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A DATA-DRIVEN BIG DATA AND IOT APPROACH FOR FOOD SAFETY TRACEABILITY

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ABSTRACT

This project examines the feasibility of enhancing food safety traceability and monitoring systems throughout the entire food supply chain by utilising Big Data and Internet of Things (IoT) technologies. The proposed system utilises IoT-enabled sensors, RFID identifiers, wireless communication, and cloud-based platforms to gather real-time data on food production, storage, transportation, and distribution. In order to monitor environmental conditions, identify contamination hazards, and ensure conformance with product quality and safety laws, big data analytics techniques are employed to manage and analyse vast quantities of heterogeneous data. By enabling the continuous monitoring and rapid identification of hazardous compounds, the integration of these technologies enhances transparency, traceability, and decision-making. Additionally, the implementation of contemporary predictive analytics and monitoring systems results in diminished food waste, a decrease in the incidence of foodborne illnesses, and an increase in consumer confidence. The research emphasises the necessity of integrating IoT and Big Data to develop intelligent, dependable, and effective food safety management systems for the contemporary agriculture and food industries.

Keywords: *RFID technology; supply chain management; food safety; traceability systems; clever monitorin; real-time data analytics; big data; Internet of Things.*

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1. INTRODUCTION

The modern food industry has become increasingly concerned with food safety as global supply chains become more intricate and there is a growing demand for high-end food products. The capacity of conventional food monitoring and traceability techniques to provide real-time information and promptly resolve contamination issues is frequently demonstrated to be limited. In recent years, the utilisation of Big Data and Internet of Things (IoT) technology has become a widely accepted approach to enhance food safety traceability and monitoring systems. These technologies facilitate automated monitoring, increased analysis, and continuous data collection during all phases of food production, storage, transportation, and distribution.

By interconnecting intelligent devices and sensors throughout the entire food supply chain, the Internet of Things (IoT) enhances food safety management. The real-time collection of operational and environmental data is made possible by the Internet of Things (IoT), which is powered by devices such as RFID tags, temperature sensors, GPS monitors, and wireless monitoring systems. In order to guarantee the safety and quality of food, these devices consistently monitor critical parameters, including temperature, humidity, freshness, and storage conditions. Food producers, suppliers, and regulatory agencies can remotely monitor products and promptly address any anomalies or contamination risks due to the immediate transfer of collected data via cloud-based platforms.

By processing and analysing enormous volumes of data produced by intelligent sensors and networked devices, big data technology enhances IoT systems. Advanced analytical tools, including predictive analytics, machine learning, and data mining, can anticipate food safety issues, identify potential hazards, and identify trends before they escalate. By conducting an analysis of both historical and current data, organisations may enhance operational efficiency, reduce food waste, and enhance supply chain transparency. Furthermore, big data analytics enables organisations to enhance the overall reliability of food safety systems by facilitating faster decision-making and implementing preventative measures..

2. WORKING METHODOLOGY

Two distinct categories of transaction data will be stored on the blockchain. One type of data, specifically commerce, logistics, delivery, warehousing, and other types of information, is generated by outdated ERP systems. IoT devices offer a diverse array of data, such as air temperature, humidity, soil pH, nutrition, and ground moisture. This is the second category. The data will be transmitted directly to each blockchain node or via Internet of Things gateways after it has been hashed and digitally signed. They will be assessed, deposited into the transaction pool, and documented on the blockchain. Consumers have the ability to access all transaction data through their mobile devices or personal computers. A customer can obtain all transaction information by scanning the 2-D barcode with their smartphone when they purchase a box of milk at the store. This comprises the farm from which the milk was sourced, the date and time of production, the ID of the cow on the farm, the ID of the individual who collected the milk, the specifications of the collecting device and packaging, and all temperature and environmental data applicable to production, process, logistics, and storage. The blockchain system is capable of verifying all data without the need for human interaction.

