Research Article / Review Article FUPRE JOURNAL 9(2):01-08(2025)

FUPRE Journal

of

Scientific and Industrial Research

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

http://fupre.edu.ng/journal

Developing A Web Application for Pandemic Palliative Food Distribution Using Blockchain Technology

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ARTICLE INFO

Received: 13/04/2025
Accepted: 20/07/2025

Keywords

Blockchain, Palliative, Food Distribution

ABSTRACT

Blockchain technology can track food supply chains and also help to build trust between donors and end-users. The COVID-19 pandemic had detrimental impacts on the world economy, resulting in food shortages. Addressing the averting of food loss in the process of the supply chain, involving both contributors and manufacturers, has emerged as a significant defiance for many establishments. This research created a web application aimed at alleviating food distribution issues during the pandemic, utilizing blockchain technology. Following an examination of the current food distribution methods in Nigeria, the study formulated a model that incorporates the Secure Hash Algorithm (SHA) 256 for effective food distribution. The result after evaluation of the developed model performance showed responsiveness as 69%, speed as 70% and availability as 80%, so with that, effective distribution of pandemic palliatives item was made possible substantially using blockchain technology.

1. INTRODUCTION

"Food shortage in the supply chain leads to food diversion. Food diversion is often described as a 'farm-to-fork' damage problem" Aung and Chang (2019) it is defined as any food substance, "liquid or solid, cooked or uncooked, that is thrown away or discarded including food processors." "Food items travel through what is often a chain of farmers, retailers, distributors, transporters, storage facilities, processors, and suppliers before reaching the end consumer and have to undergo processes such as post-production, harvesting, processing (warehouses, packaging), transportation, distribution, and sales. Yet in almost every case, this journey remains an unseen dimension of purchased food products" Ahlmann *et al.,* 2018. "The increasing globalization of food production and trade has opened up access to food and led to an increase in consumer options" Fox *et al.,* 2018. "This not only makes the supply chain longer and more difficult, but it also contributes significant tracking and safety challenges, which necessitates a change to the farm-to-fork business models" King *et al.,* 2017. "Additionally, the

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intrusion of faked products is affecting both the integrity of brands and the health of consumers" Chang *et al.,* 2019. "The food supply chain is facing uncertainties because of product perishability. In addition, "information asymmetry" between the stakeholders is one of the major factors that lead to food fraud" Mao et al., 2018; Galvez et al., 2018. Thus, there is a need for data sharing due to pilferage, unproductive transactions, etc. that lead to a mistrust among the supply chain partners. "In the agri-food sector, traceability of food is becoming a major differentiator and so is imperative for organizations" Saberi *et al.,* 2019. "Thus, it is crucial to have a centralized and effective traceability system that ensures data connectivity among all the partners" Fatorachian and Kazemi, 2018.

Problems encountered with food distribution in Nigeria, during Covid-19, were lack of traceability, trust, accountability and transparency in the storage and transmission of information about food supply through the stage of the food supply chain. Jad (2018) stated that a lack of traceability and transparency can create blind spots in the supply chain and expose unnecessary risk. "Vu *et al.* (2021) demonstrated the impact of low transparency on food supply chain quality and safety." "A blockchain is a trusted, unchangeable digital data record used to track transactions using distributed consensus" Kamble *et al,* 2019; Galvez et al., 2018.

"Blockchain technology empowers clients to screen all transactions at the same time and in genuine time while storing and sharing data over a network of clients in an open virtual space" Wang *et al.,* 2019. "To improve the proficiency of organizations and oversight along the food supply chain, blockchain technology can also be utilized as a credit rating system" Andreas *et al.,* 2019. Aileen, (2022) claims that there are three parts to a blockchain, including:

- Blocks
- Nodes
- Miners

"Blockchain technology is transparent, improves exactness by evacuating human involvement in verification, and diminishes cost by eliminating third-party verification. With blockchain technology, transactions are secure, private, and efficient." "Blockchain safeguards the discernibility and unwavering quality of each exchange in the food production network" Jeyageetha *et al.,* 2021. "Blockchain decentralization makes it harder to tamper with and according to" Andreas et al., 2019, "traceability systems help companies identify the cause and extent and resolve safety or quality control problems". "Blockchain is made up of three leading technologies which are;

- A peer-to-peer network containing a shared ledger
- Cryptographic keys
- A means of computing, to store the transactions and records of the network. Blockchain technology integrated with other artificial intelligence (AI) technologies can potentially reduce issues surrounding trust, traceability, and collaboration in a supply chain" Tiscini *et al.,* 2020. "There are four main types of blockchain technology; Public Blockchain, Private Blockchain, Hybrid Blockchain and Consortium Blockchain."

