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# Block chain-based Track and Trace System for Perishable Goods using IoT and AI

**[1] Tanmay Dhumal,**
**[2] Pushkar Londhe,**
**[3]Gargi Lande,**
**[4]Anshul Awari**
**[5] Prof. Nalini Tiwari**

[1-4], UG students, Ajeenkya D Y Patil School of Engineering, Pune, INDIA
[5] Assistant Professor, Ajeenkya D Y Patil School of Engineering, Pune, INDIA

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**Abstract:**

The growing need for safe, high quality perishable food has made it clear that modern supply chains need better ways to track products. Traditional methods often don't have clear processes, real-time monitoring, or safe data management, which can lead to problems like spoilage, fraud, and less trust from customers. Blockchain, the Internet of Things (IoT), and Artificial Intelligence (AI) are some of the new technologies that have shown a lot of promise in solving these problems in recent years. This paper offers an extensive evaluation of current research regarding blockchain-based track and trace systems for perishable commodities. Different studies are looked at to learn how IoT devices make it possible to monitor the environment in real time, how blockchain makes sure that data is accurate and open, and how AI techniques help with predictive analysis, like finding out if food is going bad and how long it will last. The review talks about the pros and cons of different methods and how combining these technologies makes the whole supply chain more efficient. We also talk about some of the biggest problems, like scalability, cost, interoperability, and data handling. The study concludes by delineating prospective research avenues focused on creating more dependable, economical, and scalable traceability solutions for perishable food supply chains.

**Keywords:** Blockchain, Internet of Things (IoT), Artificial Intelligence (AI), Perishable Goods, Food Traceability, Supply Chain Management, Real-time Monitoring, Spoilage Detection, Data Security.

## 1.0 Introduction

Managing perishable goods like fruits, vegetables, dairy, and meat has become harder and harder because they don't last long and are sensitive to changes in the environment. To make sure that quality and safety are maintained throughout the supply chain, you need to keep an eye on things, store them correctly, and have reliable tracking systems. But traditional supply chain systems don't always have clear data handling, real-time visibility, and secure data handling, which can cause spoilage, inefficiencies, and lower consumer trust. As digital technologies get better very quickly, new ways to fix these problems are being found. People are looking into technologies like the Internet of Things (IoT), Blockchain, and Artificial Intelligence (AI) to make food supply chains easier to track and watch. IoT devices can collect environmental data like temperature and humidity in real time. Blockchain technology makes sure that this data is stored safely and can't be changed. AI methods also help look at data patterns and guess problems like spoilage or quality loss. This paper reviews current methods that use these technologies together to keep track of perishable goods. It focuses on looking at current methods, finding problems, and figuring out how these technologies can work together to make the supply chain more efficient and reliable.

## 2.0 Literature Survey:

Recent studies in perishable food traceability have thoroughly examined the amalgamation of the Internet of Things (IoT), Blockchain, Artificial Intelligence (AI), and data-driven methodologies to enhance monitoring, transparency, and efficiency within supply chains. In their previous studies, Venkata Chunduri et al. (2024) presented a novel Trace-PBFT algorithm to increase the efficiency of blockchains in food supply chain management, which solves problems associated with transactional speed and scalability [1]. Another research by Daniela Mechkaroska and Ervin Domazet (2024) presented a novel chatbot-based system with a blockchain and IoT integration to increase transparency in food delivery systems [2]. In another research, Rizwan M. Ellahi et al. (2024) presented a systematic review on blockchain-based food supply chain management, focusing on new opportunities in this field, with a strong emphasis on increased transparency and sustainability [3]. Another research by Ricardo Morais et al. (2024) presented a novel platform for tracing fruits and vegetables using a blockchain, which offers full visibility from the farm to the consumer [4]. In a similar manner, another research by Vassilios Vitaskos et al. (2024) presented a novel system for olive oil supply chain management using a blockchain and IoT, with smart contracts for traceability [5]. Javier Garrido Lopez et al. (2024) studied the applicability of cellular IoT technology like NB IoT in real time monitoring of perishable goods, reducing food wastage, and improving logistics management [6]. In another study, Rizwan M. Ellahi et al. (2023) discussed various blockchain technology frameworks along with Industry 4.0 technology in modern supply chain management [7]. Techane Bosona et al. (2023) highlighted the importance of blockchain technology in improving transparency in food systems [8]. Feng Xiao et al. (2023) used deep learning techniques like YOLO and CNN in fruit recognition and detection, thus highlighting the importance of AI in quality assessment [9]. Anna Lamberty and Judith Kreyenschmidt (2022) presented a review on IoT-based environmental monitoring systems, proving their efficiency in reducing losses during post harvesting.

