

IMPLICATIONS OF BLOCKCHAIN & IoT IN FOOD SUPPLY CHAIN MANAGEMENT

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ABSTRACT

The recent trend of technologies like Blockchain and IoT has touched the feet of Agri-Food supply chains. Substantial amount of research has been done towards impelling reliable, trustable, auditable, and transparent traceability systems. Blockchain is a distributed achieve that promotes decentralization, transparency, and data integrity. Food traceability is known to be the most important and emerging blockchain applications in recent years, for improving the areas of quality assurance. Current food traceability systems do not give high level of security, reliability, scalability, and information accuracy. The food traceability methods are generally very time consuming & is vast and complex. To overcome these challenges, blockchain technology is a promise to create a paradigm shift for supply chain traceability. Furthermore, a blockchain-IoT-based food traceability system is concerned to integrate the novel deployment of blockchain, IoT technology to improvise the total shelf-life management system for maintaining perishable food. To know the needs for food traceability, characteristics which considers are shipment transit time, stakeholder assessment, and shipment volume. It is vital to collect data, real-time through sensors, and then store them in the blockchain, so that they can become unalterable and tamper-proof. The data flow of blockchain is then aligned to the deployment of IoT technologies according to the level of traceable resource units. Ultimately, the firms can deploy the decision support mechanism established in the food supply chain by using reliable and accurate data for shelf-life adjustment, and quality can be maintained.

Keywords- Blockchain, Internet of Things, Traceability, Food supply chain, Food Safety, Transparency

1. INTRODUCTION

Blockchain is one of the captivating and debated research topics. A blockchain can be defined as “an immutable ledger for recording transactions, maintained within a distributed network of mutually untrusted nodes. A blockchain is a list of ordered blocks, where each block stores a variable-size list of transactions”. The first blockchain was introduced by Satoshi Nakamoto, who proposed the concept of Bitcoin cryptocurrency in 2008.

Internet of Things (IoT) is a new paradigm that has changed the traditional way of living into a high-tech lifestyle. A lot of research has been done to enhance the technology through IoT. However, there are still a lot of challenges that need to be addressed to achieve the full potential of IoT in Food and Agricultural supply chain. In IoT is defined as the network of devices that gather and convey data via the Internet. Slowly, but surely, the Food industry is getting acquainted with the Internet of Things. With the number of remarkable applications of the IoT the food suppliers, processors, and retailers are experiencing good opportunities for operational as well as financial augmentation in their food businesses.

With ever rising population, challenge is not only to boost food production but also to protect food loss. Grains, vegetables, fruits, and dairy products are sensitive to environmental conditions as they carried from farm to warehouse to retailers. Food loss is majorly between the production process and distribution which is mainly due to improper storage or break in cold chain. This is not just the loss of food but also the wastage of natural resources like land, water, fertilizers, and human labor etc.

Today, people are increasingly conscious about the food items they consume. They are concerned about making their eating choices healthy. Use of technology can bring paradigm shift in how we see farming and supply chain today. Food supply chain with IoT and Blockchain is the need of the hour and is known as smart food supply chain. An agricultural supply chain can be defined as a set of actors involved in farming, distribution, processing, and marketing of agricultural and horticultural products, “from field to table”. Food traceability is today a topic of great standing and numerous outlines were introduced

in the recent researches for avoiding the occurrence of food scandals such as those occurred in the past. IoT in food supply chain can be used for more production and quality of food and will avoid food loss in warehouse and transportation. The blockchain-food traceability association is novel and still quite unexplored. IoT and Blockchain is to make sure food safety, lower food fraud and at the same time keeping low operating cost. Simply the issues like of food wastage, stale and contaminated food, food scarcity, food safety, food traceability, healthy food, supply chain management can be resolved by IoT and Blockchain.