2. RELATED WORKS

Numerous studies have examined blockchain technology. "George *et al.* (2019) analyzed the main food traceability techniques and suggested a restaurant prototype for combining Blockchain and product

identifiers to provide more dependable food traceability. The prototype gathers data from different parties involved in the food supply chain, separates it, and then uses the Food Quality Index (FQI) algorithm to produce an FQI value."

"Jarka (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 demonstrated 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."

"In their term paper from 2020, Casino et al., made and tried a distributed trustless and secure architecture for food supply chain traceability. An illustration of food traceability case study from a dairy company is given to help evaluate the practicality of the proposed approach. The creation of completely operational smart contracts and a local private blockchain further demonstrate the model's applicability." "Deepak et al. (2020) offered a blockchain-based solution that diminishes the need for intermediaries, exchanges of data, and a secure centralized structure, improves performance, and meets with a high standard of safety and integrity." Consequently, a model that gives a precise, clear, and traceable supply chain system was proposed.

"Kittipanya-Ngam and Tan (2020), examined the process, difficulties, and opportunities experienced by food manufacturers as they attempt to digitize their supply chains for food. The consequences of a proposed framework for the digitalization of the food supply chain for research and practices are examined." "Rejeb *et al.* (2020) showed that despite the claims and marketing hoopla, a thorough analysis of the advantages and disadvantages of using blockchain in FSCs is still lacking." "Wajde *et al.* (2021) gave a general overview of blockchain technology; it compiles all of the notable design elements, traits, and advantages that make blockchain a superior and distinctive technology; it also showed the widely utilized consensus protocols and taxonomy of blockchain systems. The report also analyzes blockchainbased applications in a number of industries, including real estate, healthcare, advertising and media, supply chain management, banking, and insurance. It endeavors to analyze the major issues facing the sectors, blockchain solutions, and application cases." "Tanwar *et al.* (2022) provided a comprehensive analysis of contemporary methods for overseeing the supply chain, tracing food, and maintaining industrial security. In addition, decentralized and secure blockchain-based food industry architecture addresses privacy and security concerns and presents 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, concluded with some observations on the unresolved problems and the difficulties in the research. Akazue *et al.* (2023) in their study investigates the existing system method of food distribution in Nigeria, and proposes a model for food distribution using blockchain technology."

3. MATERIALS AND METHODS

The basic materials requirements for the developed system to function properly include;

- Hardware requirements such as, Processor power of 2GHz or higher, RAM size of 8Gb or higher, Microsoft window 10 pro or 11, Fast Ethernet Network Interface Card/Modem, Server and client's com and also Reliable network.
- Software requirements such as, PHP 7.0, HTML, CSS, Bootstrap, JavaScript installed for the front-end and It also requires MySQL installed for the database which is the back-end.

The approach adopted in this research work for the development of the software is the Scrum method, which is an agile development method used in the development of software based on iterative and incremental processes. This research work was investigated in Delta State, Nigeria. Unstructured interviews were conducted with fifty (50) vulnerable persons at random during the Covid lockdown in 2020, at one of the sharing points in delta state.

3.1 Existing System

"Food supply chain is a system that describes the movement of food from the farm down to the buyers, the end-users. This research work examined the existing system which adopted Systematic Literature Review (SLR) to reply research questions and provides a conceptual framework for executing blockchain in food supply chains but failed to examine scalability issues in the context of Blockchain implementation."