Activities [10]. Amanpreet Kaur et al. (2022) presented a review on IoT and blockchain technology in food supply chain management, highlighting their advantages and challenges in implementation [11]. Finally, Creciana M. Endres et al. (2022) presented a systematic review on IoT and Raspberry Pi technology in food traceability [12]. Zeinab Shahbazi and Yung-Cheol Byun (2021) presented a hybrid model based on blockchain technology, machine learning, and fuzzy logic in predicting the shelf-life of food items [13]. Moreover, S.A. Bhat et al. (2021) presented a new architecture based on IoT and blockchain technology in food supply chain management, focusing on solving challenges in food storage [14]. Generally, based on these research papers, integrating IoT technology, blockchain technology, and AI plays a significant role in solving challenges in food supply chain management in terms of food traceability and decision-making in perishable food items. However, there are challenges associated with these systems, including their scalability and simplicity in implementation. Siva Peddareddigari et al. (2025) put forward an IBBA (Internet of Things, Blockchain, Big Data, and Artificial Intelligence) framework for keeping an eye on food safety in real time [15]. By using a mix of different technologies, their method creates a scalable and secure system that makes it easy to collect, store, and analyze data across the supply chain. Seung Eel Oh et al. (2025) also made a private blockchain-based food distribution system that used Hyper ledger Fabric and IoT sensors to make sure that traceability is safe and can grow [16]. Yehya Bouchbout et al. (2025) conducted a survey examining the implementation of IoT and blockchain in food supply chains, emphasizing contemporary trends and obstacles, including scalability and system integration [17]. Hao Zhang et al. (2025) enhanced this integration by amalgamating AI, IoT, and blockchain technologies to augment traceability and agricultural yield prediction, illustrating the efficacy of hybrid systems [18]. S.G. Stanescu et al. (2025) examined digital transformation in agri-food supply chains, pinpointing critical facilitators and obstacles to blockchain adoption, with a focus on system interoperability and cost management [19]. In addition, Zohra Dakhlia et al. (2025) highlighted the role of edge AI and federated learning in improving real-time analytics and data security in IoT-based food monitoring systems [20].

## 3.0 Methodology

This section provides a generalized methodology based on the analysis of the existing research work done on blockchain-based traceability systems for perishable products. Unlike the previous section, this section does not describe the actual methodology followed in the research work. Instead, it provides the common methodologies followed by the research work done on the topic.

### 3.1 Data Acquisition and Monitoring:

In the majority of the research work done on the topic, Internet of Things (IoT) devices are used to obtain real-time environmental data such as temperature, humidity, and location during the storage and transportation of perishable products. IoT sensors are connected to edge devices such as microcontrollers and single-board computers to obtain real-time data. Real-time data is used to monitor any changes in environmental conditions, which might affect the quality and freshness of the food product.