2. LITERATURE REVIEW

Consumers started demanding more over the last decades. We expect our food to be available regardless of the season. And tastes have become more exotic than ever before. While most of us love the fact, we can get tomatoes in winter, most consumers don't see the hidden costs. Businesses have been forced to source food from further afield than ever before. This has led to supply chains that span the globe. Around 14% of all food is wasted before it even reaches store shelves.

Beside these direct costs, it's becoming more challenging for businesses to maintain their brand promises. Blurred supply chains and high profile scandals, such as Uncle Ben's rice recall due to concerns about glass's possible presence, have damaged consumer trust. And more than 75% of consumers would prefer to switch to brands that provide more in-depth information about a product. There are primarily two issues with reducing and reacting to food safety problems: poor communication and lack of traceability. Many companies rely on traditional paper-based tracking mechanisms, which are slow and error-prone. To make matters worse, those involved in various stages of the supply chain often don't communicate with each other. This leaves blind spots in the supply chain. These issues have been worsened by the increasing size and complexity of supply chains. As we continue to source more of our food from further afield, we will likely see more problems appear. If businesses want to prevent this, they need to act now, before the problem spins out of control. Modern supply chains have become rapidly sophisticated, and their effect on the competitiveness of most companies is a crucial factor to consider. Risks involved in a supply chain are associated with its interlinked nature.

2013's survey on Global Supply Chain Risk by Deloitte unveiled the direct impacts and causes of the risks and challenges like Ineffective supply chain risk management, Margin erosion and sudden demand, Insufficient end-to-end visibility, Ripple effect because of extended value chain, Obsolescent technologies. There's no way-out to the food industry-related problems/ challenges. But, the powerful combination of blockchain and internet of things (IoT) technology could tackle the root causes. It's essential to understand these technologies' strengths and limitations with the help of certain tracking apps or traceability options (Figure1).

