchain applications are grouped and assessed. Thirdly, it highlights the attempts and potential solutions being made to address the major issues in many future agricultural systems.

Caro et al., (2018), present AgriBlockIoT, a fully decentralized, blockchain-based traceability solution for Agri-Food supply chain management, able to seamlessly integrate IoT devices producing and consuming digital data along the chain.

Wang et al., (2019), in their findings, while blockchain technologies remain in their infancy, they are gaining momentum within supply chains, trust being the predominant factor driving their adoption. The value of such technologies for supply chain management lies in four areas: extended visibility and traceability, supply chain digitalization and disintermediation, improved data security, and smart contracts. Several challenges and gaps in understanding and opportunities for further research are identified by this research. How a blockchain-enabled supply chain should be configured has also been explored from a design perspective. This paper offers valuable insight for supply chain practitioners into how blockchain technology has the potential to disrupt existing supply chain provisions as well as several challenges to its successful diffusion.

2. APPLICATION AREAS OF BLOCKCHAIN TECHNOLOGY

2.1. Blockchain in Money Transfer

Tse et al., (2017), This was invented by Bitcoin, and at the moment, the use of cryptocurrency transfer apps is soaring. Due to the time and money that blockchain may save financial institutions of all kinds, it is particularly well-liked in the industry. Blockchain can save the biggest bank a lot of money by cutting third-party fees, getting rid of bureaucratic red tape, and making ledger systems real-time. These businesses efficiently move money using blockchain technology. Compared to using current money transfer services, using blockchain for money transfers may be cheaper and faster. Money transfers between accounts can take days, whereas a blockchain transaction just takes minutes. This is particularly typical of cross-border transactions, which are frequently expensive and lengthy (Adam 2021).

2.2. Blockchain Smart Contracts

Tse et al., (2017), Smart contracts are similar to ordinary contracts with the exception that smart contracts eliminate the middleman and offer degrees of accountability for all parties involved that are not feasible with conventional agreements. Smart contracts' rules are implemented in real-time on a blockchain. This ensures compliance from all parties involved while also saving businesses time and money. As industries like government, healthcare, and real estate learn about the advantages, blockchain-based contracts are growing in popularity.

2.3. Blockchain and IoT

Tse et al., (2017) reported that the next logical explosion in blockchain applications is the Internet of Things (IoT). IoT offers a wide range of uses and several security

issues, and as the number of IoT products rises, hackers will have more opportunities to steal your data via devices ranging from Amazon Alexa to smart thermostats. By harnessing the openness and theoretical incorruptibility of the technology to keep things "smart," blockchain-infused IOT offers a greater level of security to prevent data breaches.

2.4. Blockchain in Security

Up to 42 million Americans were victims of identity fraud in 2021 alone, according to AARP (2022). Fraud on this scale can take many forms, from falsifying documents to accessing private data. The government may see a sharp decline in identity theft claims by storing social security numbers, birth dates, birth certificates, and other sensitive information on a decentralized blockchain ledger. Here are some blockchain-based companies leading the way in identity security (Tse et al., 2017).

2.5. Blockchain in Healthcare

Tse et al., (2017), stated that Blockchain in healthcare though early in its adoption, is already showing some promise. Early blockchain solutions have shown the potential to reduce healthcare costs, improve access to information across stakeholders and streamline business processes. An advanced system for collecting and sharing private information could be just what the doctor ordered to make sure that an already bloated sector can trim down exorbitant costs.

2.6 Blockchain in Logistics: Tse et al., (2017). A significant issue in the shipping sector is the lack of transparency and communication brought on by the dense concentration of logistics firms. Over 500,000 shipping companies operate in the US, which leads to data soiling and transparency problems, according to a joint study by Accenture and logistics behemoth DHL. According to the paper, supply chain management and logistics are plagued by a number of issues that can be resolved by blockchain technology.