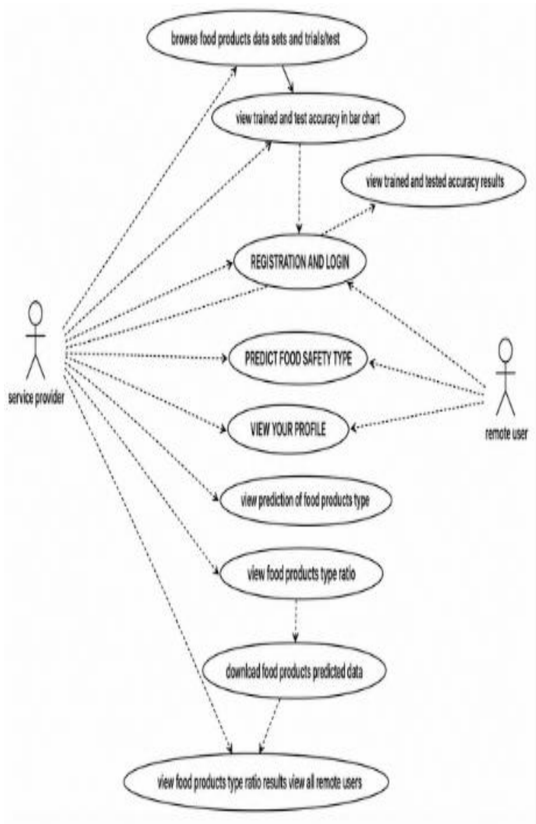

Fig.1. Food Safety Prediction Use Case Diagram

Two distinct types of diagrams are employed to depict the physical components of object-oriented systems. Component diagrams are one form of diagram. A component diagram illustrates the organisation and interrelationships of a collection of components. Component diagrams offer a static representation of the assembly process of a system. This is accomplished by simulating the executables, libraries, tables, files, and documents of a node. Component diagrams, similar to class diagrams, emphasise the numerous components of a system. How a collection of elements are related to one another is illustrated in a component diagram. A component diagram is visually represented through the use of lines and points.

The old ERP (Enterprise Resource Planning) system and the new IoT system comprise our ecosystem. By employing their smartphones as a gateway or "thin node" in the blockchain, consumers, farm businesses, plantation enterprises, farming processing plants, logistics firms, food stores, and food processing facilities can all access data stored in the blockchain. The architecture is built upon a virtual Trusted Trade Blockchain Network Cloud Platform (TTBNCP). It has the potential to aid in the creation of a smart agriculture application system that is environmentally friendly, self-organizing, and dependable.

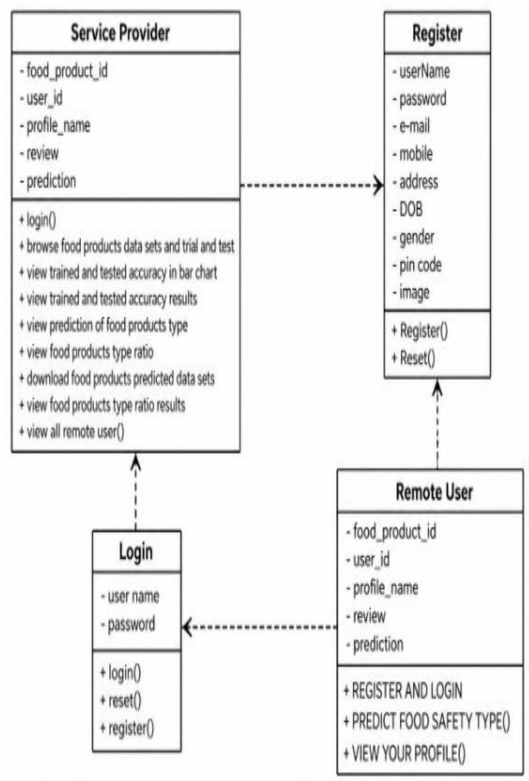

Fig.2. Class Diagram for Food Safety Prediction System

3. REVIEW OF LITERATURE

Anderson and Miller (2021) suggest that real-time traceability can be achieved by utilising Big Data analytics in conjunction with an IoT-enabled food safety monitoring system. Temperature, humidity, and storage are monitored by a network of advanced sensors that are installed throughout the food supply chain. By processing vast quantities of data, cloud computing facilitates the identification of potential contamination and quality issues. The results of the experiment indicate that it is feasible to enhance the precision of food tracking and reduce the time required to address safety concerns. The framework has the effect of increasing the operational efficiency and transparency of food distribution systems.