3.2 Proposed System

A web application system for food distribution was developed using SHA 256 algorithm to secure information of the distribution. The developed system has a multi-user dashboard that enables users to access the system. The application is inserted with full functionalities, that's responsive, energetic, strong, intuitively, and user-friendly. This application takes inventory and tracks all the palliative food distributions within Delta state, Nigeria. The developed system seeks to tackle lack of traceability, accountability and transparency. "There are five major stakeholders or participants in the proposed system which include, the governor, the local government chairman, the counselor, the community head and the end users." The blocks of data are stored in chronological order with the assistance of timestamps. With the proposed framework, one can trace back the palliatives origin by tracing the blockchain node. The proposed framework gives different benefits such as upgrading security, providing instant traceability and efficiency. The proposed system implements blockchain technology by developing a web application for palliative for food distribution that will improve the food distribution system and tackle lack of traceability, accountability and transparency.

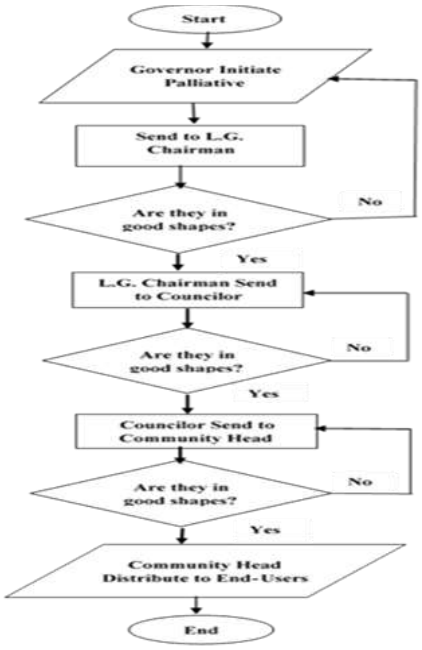


Figure 1: Flowchart for Palliative Food Distribution System (PFDS)

3.3 SHA 256 Algorithm

"Blockchain technology uses hashing and encryption to secure the information, relying mainly on the SHA256 algorithm to secure the information. The developed system adopted the SHA (Secure Hash Algorithm) 256 algorithm.The address of the sender (public key), the receiver's address, the transaction, and his/her private key details are transmitted through the SHA256 algorithm. The encrypted information, called hash encryption, is transmitted over the world and included to the blockchain after verification. The SHA256 algorithm makes it almost impossible to hack the hash encryption, which in turn simplifies the sender and receiver's authentication." Figure 1 illustrates the hashing algorithm according to Aditya (2019).

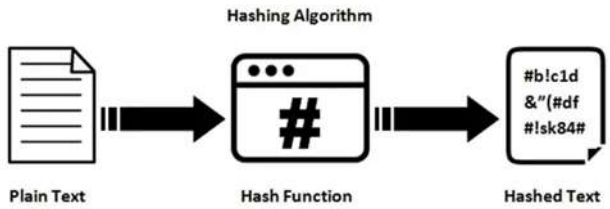


Figure 2: Hashing Algorithm Diagram

3.3.1 How Sha-256 Algorithm Works

- Convert the message to binary, i.e. 1's and 0's.
- Add a single 1 to the converted message.
- Pad with 0's until the data is a multiple of 512
- Append or add 64 bits to the end and make the whole message an exact multiple of 512
- Initialize the buffers. Determine the default values for eight buffers to be used for the computation of the final hash. Eight hash values are created as seen below;

  a= 0x6a09e667
  b= 0xbb67ae85
  c= 0x3c6ef372
  d= 0xa54ff53a
  e= 0x510e527f
  f= 0x9b05688c
  g= 0x1f83d9ab
  h= 0x5be0cd19
- Compression functions. The whole message is broken down into different square of 512 bits, each of them is put through 64 rounds of operation where the output of each piece is utilize as the input for the next block of operation.
- Output. After compression iteration, the message block gives the hash result of the whole message as the final output which has a length of 256 bits.

3.4 Implementation

In the implementation of this work, the manual way of distributing palliatives is converted to a web based application whereby palliatives are being distributed, this application tracks the movement of the palliatives in order to know how they are being shared, making the system more functional than the manual way of distribution without disturbing the normal operation. This implementation includes the creation of compatible files, training of people who are going to operate the newly developed system and the installation of necessary software and other things that the system needs to function well.