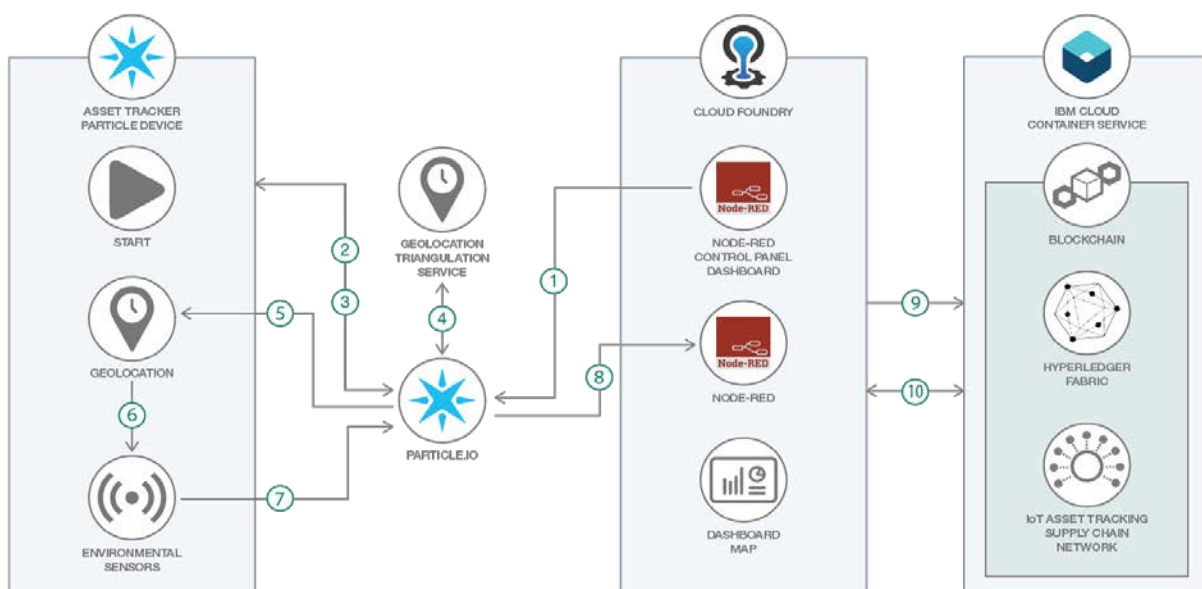


Figure 1: IoT asset tracking app using Blockchain – Adapted from IBM Developer

2.1 IoT (Internet of Things): The Future of Food Safety

The Internet-of-Things (IoT) adds a layer of technology to the food manufacturing process to ensure greater food safety. A broad series of networked sensors, monitors, and other Internet-connected devices, IoT technology can oversee the entire food manufacturing and distribution process from the warehouse to the point of sale. The true potential of IoT lies in its ability to harvest data in real-time automatically and then share that data. Boosting transparency across the board, intelligent sensors and cameras can transform any food manufacturing operation into a highly visible, data-backed process that allows for better

decision-making and improved real-time knowledge technology greatest potential lies in its ability to safely monitor food preparation and production. Live data from IoT devices makes it possible to closely monitor food safety data points, allowing manufacturers and restaurants to reduce the risks of foodborne illness outbreaks through enhanced data collection and automated reporting. Domino's Pizza, for instance, embraced IoT technology to enhance management processes and monitor the food safety of its products. In the past, restaurants have relied on workers to record food temperatures, a practice that was occasionally overlooked and could lead to issues with health inspectors. Using IoT devices for real-time temperature monitoring, Domino's automatically records and displays temperature levels of a store's production, refrigeration, and exhaust systems, allowing employees to view conditions from a live dashboard.

In addition to boosting food safety, the comprehensive monitoring offered by IoT technology can help food companies reduce waste, keep more effective records, and analyze more data for improved operations' devices rely upon various sensors. These can monitor everything from shipping time to temperature to even which agent handled the food and when. These sensors can be anything from drones to smart thermometers to radio-frequency identification (RFID) and GPS. They help remove human error from each point on the supply chain. This cuts down on potential errors and theoretically will remove many of the failure points in the supply chain. Sensors can be used to track where an animal was raised, or a crop was grown and whether the conditions comply with organic and cruelty-free labels. Then IoT-enabled vehicles will transport the products for processing. The temperature the goods are kept at and who has interacted with them will be recorded and stored on the blockchain throughout the entire process. This enables retailers to keep track of when produce will arrive but more importantly, it provides transparency to consumers. It should be possible to use a QR code and see a product's entire life cycle before you buy it. IoT isn't just a safe solution for improving food safety: It's a smart solution. The trouble is that IoT alone can't fully solve the transparency and communication problems that plague food supply chains. That is where blockchain comes in.

2.2 Implications of Blockchain in Food Supply Chain

2.2.1. Traceability

The most common use of blockchain in food and agriculture supply chains is to improve traceability. It enables companies to quickly track unsafe products back to their source and see where they have been distributed. This can prevent illness and save lives, as well as reducing the cost of product recalls. The omnipresence of QR codes has made it simple for consumers to quickly access information by scanning an image with their smartphone. Blockchain technology provides a powerful opportunity to provide consumers with similar information about food safety. Able to instantaneously trace the lifecycle of food products, it can report a food's every point of contact throughout its journey from farm to table. By scanning a QR code, for instance, users can quickly access relevant information about a food product's source, such as an animal's health, and welfare in animal products. Real-time product tracing can be conducted in just two seconds, enabling Walmart and other vendors to provide consumers with access to food safety information that could easily be updated should an outbreak or contamination occur.

Blockchain's inherent transparency not only makes it possible to identify the safety of food production; it also enhances the safety of the business of food production itself. Because blockchain is based upon an immutable, anonymous ledger, record keeping, and accounting can be made more secure and less prone to human error. Improving track-and-trace reduces the need for buffer stock by providing real-time visibility of inventory levels and shipments. Payments to farmers and other food suppliers can also become more transparent and equitable. Urgent orders can also be expedited and rerouted, minimizing disruptions to production schedules and customer shipments. The combination of blockchain and IoT sensors is showing potential to revolutionize food supply chains.