### 3.2 Data Pre-processing and Management

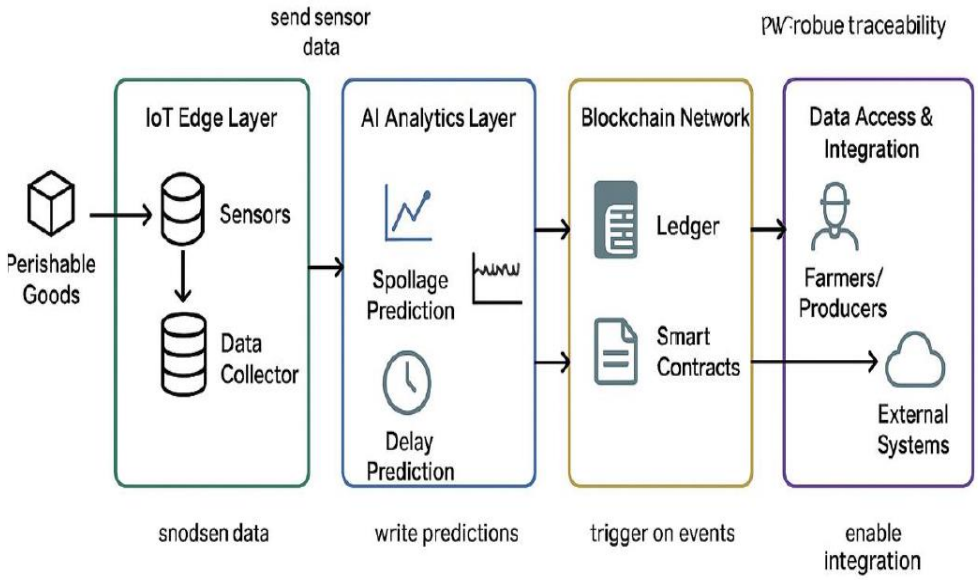
The collected data is normally pre-processed before further utilization. This includes various processes such as removing noisy data, handling missing values, and ensuring consistency. Various research works have utilized different filters and normalization processes to improve data quality. Cloud platforms and databases are normally utilized to store and manage huge amounts of data. In some cases, edge computing is also utilized to improve data processing, thereby reducing delays and enhancing system performance.

### 3.3 Blockchain based Data Storage

Blockchain technology is normally utilized to enhance data security, transparency, and immutability. Most systems utilize hash values to store data on a blockchain, whereas actual data is normally stored on a cloud database. Smart contracts are utilized to enhance different processes such as product registration, tracking, and transfer of ownership. This enables a tamper-free system where all stakeholders can verify information securely.

### 3.4 AI and Data Analysis

The Artificial Intelligence techniques such as machine learning and deep learning are employed for data analysis. Predictive techniques of spoilage, estimation of the shelf life of food products, and pattern identification in the data of the supply chain are carried out. Image processing techniques are also employed for grading fruits. The techniques help in improving decisions for reducing food waste.



### 3.5 Communication Technologies

MQTT, HTTP protocols, and cellular IoT protocols such as NB-IoT are employed for data transmission. The protocols help in smooth communication between sensors, clouds, and blockchains. Secure communication techniques are employed for data security.

### 3.7. System Integration and Visualization

The majority of the systems combine IoT, blockchain, and AI in one system. A user interface, either in the form of a web-based application or mobile application, is created to visualize the data in real time. This enables the end user to track the product, view the environment, and even get alerts in case anything abnormal occurs. Overall, the methodologies proposed in different studies suggest that the integration of IoT, blockchain, and AI can provide an efficient solution to improve traceability and monitoring in the perishable food chain. However, there are still some issues to be addressed in the future.

## 4.0 Conclusion

The paper provided a critical analysis of existing techniques using Blockchain, Internet of Things, and Artificial Intelligence for improving traceability in the supply chain of perishable food items. From the analysis, it is clear that existing supply chain management systems are facing significant issues in terms of transparency, efficient monitoring, and data manipulation. The use of new technologies has helped in overcoming these issues The Internet of Things is significantly contributing to the efficient monitoring of environmental conditions such as temperature and humidity, which are critical factors in the quality of perishable food items. Blockchain is contributing to the efficient management of data, which is accessible to everyone in a tamper-proof manner. In addition, Artificial Intelligence is contributing to efficient decision-making using techniques for predicting spoilage and determining the shelf life of food items. However, based on the studies that have been reviewed, although these technologies have shown promise for increasing efficiency, accuracy, and reliability, there are still a number of challenges that have to be ad dressed. Some of these challenges include high costs of implementation, scalability challenges, integration challenges, and data management challenges. In addition, the practical application of these technologies will require user-friendly systems and infrastructure. In conclusion, based on the potential of these three technologies working together, the food supply chain for perishable foodstuffs is likely to be revolutionized. The next course of action will be to come up with cost-effective and efficient solutions.

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