IoT Harvest: Innovations in Sustainable Food Processing

*,1Angam Raleng, 2Thameridus B. Marak and 1Sajesh Chettri

1College of Agricultural Engineering & Post Harvest Technology (Central Agricultural University Imphal), Ranipool, Gangtok, Sikkim – 737135

2 Department of Agricultural Engineering, Assam Agricultural University, Silchar, Assam - 788011

*Corresponding Author: angamraleng@gmail.com

The Internet of Things, or IoT, has significantly expanded recently across all industries. The Internet of Things (IoT) connects devices to people, locations, and times. The phrase "Internet of Things" describes devices that can connect to the Internet and exchange data with other devices. Software and hardware are combined in embedded systems. The Internet of Things (IoT) enables remote management and surveillance of physical things. Data sharing and communication are possible with the Internet of Things (IoT). This technology allows the user to manage unforeseen issues by providing real-time data insights. The core technologies that underpin the Internet of Things, a collection of networked things, are networking, communication, sensing, and data processing. IoT technology enables physical things to be remotely monitored and controlled across a network (Badarinath and Prabhu 2017). Smart cities, farms, self-driving cars, smart rehabilitation systems, home health care, industrial Internet, smart supply-chain management, automated environmental monitoring, automated assembly planning of complex products, management, and snowmelt flood early-warning systems are among the most beneficial uses of the Internet of Things. The Internet of Things (IoT), a disruptive technology, has proven extremely beneficial to the food processing business. Min et al. (2019) claim that computational techniques used in food research constitute the majority of the field of food computing. The network of commonplace items linked to the internet for the purpose of exchanging data and gathering insights to enhance productivity and decision-making is known as the Internet of Things, or IoT. IoT has the potential to improve working conditions in the food processing sector, reduce energy consumption, slash manufacturing costs, and improve worker health and safety during the food manufacturing process. IoT has brought about a number of benefits that have a significant impact on the food processing industry, fundamentally altering the way that food is produced, stored, and transported. Meanwhile, a new era in food processing has been brought about by the use of the Internet of Things (IoT), which has enhanced control, enabled real-time data detection and optimization, and enhanced production and monitoring capabilities, thereby transforming the aging process into a smart process.

Enhancing Food Processing Through IoT Integration

Nowadays, the food business is quite inefficient, consumes a lot of water and energy, and generates a lot of food waste. Increasing costs and stricter regulations for carbon emissions, wastewater discharge, and the treatment and disposal of food waste exacerbate the situation (Jagtap et al., 2021). "Smart processing," "smart manufacturing," and "smart farming" are equally important as "smart farming" in order to address issues with food production related to efficiency, environmental impact, food security, quality, sustainability, and meeting global demand through productivity growth (Kamilaris et al. 2017). Below is a full discussion of IoT applications in food processing:

Quality assurance and supervision

In the food processing sector, preserving the food products' quality and safety is crucial. IoT devices are essential in this regard since they continuously monitor several environmental conditions, including temperature, humidity, and others, in storage facilities and during transportation. IoT sensors can provide real-time notifications in the event that circumstances deviate from ideal levels, enabling remedial measures to be implemented in order to avoid contamination or spoiling.

Logistic administration

The food supply chain now has traceability and transparency thanks to IoT. From farm to fork, sensors and monitoring devices may follow the flow of raw materials and completed goods. By ensuring

prompt and secure delivery of goods, this real-time tracking lowers the possibility of foodborne infections and spoiling. Using RFID tags as a tool to identify, track, and obtain data from a target object—food products—WiFi sensor networks and actuators can then be used to monitor related data obtained by RFID and route the data obtained to internet cloud services via a network gateway. This is one way that the IoT concept on warehouse management systems can be used to improve traceability. The warehouse will leverage internet cloud services as a location to store data about food products.

Traceability mechanism

Another important area where IoT is quite helpful is traceability. Stakeholders can quickly determine the cause of any problems or contamination by tracking and monitoring every stage of the production and distribution process. This reduces the negative effects on customers and the reputation of the brand while simultaneously facilitating recalls when needed and assisting in the maintenance of food safety.

The relevance of IoT in food processing

Industry-specific IoT application is frequently denoted as "Industrial Internet of Things (IIoT)." An emerging technique known as the Internet of Things is reshaping the information and communication technology (ICT) industry (Shih and Wang 2015). The use of IoT technologies in "farm to fork" was highlighted by Nukala et al. (2016). IoT applications need to be developed more quickly because they are sector-specific and cross-industry. Discussed below is the significance of IoT in the food processing industry, encompassing post-harvest activities as well as primary and secondary processing, preservation, packing, handling, storage, and marketing.

Enhanced Food safety measures

Food safety is improved by IoT's capacity to continuously track items along the supply chain, monitor and regulate ambient conditions, and monitor both. It helps avoid foodborne diseases and contamination outbreaks by enabling prompt responses to deviations through the provision of real-time data.