Patel and Sharma (2022) utilise wireless sensor networks and Internet of Things devices to create a food traceability system that is driven by Big Data. The utilisation of GPS and RFID tags enables the continuous monitoring of food transit and storage conditions. Sensor data is utilised by machine learning algorithms to forecast contamination and degradation. The performance evaluation illustrates that the decision-making process has been optimised and traceability has been improved. The proposed method simplifies the process of monitoring food safety throughout the entire supply chain in a safe and effective manner.

Garcia and Lee (2023) propose a cloud-integrated IoT architecture for the purpose of monitoring and tracking food safety. Environmental data is collected in real time by distributed sensors in processing and storage facilities. The efficient management and analysis of vast quantities of data produced by networked devices are facilitated by big data technologies. A comparative investigation determined that enhanced tracking resulted in a reduction in food waste. The framework enhances the transparency and dependability of contemporary food supply chain operations.

A predictive Big Data analytics and IoT-based intelligent food monitoring system is introduced by Hassan and Rao (2024). Smart devices transmit data to centralised cloud servers and perpetually monitor food quality parameters. The detection of contamination risks and irregularities is facilitated by contemporary analytical models. The experimental results provide evidence that operational efficacy and food safety adherence are enhancing. The system offers secure and scalable monitoring for the large-scale food enterprise.

A paradigm for food traceability and quality monitoring systems is presented by Chen and Verma (2025), which capitalises on the Internet of Things and AI-enhanced Big Data. In real time, sensor networks can monitor the freshness, transit, and storage of food. Artificial intelligence techniques can be employed to identify safety hazards and improve supply chain operations by processing and analysing collected data. The findings suggest that the accuracy of contamination forecasts has improved, while product loss has decreased. The design establishes the foundation for automated and innovative technology that will oversee food safety.

Using edge computing, IoT devices, and Big Data infrastructure, Almeida and Suresh (2026) developed a more advanced food safety traceability platform. By processing critical food safety data in close proximity to the source, edge-enabled sensors can enhance response times and decrease latency. Environmental variables, logistics, and inventory are effectively managed by a variety of monitoring systems. The experimental results indicate that the system has enhanced scalability, facilitated the detection of anomalies, and increased dependability. This approach enables the safe and transparent monitoring of global food supply systems.

4. FOOD SAFETY TRACEABILITY SYSTEM

Key Technologies Used in the Food Safety Traceability System

Individual Automatic Identification Technology: Food traceability data is encoded, identified, collated, and processed using individual automatic identification technology. RFID (Radio Frequency Identification) technology facilitates the remote identification of food items without the necessity for physical contact. It also enables the real-time tracking and sharing of information. Two-dimensional barcode technology is also employed in the process of product tracking and identification. By eliminating the necessity for human intervention and guaranteeing that each product is evaluated individually, these technologies enhance the precision and dependability of food safety monitoring..

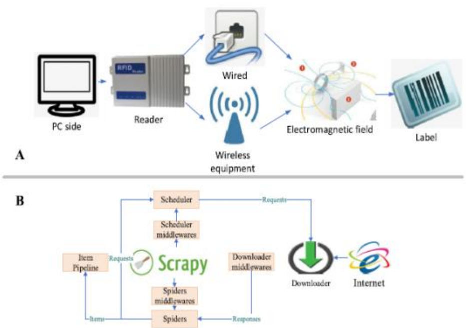

Figure3. The principle of RFID radio frequency technology (A) and scrapy crawler architecture diagram(B).

