ROLE OF TECHNOLOGY IN ENHANCING THE VISIBILITY AND TRACEABILITY IN THE AGRI-FOOD SUPPLY CHAIN MANAGEMENT

Richa Saxena, Satyendra Arya

TMIMT, Teerthanker Mahaveer University, Moradabad, India

Abstract

This study examines how technology is critical in improving traceability and visibility in the complex ecology of agri-food supply chain management. The agri-food business recognizes that incorporating advanced technologies is essential in an era distinguished by changing customer preferences, strict regulations, and a rising emphasis on sustainability. This study offers a comprehensive analysis of the ways in which technological advancements help the Agri-food supply chain as whole overcome obstacles, become more efficient, and maintain its integrity.

The study investigates the advantages of Radio-Frequency Identification (RFID) technology and Internet of Things (IoT) devices for real-time monitoring of vital parameters like temperature, humidity, and product placement. Implementing blockchain technology is closely examined because of its potential to establish end-to-end traceability, strengthen the integrity of the supply chain, and produce an indestructible and transparent database. The purpose of this research paper is to present an in-depth understanding of the ways in which technology is transforming the agri-food supply chain. The findings show how important these technical developments are to fulfilling customer demands, ensuring food safety, and promoting sustainability in the agri-food sector.

Keywords

Food traceability; Agri-food supply chain; technology in the Agri-food Supply Chain

Introduction

Food safety is a major concern in the modern world. Food contamination can have a serious negative effect on public health and possibly be lethal. It may also have a negative impact on the economy and impede growth in general. The World Health Organisation claims that contaminated food is to blame for 42,000 annual fatalities as well as 600 million illnesses. More than 200 ailments, ranging from cancer to diarrhoea, can be brought on by eating unsafe foods that contain dangerous germs, viruses, parasites, or toxins. Approximately 7000 children die each year from food-borne illnesses, with children under the age of five accounting for 30% of cases.

With agricultural technology constantly advancing, marketable agricultural products now require more secure and dependable quality assurance since the production of agricultural products is no longer the primary factor limiting agricultural development. Numerous issues with food safety have resulted from planned or accidental regulatory infractions during the production, processing, transportation, and sales of agricultural products. Food safety may be put in danger due to fraud in any of the abovementioned links. As a result, a variety of management systems applying automation, IoT, and Cloud Computing Solutions has been emerged. These systems are capable of tracking the entire process on their own, but they still need to address issues with tampered data and food poisoning. This is because there is always a chance that data will be lost or altered when using a traditional data storage method. However, by overcoming these issues, blockchain technology can be used to store data and safeguard data security. It creates a blockchain-based system to store provenance information about agricultural products. Agricultural items that are connected to the Internet of Things will automatically send whatever data they gather to a network.

Literature Review

(Lv et al. 2023) examined the impact of IoT in precision agriculture, where sensor networks monitor soil conditions, crop health, and weather patterns in real-time, enabling data-driven decision-making for farmers. Additionally, IoT facilitates livestock monitoring and automated equipment in smart farming practices, contributing to improved productivity and animal welfare.

(Babu and Devarajan 2023) depicted in their research about how block chain technology has gained attention for its ability to enhance transparency and traceability. Research underscores the use of block chain in creating immutable ledgers for recording every transaction in the supply chain, reducing the risk of fraud and ensuring the authenticity of products.

(Tripti and Shankar 2022) examined the discuss the challenges associated with the adoption of technology in the Agri-food supply chain. Common challenges include issues related to interoperability, data security, cost, and the need for standardized protocols. Understanding and addressing these challenges are crucial for successful implementation.

(Marchese and Tomarchio 2022) presented in their research paper the application of data analytics in agri-food supply chains, emphasizing its role in optimizing routes, predicting demand, and improving overall decision-making. Big data analytics, coupled with predictive modeling, is shown to empower supply chain managers to proactively address challenges and enhance operational efficiency.

Objective of the study

After reviewing various research paper I find out the following object for the current study:

- To enhance the visibility and traceability in the Agri-food Supply Chain Management.

- To create a transparent and interconnected system in the Agri-food Supply Chain Management
- To improve the efficiency, reduce waste, and build greater trust among consumers
- To ensure the quality and safety of food products

Research methodology

The study is the Conceptual research in nature as it is based on the secondary data of Agri-food supply chain based industries. In which I have done a systematic examining and summarizing of the existing literature review and find out the advantages for applying the technologies in our Agri-food supply chain based industries

Technologies Enhancing Visibility and Traceability

- Internet of Things (IOT) Applications

- Block-chain Technology

- DNA bar-coding

- RFID Technology for Tracking

Impacts of Technology on Agri-food Supply Chain Management

- **Internet of Things (IoT) Applications**

The agri-food supply chain management industry can benefit greatly from the Internet of Things (IoT), which is transforming the production, processing, and delivery of agricultural products. IoT devices like electronic collars and tags may track livestock health and behavior in real time. (La Sala et al. 2016) This aids in managing feeding schedules, spotting disease symptoms disease, and enhancing animal welfare in general for farmers. Real-time visibility into the location and condition of agricultural products during transit is made possible by IoT-enabled tracking devices. This facilitates route optimization, delays reduction, and assurance

- **Blockchain Technology**

With blockchain technology, every transaction in the supply chain—from farming to distribution—is recorded in an unchangeable, transparent database. Transparency is ensured since every network member has access to the same data.