Cost minimization

IoT technology lower operating costs by improving inventory control, using less energy, and enabling predictive maintenance. Food processing facilities can thereby increase their profitability without sacrificing quality.

Value augmentation

The creation of smart packaging solutions is facilitated by IoT, offering value addition. In order to provide information on freshness, shelf life, and possible spoiling, smart packaging includes sensors that track the state of the product within. Through smartphone apps, consumers can obtain this data, encouraging openness and assisting them in making wise purchases. In addition, intelligent packaging can help cut down on food waste by alerting consumers when products are about to expire and promoting prompt use.

Challenges of IoT in the Food Processing Industry

Concerns regarding data security and privacy

A larger risk of data breaches and cyber-attacks is associated with devices being more connected. A key component of preserving the integrity of the food supply chain is safeguarding sensitive data, such as information about manufacturing and processing.

Significant costs involved in implementation

Implementing IoT technology can be expensive. The correct integration of this technology into the food business requires a significant financial investment. The price of acquiring and setting up sensors and other Internet of Thing's devices is covered by this budget. It also covers the price of keeping them updated and maintained. Evaluating the costs and advantages of putting IoT technology into practice is essential.

Data governance and analysis

It can be quite difficult to manage and analyze the massive volumes of data that Internet of Things devices create. Putting into practice efficient data processing, analytics, and storage solutions is necessary to extract useful information from the gathered data.

Collaboration between industry players, such as technology suppliers, government agencies, and

food processing firms, is necessary to address these issues. Resolving these issues will be essential to optimizing the advantages of IoT in the food processing industry as technology advances.

Prospective Developments and Potential IoT in Food Processing

Future approaches to ensure that the value of data will be distributed without compromising the confidence between the parties include robust algorithms for data privacy and smart contracts for data sharing (Misra et al. 2020). The way the food processing industry develops in the future is anticipated to be greatly influenced by the Internet of Things (IoT). The industry's use of IoT applications is expected to grow as a result of the following trends and opportunities:

Intelligent Farming and Precision Agriculture

Agricultural processes may be monitored and optimized with the help of IoT devices, guaranteeing effective crop management, soil health, and water efficiency. Improved yield forecasts and quality assurance for the raw materials used in food processing can be facilitated by this data.

Integration of Blockchain Technology

Blockchain technology and Internet of Things together can provide a transparent, safe method for monitoring and authenticating the movement of commodities in the food supply chain. This is especially crucial for guaranteeing the legitimacy of high-end or organic items.

Consumer Involvement and Transparency

The Internet of Things (IoT) makes the food supply chain more transparent by telling customers about the items' provenance, methods of manufacture, and nutritional value. Among customers, this more openness can foster loyalty and trust. The breadth of IoT in the food processing industry is anticipated to grow as these trends develop further, promoting sustainability, efficiency, and innovation throughout the whole food supply chain. But in order to fully reap the rewards of IoT in this sector, issues like data security, standardization, and regulatory compliance must be resolved.

Conclusion

The food manufacturing sector has seen a paradigm shift thanks to the Internet of Things. Food processing businesses may increase inventory optimization, expedite supply chain management, improve quality control, and boost energy efficiency by incorporating IoT technology into their operations. It is impossible to exaggerate the importance of IoT in the food processing industry because it not only produces safer and better-quality food items but also lowers costs and promotes sustainability. The Internet of Things (IoT) will play an increasingly bigger role in determining how food processing develops in the future as technology progresses.

References

Badrinath R, Prabhu VV (2017). Advances in Internet of Things (IoT) in Manufacturing. Hal Open Science. 1-8

Jagtap S, Garcia-Garcia G, Rahimifard S. (2021). Optimization of the resource efficiency of food manufacturing via Internet of things. Computers in Industry. DOI: 10.1016/j.compind.2021.103397.

Kamilaris A, Kartakoullis A, Prenafeta-Boldu FX (2017). A review on the practise of big data analysis in agriculture. Computers and Electronics in Agriculture. Volume 143. December 2017. 23-37.

Min W, Jiang S, Liu L, Rui Y, Jain R (2019). A survey on food computing. ACM Computing Surveys 52:92.

Misra NN, Dixit Y, Al-Mallahi A, Martynenko A, Bhullar MS, Upadhyay R (2020). IoT, Big data, and Artificial Intelligence in Agriculture and Food Industry. IEEE Internet of Things Journal. PP(99):1-1.

Nukala R, Panduru KK, Shields A, Riordan D, Doody P, Walsh J (2016). Internet of things: A review from 'Farm to Fork'. Conference paper.

Shih SW, Wang CH (2015). Integrating wireless sensor networks with statistical quality control to develop a cold chain system in food industries. Computer Standards and Interfaces.

* * * * * * * *