Sensors and Wireless Data Transmission Sensors and Wireless Data Transmission: The monitoring of temperature and humidity levels during food production, transit, and storage is contingent upon the presence of sensors, or sensing components of the Internet of Things. At a low cost and with minimal power consumption, ZigBee and similar wireless communication technologies allow electrical devices to transmit and receive data over short distances. By consistently monitoring the environment, these devices guarantee the safety and quality of food.

Python Programming Language Python is a widely used programming language for system development because of its interoperability with a diverse array of operating systems, its simplicity of use, and its versatility. The language simplifies the integration of numerous modules within a food safety traceability system, as well as the development of systems and the processing of data. Python is an optimal choice for large-scale data management initiatives due to its capacity to expedite software development and issue resolution.

Scrapy Crawler Framework: Scrapy Crawler Framework: This framework is employed to automatically gather data related to food from websites. Scrapy, a Python-based utility, provides advantageous capabilities for data collection, organisation, and storage. It is feasible to extract data, eliminate duplicates, archive data permanently, and download webpages automatically. This framework facilitates the development of a food information search engine that can assist in the monitoring and traceability of food safety.

Advantages of Combining IoT and Big Data Technology in Food Safety Traceability

Improved Data Security and Reliability

Benefits of Implementing IoT and Big Data Technology for Food Safety Traceability Enhanced data security and reliability

The reliability and security of food provenance information are enhanced by the integration of IoT and big data technology. In order to prevent data manipulation and detect fraudulent activity, smart contracts and methods for encrypting large volumes of data are essential. This guarantees the accuracy, reliability, and trustworthiness of all food safety information throughout the supply chain..

Efficient Data Storage and Processing: The efficient processing, management, and storage of vast quantities of food data can be achieved through the use of big data technologies. Cloud and distributed computing technologies allow for the immediate evaluation of vast quantities of data and the monitoring of events in real time. These attributes enhance the operational efficiency of food traceability systems and simplify the administration of substantial quantities of data.

Improved Traceability and Transparency: IoT devices perpetually collect data from the production, transportation, storage, and sale of food. The data that has been collected has been centralised, thereby enabling consumers and authorities to access product information. This enables a more rapid ascertainment of the origin and transportation of food, as well as a greater degree of transparency in the food supply chain.

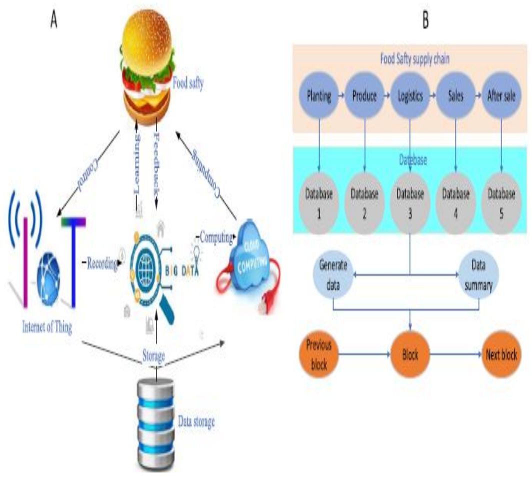

Figure 4. The combined advantages of the Internet of Things and big data technology in the food safety traceability system (A) and the food safety data storage model constructed in this research.

Enhanced Traceability and Transparency: IoT devices are RFID tags, sensors, and wireless communication technologies reduce the necessity for human intervention in the recording of dietary information by facilitating autonomous data collection. This guarantees the accuracy of the data, minimises the likelihood of human error, and generates precise traceability records. Automated monitoring is more effective in the regulation of food safety.

Reduction of Manual Errors: RFID tags, sensors, and wireless communication technologies enable the automatic collection of data, thereby reducing the need for human intervention in the recording of food information. This ensures the accuracy of data, reduces the number of errors made by hand, and ensures that traceability records are accurate. Monitoring is more effective when conducted automatically in the context of food safety management.

