Trust and Traceability

Blockchain and IoT in Agricultural Supply Chains

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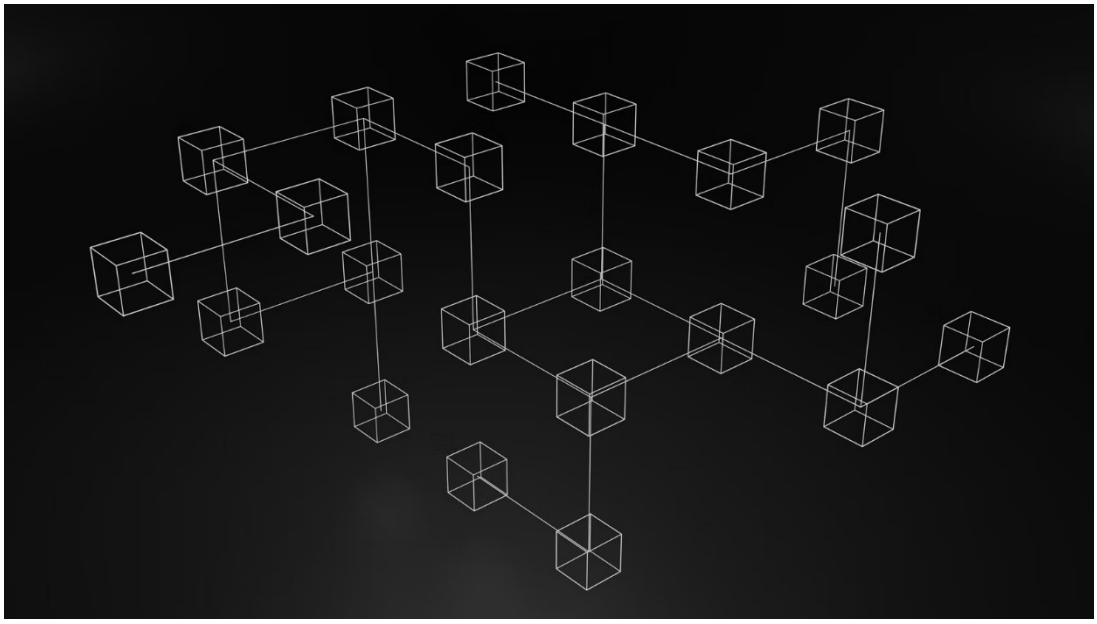


1 "Connected blocks in blockchain" by Shubham Dhage, Unsplash is licensed under Unsplash License

INTRODUCTION

Brave New Agra, Inc. faces unique new challenges to our supply chain operations. For example, there are increased demands for end-to-end product traceability, accurate recall identification, and growing paperwork filing requirements from regulators. Additionally, our company needs further product-level data to inform business decisions and identify future trends.

Supply chain management is increasingly focused on "visibility, connectivity, and efficiency," as described by a contributing editor to the Supply Chain Management Review Magazine. (McCrea, 2019). Considering these three areas, integrating blockchain and IoT devices in our supply chain activities may provide needed solutions. For example, blockchain is a feasible technology for enhancing end-to-end traceability and product identification.

Additionally, IoT sensors can improve the reliability and trustworthiness of supply chain transactions stored in a blockchain. IoT sensors can also assist in automating the burdensome aspects of paperwork filing, such as gathering product quality metrics. Finally, IoT additions will allow us to accurately harness machine learning to predict future supply chain trends.

2 "Person in blue shirt writing on white paper" by UX Indonesia, Unsplash is licensed under Unsplash License

PRODUCT/SERVICE/METHODOLOGY

The findings gathered and presented were found from ongoing academic research in the field. Currently, the technology is relatively new, and adoption has only begun. However, Lukas Schweiger writes in an article for Blockdata that "65 of the top 100 publicly-traded companies are actively developing blockchain solutions." (2021). This statement highlights the need to integrate blockchain and IoT into our supply chain

management activities. The message across the industry is clear: keep up or be disrupted.

