Application of blockchain technologies in the supply chain in food enterprises

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Abstract. The food supply chain encompasses all the stages that food products pass through during their movement from the producer to customers and consumers. It is influenced by several specific factors that must be taken into account. Such are, for example, requirements related to the specifics of the products, legislation, food safety, etc. Information technologies are successfully applied in the food supply chain. Blockchain is a new concept that has attracted increasing attention in recent years. Blockchain is a decentralized and distributed record of transactions that are stored in blocks and linked sequentially in a chain. It represents an innovative way of managing and exchanging data and information. Blockchain technology can improve the supply chain in the food industry in a variety of ways, providing greater transparency, security, and efficiency. Therefore, this paper aims to present in detail Blockchain technology and how it would help the supply chain in food enterprises.

1 Introduction

Modern information and communication technologies are a major factor in the automation and digitization of production and business processes and in the development of the digital economy as a whole. Cloud computing, communication networks of the fifth generation (5G), Internet technologies, including the Internet of Things (IoT), technologies for extracting information from big data (Big Data, Data Mining), blockchain technologies (Blockchain), the development of artificial intelligence (Artificial intelligence - AI) changes products and services, processes and business models in all spheres and ultimately leads to the Fourth Industrial Revolution. The term Industry 4.0 is defined as the application of the digital technologies described above in the production sector and is a powerful tool for creating new business opportunities and models. A basic concept in Industry 4.0 is the so-called "smart factory" in which production systems communicate directly with relevant business management information systems (MIS, ERP, etc. systems) and through them with people (employees, customers). Information about the current state of the processes is obtained from sensors located at key points of the "smart factory", recorded in the database of the information system, and used by the various departments, including to support the managerial decision-making process. An important moment in the transition to Industry 4.0 for companies is the digitization of the supply chain. With the help of business management information systems, not only the company's value chain is automated, but also the business processes of external partners and large customers. As a result, the economic efficiency of production operations increases, competitiveness increases and greater flexibility is achieved in production operations.

Paradoxically, is that although information and communication technologies already being applied in practice, a large part of them are unknown. And this naturally creates fear, especially of the unknown. An example of this is artificial intelligence. As a concept, it is very advanced, it is used daily by people and in production, but there is no generally accepted definition that explains what artificial intelligence is. The same applies to blockchain technologies. Commonly associated with cryptocurrencies, they are actually a decentralized and distributed record of transactions that are stored in blocks and linked sequentially in a chain. Blockchain technology has the potential to transform a number of areas of life, including education, healthcare, logistics, and more. It can also be particularly useful for businesses in the food industry, providing greater transparency, security, and efficiency Therefore, this paper aims to present in detail the blockchain technology and the ways in which it would help the supply chain in food businesses. The most popular platforms suitable for creating applications for the food industry focused on ensuring transparency and safety in the food chain, facilitating the traceability of food products and improving food quality will also be covered.

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2 Blockchain technology

2.1. History

The creation of blockchain technology is associated with the name of Satoshi Nakamoto and his White Paper published in 2008 [1]. On 12/18/2008, he registered the Bitcoin.org domain, which marked the beginning of the Bitcoin cryptocurrency. However, the figure of Satoshi Nakamoto is shrouded in mystery. It is known to be a pseudonym, but to this day absolutely nothing is known about the person behind it.

In fact, the emergence of blockchain technology was preceded by a number of discoveries in the field of cryptography and information technology, which prepared the ground for its emergence. Ideas for creating decentralized systems and digital signatures became the basis for future developments. The development of the blockchain also contributes to the work on various experimental digital currencies, which, however, fail to solve the problems of decentralization and prevention of double payment.