Blockchain enables the recording of detailed information about the conditions in which crops are grown, harvested, and transported. (Ganeshkumar 2017) This information, coupled with IoT sensor data, ensures that the quality and safety of agricultural products can be verified at each stage of the supply chain.

- **DNA bar-coding**

DNA bar-coding allows for precise identification of plant and animal species, helping to verify the authenticity of agricultural products. This is particularly crucial in preventing fraud and mislabelling, ensuring that consumers receive the exact species they expect.

DNA bar-coding can be used to assess the genetic makeup of crops and livestock, aiding in quality control measures. This technology ensures that products meet specific standards and certifications, providing consumers with accurate information about the genetic characteristics of the food they purchase.

- **RFID Technology for Tracking**

RFID (Radio-Frequency Identification) technology has proven to be a valuable tool in optimizing various processes within the agri-food supply chain.

RFID tags can be embedded in product packaging to provide a unique identifier for each item. This facilitates accurate and efficient traceability, allowing stakeholders to trace the origin of products and verify their authenticity. This is particularly important in cases of recalls or quality assurance.

RFID technology streamlines logistics and distribution processes by providing accurate and real-time information about the location and status of products.

Challenges

- **Cost of Implementation**
  Implementing advanced technologies such as IoT, blockchain, and RFID can require a significant upfront investment. Small and medium-sized enterprises (SMEs) in the agriculture sector may find it challenging to allocate resources for the adoption of these technologies. The cost of technology implementation and ongoing maintenance needs to be balanced against the potential benefits.

- **Education and Training**
  The successful implementation of technology requires a workforce that is knowledgeable and skilled in using these tools. Lack of awareness and training among farmers and other stakeholders in the supply chain can hinder the adoption of technology. Educational programs are needed to ensure that users can leverage technology effectively.

- **Infrastructure Limitations**
  In some regions, especially in developing countries, there may be limitations in terms of reliable internet connectivity and other necessary infrastructure. Without robust infrastructure, the real-time monitoring and communication capabilities of technologies like IoT may be compromised.

- **Resistance to Change**
  The agricultural sector has traditionally been slow to adopt new technologies. Resistance to change from farmers, suppliers, and other stakeholders can impede the widespread adoption of technology in the agri-food supply chain. Education and demonstration of the benefits are essential to overcoming this resistance.

- **Standards and Regulations**
  The absence of standardized protocols and regulations for implementing technologies like blockchain and IoT in the agri-food supply chain can lead to inconsistencies and interoperability issues. Clear standards and regulations are necessary to create a unified and effective technology framework across the industry.

Outcomes of the study

▶ Through the implementation of IOT, RFID, block-chain in the Agri-food industry gains the visibility and traceability and also the Real-time monitoring of their products.

▶ Technologies such as DNA Bar-coding and block-chain contribute to proper product identification, significantly reducing the risk of fraud and contamination of food.

Conclusion

This paper shows the adoption of technology in Agri-food supply chain management by which there is more transparency, secured, and effective system's that benefits the producers, distributors, and consumers and make the supply chain more transparent

References

Lv, Guangjie et al. 2023. "Blockchain-Based Traceability for Agricultural Products: A Systematic Literature Review." Agriculture 13(9): 1757.

Babu, Subashini, and Hemavathi Devarajan. 2023. "Agro-Food Supply Chain Traceability Using Blockchain and IPFS." International Journal of Advanced Computer Science and Applications 14(1): 393–99.

Ngo, Quang Huy. 2022. "The Adoption of Green Market Orientation in Logistic Industries— Empirical Evidence from Vietnamese SMEs." *Journal of Open Innovation: Technology, Market, and Complexity* 8(4).

Tripti, and Ravi Shankar. 2022. "Modelling a Sustainable Agri-Food Supply Chain: A Theoretic System Construct." International Journal of Business Performance and Supply Chain Modelling 13(1): 1–26.

Marchese, Angelo, and Orazio Tomarchio. 2022. "A Blockchain-Based System for Agri-Food Supply Chain Traceability Management." SN Computer Science 3(4).

Kumperščak, Samo et al. 2019. "Traceability Systems and Technologies for Better Food Supply Chain Management." Quality Production Improvement - QPI 1(1): 567–74.

Ganeshkumar, C., M. Pachayappan, and G. Madanmohan. 2017. "Agri-Food Supply Chain Management: Literature Review." Intelligent Information Management 09(02): 68–96.

La Sala, Piermichele et al. 2016. "RFID Sensor for Agri-Food Supply Chain Management and Control." International Journal of Sustainable Agricultural Management and Informatics 2(2/3/4): 206.