2.2.2 Data Management

Another advantage of block chain is that it forces companies to clean-up and systematize their existing data. It has been estimated that 75% of the work that goes into implementing block chain is spent fixing the data to work in the new system. This enables companies to improve their overall processes while making historical data more accurate and useful.

2.2.3. Marketplace Creation

One challenge for commercial food companies is sourcing quality ingredients in sufficient quantity. Farmers may not know who the big customers are or what end customers are looking for. Historically, intermediaries have controlled a significant percentage of profits. Digital marketplaces allow buyers and growers to connect directly, increasing the amount of profits that go to the farmers, and investors to invest directly into farms producing commodities and then trade on that investment.

2.2.4. Data Sharing

Companies that buy or invest in agricultural products have an inherent interest in having information about the product before they commit to a purchase. This can include everything from salt and sugar levels in tomatoes, which would affect flavor, to crop health information, which can help banks and others predict whether a farm will be able to repay a loan. As block chain technology continues to mature, retailer both big and small can benefit from the transparency, trust and transaction efficiency it brings.

2.3 Food Supply Chain with Block chain and IoT

2.3.1 Farmers could store the information about food crops on the block chain

A farmer could save details of grown-up crops like origination, type of crop, the procedure used for sowing, storage info and so on using the mobile app or center location on the block chain. The information stored by farmers could be accessible by all involved stakeholders within the system. Once the crops are grown up, the farmers distribute them to the food processing companies or refineries for further processing.

2.3.2 Food Processors add the processing details on the block chain

After receiving food items from the farmers, refineries or food processing companies can bid for the crops through smart contract. Once the bid is accepted, they could start processing and store the information related to the refining of crops on the public block chain. Information stored on the block chain could help retailers or consumers verify if the food has been appropriately processed or not.

2.3.3 Wholesalers would bid for the processed products through smart contracts

After processing the food items, refining companies could put the processed items for bidding. Wholesalers could start bidding through the smart contract. Once the food processing companies accept the bid, processing companies would transport the processed food to the wholesalers and update transportation details on the block chain. Transporting the processed food through IoT-enabled vehicles or trucks could help to keep the food items safe under the controlled temperature. The sensors built in the IoT vehicles could send information related to the temperature of food items and real-time location to the block chain. It could help retailers to keep an eye on food items they are going to receive.

2.3.4 End consumers could ensure if the food they are having is safe to eat or not

From source to destination, the information such as farm origination details, batch numbers, transportation details, factory and processing data, storage temperature, expiration details, and other details can be linked digitally to the food items. An end-consumer could then ensure if the food is safe or not by scanning QR code from their smartphones and get whole food information.

Moreover, the government auditors could also perform audit checks on the cost and quality of the crops quickly through the records stored in supply chain block chain. Once different stakeholders could be able to access every piece of information related to food items at every stage, the quality of food item could never be compromised

3. CONCLUSION & IMPLICATION

A deadly combination of block chain technology and IoT has a potential to save the food industry from backlogs. The block chain and IoT for supply chain can transform the agricultural industry by streamlining all stages of the food and agricultural supply chain. Not only this, tracking a product along its entire path from farmland to store shelf is possible which improves the food safety and eliminate counterfeit items. It also submits clear data of food to customer and generate smarter market data for better decision-making for firms. Better sensors would reduce food wastage, increasing the total amount of food that hits store shelves. Fewer product recalls would also generate savings and

enhance profit. Food wastage reduction help industry to supply more food to large number of people. This also help WHO and government authorities to keep check on food. It ensures your food is safe and food is not wasted.

In order to bring this technology to the mainstream of the processed food world, food processors, supply chain participants, government authorities, and IT experts have to come together to build an all-inclusive plan to implement Block chain and IoT Technology.

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