The study argues that blockchain enables data transparency by revealing a single source of truth. By acknowledging data sources, a blockchain can build greater trust within the industry. The technology can also make the logistics process leaner and more automated, potentially saving the industry billions of dollars a year. Blockchain is not only safe but a cost-effective solution for the logistics industry.

3. PROPOSED MODEL FOR PALLIATIVE DISTRIBUTION OF FOOD FOR DEVELOPING COUNTRIES

Based on the literature review and the application of blockchain to several fields, a palliative distribution model is proposed for palliative distribution for developing countries.

The proposed model (figure 1) brings a solution to all the weaknesses of the existing system, making the supply chain more secure and traceable. There are five major stakeholders or participants in the proposed system which include, the governor, the local government chairman, the councilor, the community head, and the end users who are vulnerable. The distribution process starts with the governor taking the inventory of all the palliatives received into the warehouse. The governor then creates a block of palliatives and stores details about their states in a blockchain down to the community head which now distributes to the end users. The application will be embedded with full functionalities, responsiveness, dynamic, robust, interactive, and user-friendly.

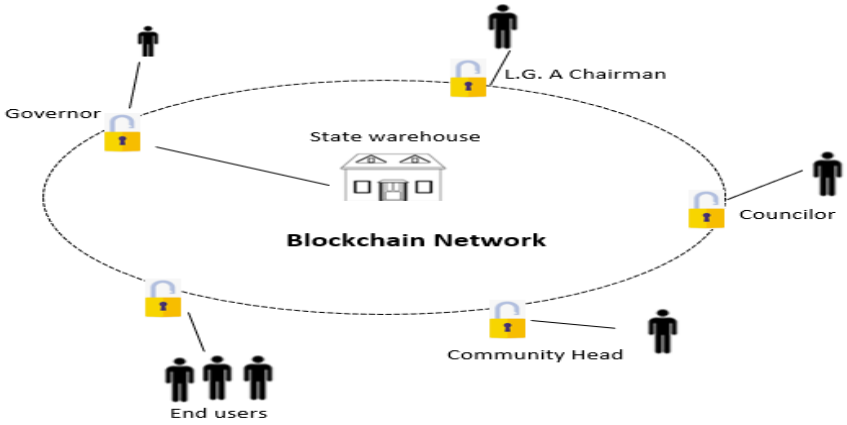

Figure 2: Blockchain network for palliative distribution for developing countries

Discussion

A palliative distribution system can be developed using blockchain to mitigate all the challenges associated with traditional palliative distribution such as lack of traceability, trust, and accountability. Blockchain has being successfully applied to different fields and applying it in a palliatives distribution system will bring greater trust and transparency to the process.

4. CONCLUSION

This research proposed the adoption of blockchain technology in the distribution of palliatives and it became obvious that tracking and traceability of palliative distributed can be done with ease, as they move and change hands throughout the supply chain, which built greater trust, greater security, and many more in the distribution process and the recipients, so it can be boldly said that the adoption of blockchain paid for palliatives distribution.

References

Adam L. (2021). 15 Applications for Blockchain Technology. www.fool.com. Retrieved 7th April 2022.

Ahlmann, J. (2018). Farm-to-Fork Transparency: Food Supply Chain Traceability. *Cutter Business Technology Journal*, 31(4), Available:

Aileen S. (2022, 02 13). An Overview of Blockchain Technology and its Functionality. Retrieved from https://www.datasciencecentral.com.

Akazue M. I., Yoro R. E., Malasowe B. O., Nwankwo O., and Ojugo A. A. (2023). Improved services traceability and management of a food value chain using block-chain network: a case of Nigeria. Indonesian Journal of Electrical Engineering and Computer Science, 29(3):1623~1633

Andreas, K., Agusti, F., Francesc, X., & Prenafeta-Boldύ, (2019). The rise of blockchain technology in agriculture and food supply chains. Trends in Food Science & Technology journal homepage: www.elsevier.com/locate/tifs.