KEY FINDINGS

End-to-End Traceability Increases Trust

3 "Two people shaking hands" by Cytonn Photography, Unsplash is licensed under Unsplash License

End-to-end traceability provided by blockchain-enabled supply chains enhances the trust of all parties. Supply chain transactions logged on the blockchain are immutable. Anyone with access can assess that the transaction data is genuine by checking the validity of its cryptographic hash.

IoT Sensor Integration Provides Key Metrics on Product Quality

4 "Meadow Clima" by Jorge Ramirez, Unsplash is licensed by Unsplash License

The need for IoT sensor integration is apparent. IoT sensors provide necessary data on the quality of our products throughout the supply chain. IoT sensors can report environmental variables from sourcing to packaging and ultimately delivery to the retailers where consumers purchase our products. This IoT sensor data can assess product quality, identify product recalls more rapidly, feed machine learning algorithms, and yield more accurate consumer reporting. Additionally, these sensors can assist in generating necessary quality control paperwork. Finally, it would increase consumer trust in our brand image by publicly making the data available.

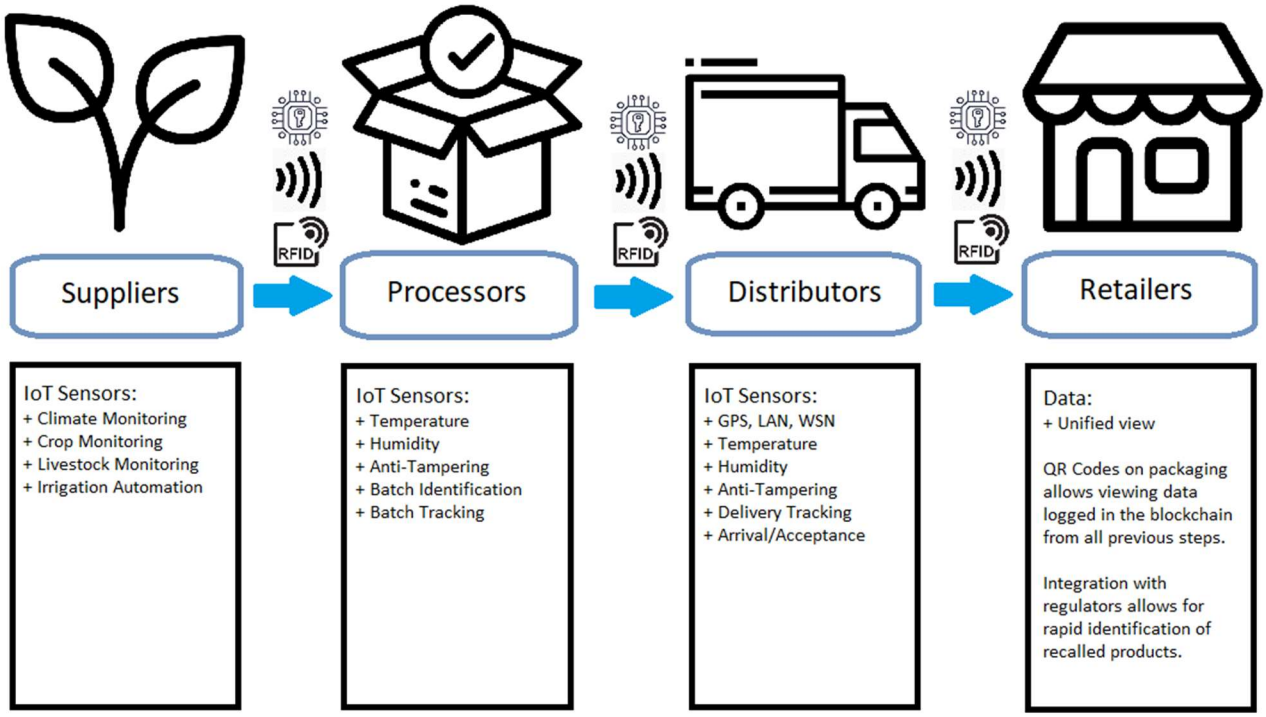
Regulators Already Support Technology Like Blockchain

5 "Fountain pen on stationery" by Álvaro Serrano, Unsplash is licensed by the Unsplash License

The FDA has outlined a ten-year blueprint called the New Era of Smart Food Safety. Baxter (2021) writes that in this blueprint, the FDA states its support of technologies like blockchain "to create a safer, digital traceable food system" in comments made to Jurimetrics: The Journal of Law, Science, & Technology. By developing solutions per this ten-year blueprint, we will be ready to achieve compliance when new regulations govern digital food traceability.