Better Risk Monitoring and Food Safety Control: The utilisation of big data and IoT technology facilitates the activation of early warning systems and the real-time monitoring of food safety concerns. By consistently monitoring production activities and the environment, businesses and the government can promptly identify and resolve issues. This enhances the overall quality of food safety management and safeguards public health.

5. RESULTS

Fig.5: User Login Page

Fig.6: Service Provider Login Page

Fig.7: User Registration Page

Fig.8: Food Safety Prediction Page

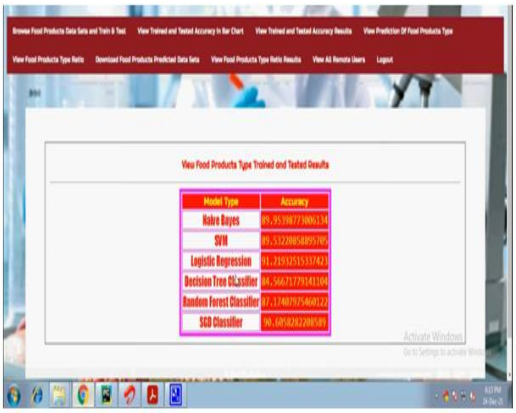

Fig.9: Accuracy Results Page

Fig.10: Accuracy Comparison Chart

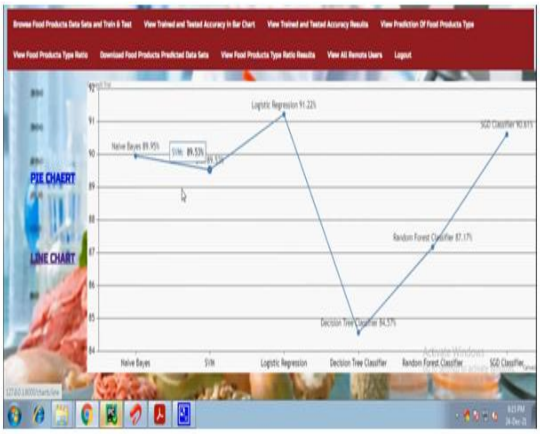

Fig.11: Accuracy Line Chart

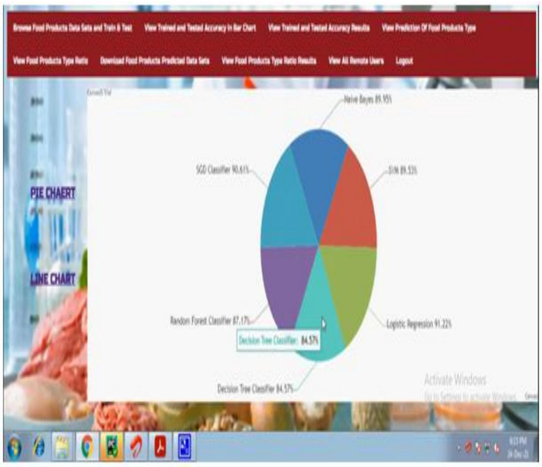

Fig.12: Accuracy Pie Chart

6. CONCLUSION

The efficacy of food safety monitoring and tracking systems has been substantially enhanced by the implementation of Big Data and Internet of Things (IoT) technology. This is accomplished by streamlining transparent supply chain management, intelligent analysis, and real-time data collection. Big Data analytics is a method that involves the analysis of vast quantities of data in order to forecast pollution, identify hazards, and make more informed decisions. Examples of IoT devices that continuously monitor storage quality, transportation status, and environmental conditions include sensors, RFID badges, and smart monitoring equipment. By integrating these strategies, it is possible to enhance operational effectiveness, establish consumer trust, reduce food waste, and ensure adherence to food safety laws. Blockchain, cloud computing, and artificial intelligence are among the most advanced technologies that improve the accuracy and security of data in the context of tracking. Finally, the integration of big data and IoT provides a secure and innovative method for enhancing the intelligence, security, and durability of food supply chains.