Aung, M.M., & Chang, Y.S. (2019). Traceability in a food supply chain: Safety and quality perspectives. Food control, 39:172-184.

Caro, P., Ali, S., Vecchio, M., and Giaffreda, R., (2018). Blockchain-based Traceability in Agri-Food Supply Chain Management: A Practical Implementation. https://doi.org/10.1109/IOT-TUSCANY.2018.8373021.

de Lange, W., & Nahman, A. (2018). Costs of food waste in South Africa: Incorporating inedible food waste. Waste management, 40:167-172.

Godsiff, P. (2016). Blockchains could help restore trust in the food we choose to eat. The Conversation: foodwe-choose-to-eat-62276

Hui, F., Weijun, L., Xinghong, H., Victoria, W., Yining, H., Jingjie, W., Haining, Y., … Laihung, Y., (2021). Blockchain Technology in Current Agricultural Systems: From Techniques to Applications. IEEE Access journal. DOI10.1109/ACCESS.2020.3014522.

Jad, A., (2018). Fixing the 5 Big Problems in the Food Supply Chain. The ...https://supplychainbeyond.com › 5-big-problems-in-the...

Kittipanya-Ngam, P., and Tan, K., (2020). A framework for food supply chain digitalization: lessons from Thailand. Production Planning & Control, 31(2-3):158–172.

Kummu, M., de Moel, H., Porkka, M., Siebert, S., Varis, O., & Ward, P. J. (2020). Lost food wasted resources: Global food supply chain losses and their impacts on freshwater, cropland, and fertilizer use. *Science of the Total Environment*, *438*, 477-489.

Lin, I. C., & Liao, T. C. (2017). A Survey of Blockchain Security Issues and Challenges. *International Journal of Network Security*, *19*(5), 653-659.

Manski, S., (2017). Building the blockchain world: Technological commonwealth or just more of the same? Strategic Change, 26(5), 511–522.

Perboli, G., Musso, S., & Rosano, M. (2018). Blockchain in logistics and supply chain: A lean approach for designing real-world use cases. *IEEE Access*, *6*, 62018-62028.

Premium Times Nigeria by Agency Report April 16, 2020 published Wednesday, January 19, 2022.

Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019). Blockchain technology and its relationships to sustainable supply chain management. *International Journal of Production Research*, 57(7), 2117-2135

Sabir, A., Sheerazination, A., Fasee, U., Asif, N., Atif,K., Uddin, M., Abdullah, A., …Hashem, A., (2021). IoT with Blockchain: A Futuristic Approach in Agriculture and Food Supply Chain. HindawiWireless Communications and Mobile Computing Volume 2021, Article ID 5580179, 14 pages.

Sławomir Jarka (2019). Food safety in the supply chain using blockchain Technology. Acta Sci. Pol. Oeconomia 18 (4):41–48, DOI: 10.22630/ ASPE.2019.18.4.43

Tanwar S., Parmar, A., Kumari, A., Jadav, N., Hong, W., and Sharma, R., (2022). Blockchain Adoption to Secure the Food Industry: Opportunities and Challenges. Sustainability, 14, 7036.

Tiscini, R., Testarmata, S., Ciaburri, M., and Ferrari, E. (2020). The blockchain as

a sustainable business model innovation. Management Decision.

Tse, D., Zhang, B., Yang, Y., Cheng, C., and Mu, H. (2017). Blockchain application in food supply information security. In *2017 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)* (pp. 1357-1361). IEEE.

Vu, N., Ghadge, A., and Bourlakis, M., (2021). Blockchain adoption in food supply chains: a review and implementation framework. Production planning & control. https://www.researchgate.net/publication/352092641.

Wang, Y., Han, J., and Beynon-Davies, P., (2019). Understanding blockchain technology for future supply chains: a systematic literature review and research agenda. Supply Chain Management: An International Journal. Volume 24· Number 1. 2019. 62–84 https://www.britannica.com