RESULTS

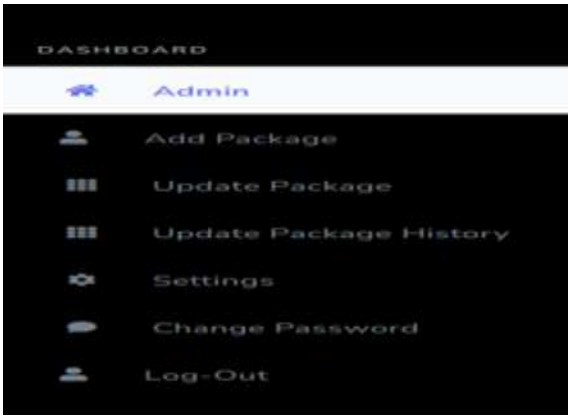


Figure 3: Main menu



Figure 4: Sample of registered palliatives



Figure 5: Blockchain movement result page for palliatives in good shape

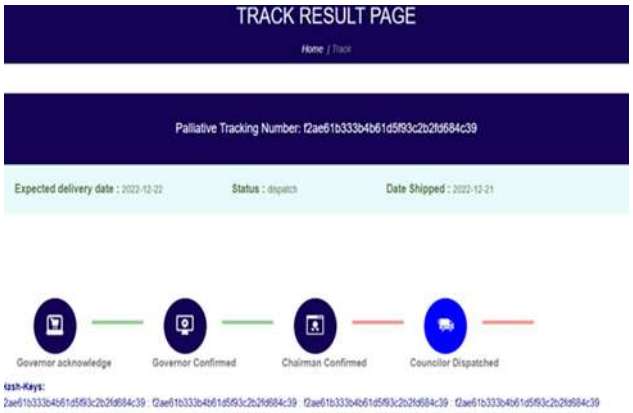


Figure 6: Blockchain movement result page for palliatives not in good shape

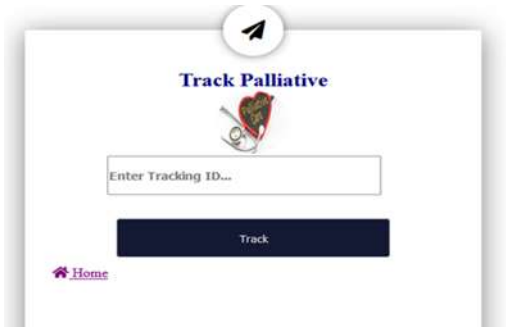


Figure 7: Tracking page for palliatives

Table 1: Performance evaluation Table

Palliatives in Distribution	Responsiveness and Reachability	Speed/Number of Transaction per second	Availability	Blockchain Flow
Palliative 1	50%	57%	67%	Items traced and found in good shape
Palliative 2	40%	45%	48%	Items traced and not found in good shape
Palliative 3	67%	60%	71%	Items traced and found in good shape
Palliative 4	69%	70%	80%	Items traced and found in good shape

The responsiveness and the reachability, the speed and availability of the application revealed that the performance was perfectly okay following the progression of the proposed system.

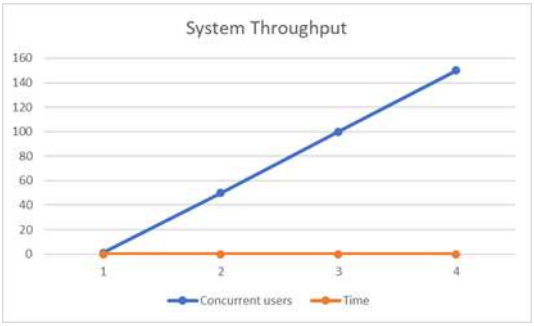


Figure 8: System throughput

The number of transactions per seconds was obtained and converted into minutes which were plotted against concurrent users. "*The finding shows that the higher the number of users, the higher the number of times to process transactions.*"

4. CONCLUSION

This study developed a web application for pandemic palliative food distribution using blockchain technology to tackle the problems associated with the existing system, which helps to enhance transparency and security for palliatives distribution during pandemic as they move and alter hands all through the supply chain. It can be strikingly said that the adoption of blockchain paid for palliative distribution.

Conflicts of interest

There is no conflict of interest regarding the publication of this paper

Acknowledgments

The authors acknowledge the Editor in chief and the Reviewers for their hard work and dedication to improve this research work.

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