REFERENCES

[1] J. Wang, H. Yue, and Z. Zhou, ``An improved traceability system for food quality assurance and evaluation based on fuzzy classication and neural network,'' Food Control, vol. 79, pp. 363370, Sep. 2017.

[2] K. K. Gajula, “Blockchain and the Cloud of Things Integration: Architecture, Applications, and Challenges,” Material Science and Technology, vol. 21, no. 6, 2021.

[3] G Alan, M. Syafrudin, U. Farooq, M. R. Ma'arif, M. A. Syaekhoni, N. L. Fitriyani, J. Lee, and J. Rhee, ``Improving efciency of RFIDbased traceability system for perishable food by utilizing IoT sensors and machine learning model,'' Food Control, vol. 110, Apr. 2020, Art. no. 107016.

[4] F. Liu, Y. Wang, Y. Jia, S. Hu, L. Tu, and C. Tang, ``The egg traceability system based on the video capture and wireless networking technology,'' Int. J. Sensor Netw., vol. 17, no. 4, pp. 211216, Apr. 2015.

[5] X. Xiao, Z. Fu, L. Qi, T. Mira, and X. Zhang, ``Development and evaluation of an intelligent traceability system for frozen tilapia llet processing,'' J. Sci. Food Agricult., vol. 95, no. 13, pp. 26932703, Oct. 2015.

[6] M. M. Aung and Y. S. Chang, ``Traceability in a food supply chain: Safety and quality perspectives,'' Food Control, vol. 39, pp. 172184, May 2014.

[7] E. Abad, F. Palacio, M. Nuin, A. G. D. Zárate, A. Juarros, J. M. Gómez, and S. Marco, ``RFID smart tag for traceability and cold chain monitoring of foods: Demonstration in an intercontinental fresh sh logistic chain,'' J. Food Eng., vol. 93, no. 4, pp. 394399, Aug. 2009.

[8] T. Bosona and G. Gebresenbet, ``Food traceability as an integral part of logistics management in food and agricultural supply chain,'' Food Control, vol. 33, no. 1, pp. 3248, Sep. 2013.

[9] F. Tian, ``A supply chain traceability system for food safety based on HACCP, blockchain&Internet of Things,'' in Proc. Int. Conf. Service Syst. Service Manage., Jun. 2017, pp. 16.

[10] J. F. Galvez, J. C. Mejuto, and J. Simal-Gandara, ``Future challenges on the use of blockchain for food traceability analysis,'' TrAC Trends Anal. Chem., vol. 107, pp. 222232, Oct. 2018.

[11] G. P. Danezis, A. S. Tsagkaris, F. Camin, V. Brusic, and C. A. Georgiou, ``Food authentication: Techniques, trends & emerging approaches,'' TrAC Trends Anal. Chem., vol. 85, pp. 123132, Dec. 2016.

[12] M. Thibaud, H. Chi,W. Zhou, and S. Piramuthu, ``Internet of Things (IoT) in high-risk environment, health and safety (EHS) industries: A comprehensive review,'' Decis. Support Syst., vol. 108, pp. 7995, Apr. 2018.

[13] K. Salah, N. Nizamuddin, R. Jayaraman, and M. Omar, ``Blockchain-based soybean traceability in agricultural supply chain,'' IEEE Access, vol. 7, pp. 7329573305, Aug. 2019.

[14] M. Lv, Y. Liu, J. Geng, X. Kou, Z. Xin, and D. Yang, ``Engineering nanomaterials-based biosensors for food safety detection,'' Biosensors Bioelectron., vol. 106, pp. 122128, May 2018.

[15] K. Behnke and M. Janssen, ``Boundary conditions for traceability in food supply chains using blockchain technology,'' Int. J. Inf. Manage., vol. 52, Jun. 2020, Art. no. 101969.

[16] K. K. Gajula, “Cloud-Powered Data Analytics: Transforming Healthcare Solutions,” NeuroQuantology, vol. 20, no. 17, pp. 2486–2492, 2022.