BLOCKCHAIN AND IOT IN ACTION

The following subsections describe how a supply chain integrated with blockchain and IoT devices might look.



6 Depiction of blockchain and IoT sensor integration within a supply chain.

Plant, package, truck, and shop icon attributions from left to right: Gregor Cresnar, Monkik, Freepik, Pixel Perfect from Flaticon, free to use for digital and print media under the Flaticon License.

Blockchain and IoT Sensor Integration in a Supply Chain

The graphic above illustrates how IoT sensors can be used to enhance product reporting and tracing at each step in our supply chain. Additionally, it depicts devices such as RFID, NFC, and cryptographic processors for logging IoT sensor data alongside a blockchain transaction. Transactions are recorded as product "batches" with their IoT sensor history. Additionally, "verifiers" perform the transaction verifications for each new block added to the blockchain following

a trust-based proof-of-consensus model. According to Al-Rakhami & Al-Mashari on p.6, verifiers are the actors who maintain the integrity of transactions stored on the blockchain by "verifying all logged information." (2021).

Blockchain Transaction Recording

Logging supply chain transactions on the blockchain will require several components. First, all products forming a "batch" must be logged and tagged with devices using RFID, NFC, or other suitable means. This tagging allows for identifying products on a batch-by-batch basis. Then, when a batch is dispatched to the next step in the supply chain, the up-to-date IoT sensor history for the batch at this step is logged with a batch identification number.

Next, a cryptographic processor on the device scanning the RFID or NFC tag computes a cryptographic hash for all data being logged as a new transaction on the blockchain. The hash of the previous supply chain step with a matching batch identifier is then added to the transaction. Cryptographic hashing provides resiliency against data tampering after a transaction has been logged on the blockchain. Once a new block containing the transaction reaches consensus through the proof-of-consensus model, the transaction becomes immutable, and the previous block's hash is added to the new block.

After this step, any data tampering of logged transactions would be discoverable by comparing the cryptographic hashes and rejected under the proof-of-consensus model. This model additionally allows punishing verifiers who maliciously add false transactions under the trust model.

Trust-Based Proof of Consensus

Verifiers are the actors in the blockchain recording process who verify transactions and new blocks added to the blockchain. They follow a mathematical "trust model" where verifiers who accurately record transactions in new blocks receive a trust reward through an increased trust score. On p.7, Al-Rakhami and Al-Mashari explain that when verifiers interact to record a new block on the blockchain, trust scores are recalculated based on a "series of queries with each other." (2021).

This model allows for taking punitive actions against verifiers who maliciously record false transactions or attempt to alter previously registered blocks by lowering their trust score. A trust threshold is put in place for flagging malicious verifiers. A verifier will supervise another if its trust score drops below the threshold. Al-Rakhami and Al-Mashari describe on p.8 that if its actions are not found to be "abnormal, then its trust score is restored." (2021). If its behaviors are determined to be malicious, it is blocked from participating in block verification.

CONCLUSION

The emergence of technologies like blockchain and IoT sensor-based devices threatens to disrupt the traditional ways of doing supply chain management. Disruption is especially alarming to participants in the agricultural industry, where heightened demand exists for product tracking and tracing from farm to table. In addition, these technologies will add value to the company by using collected data to inform business decisions. Lastly, by getting ahead of the curve now, we can be ready to achieve compliance when future regulations regarding digital food traceability are enacted into law.

Key Takeaways

- Blockchain integration would enforce the integrity of transaction-level data
- IoT devices will generate the quantities of data needed for machine learning
- IoT sensor data can create new quality metrics regarding our products
- Enhanced metrics identify non-conforming products before they require a recall
- Regulators have already shown support for technologies like blockchain
- Blockchain and IoT integration enable creating a unified view of product data

SOURCES

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