Since the emergence of Bitcoin, in the period from 2010 to 2013, a number of other cryptocurrencies using blockchain technology have been proposed. In 2011, Charlie Lee [2] introduced Litecoin, which is a faster and lighter version of Bitcoin. three engineers - Arthur Brito, Jed McCaleb and David Schwartz - in 2012 introduced Ripple, which aims to provide faster and cheaper international transactions, mainly for banks and financial institutions. The increasing energy consumption of cryptocurrency mining is the reason behind the emergence of Peercoin [3]. Along with this cryptocurrency, a new consensus mechanism, Supernode Proof-of-Stake (SPoS), has been introduced to help reduce energy consumption. In 2015, Ethereum appeared [4] - a platform that allows the creation of smart contracts and decentralized applications based on blockchain technology. Smart contracts are self-executing codes that automate and verify the execution of contractual tasks and transactions, without the need for a central intermediary. The Solidity programming language and an integrated development environment (IDE) such as Remix or Truffle are used to create smart contracts. In fact, smart contracts are the first application of blockchain technology outside of cryptocurrencies. After them, blockchain technology began to be adopted in various fields, including logistics, supply chain management, healthcare, education, and more. 1. Various blockchain platforms are also created, such as Hyperledger [5], Corda [6] and many others, which contribute to the development of the technology.

2.2 Blockchain – definition and mechanism of functioning

A blockchain is a decentralized digital ledger that is maintained by multiple computers spread around the world that are included in a Peer-to-peer (P2P) network. Blockchain data is organized into blocks that are chronologically ordered and secured by cryptography and consensus mechanisms, meaning that once information is recorded, it cannot be changed retrospectively. The mechanism by which blockchain technology works is described in fig. 1. The process starts with a transaction request. A block containing transaction data is then created and sent to every node in the network. After all nodes validate the transaction, it is complete and the block, containing information about it, is added to the already existing blochchains, and nodes receive a proof-of-work reward.

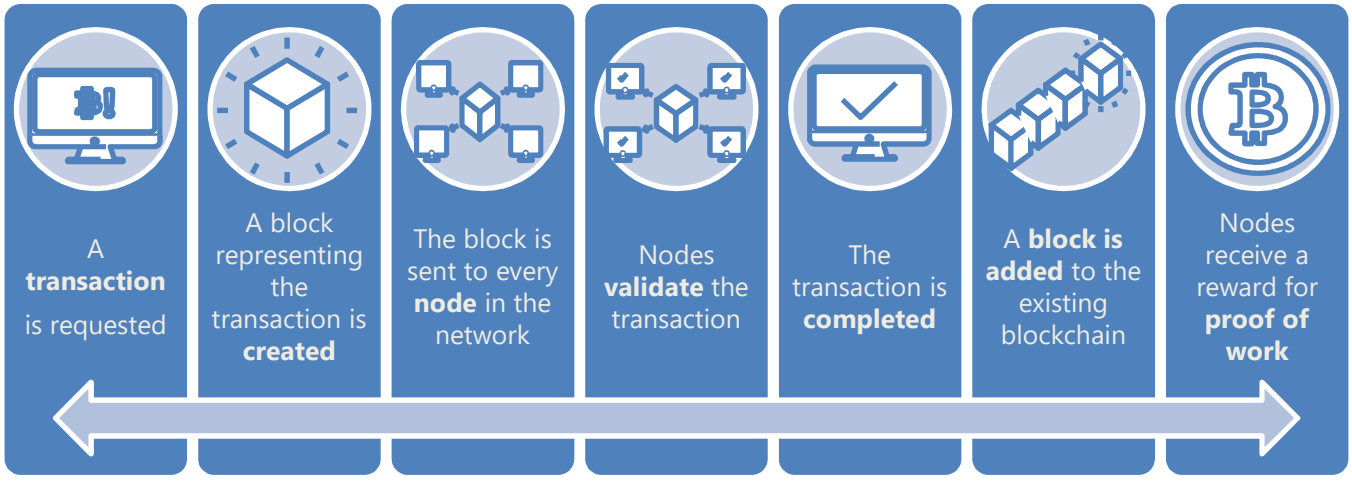

Fig. 1. Blockchain – mechanism of functioning

2.3 Main components of blockchain

As evident from the previous section of the article, the main components of blockchain technology are several. These are transaction, node, block, chain, Consensus protocol.

A blockchain *transaction* is the basic unit of information that is recorded in the blocks of the blockchain network. It contains data to transfer values or perform actions and serves to exchange values or information between network participants. Transactions can be diverse and include the following elements:

➢ **Transaction ID**: A unique code or hash that identifies a particular transaction on the network.

➢ **Source and Receiver**: Information about the addresses or keys of the transaction participants that send and receive values or perform actions.

➢ **Amount**: An amount of value that is transferred from the source to the recipient in the case of cryptocurrencies such as Bitcoin.

➢ **Signatures and Authentication**: Data that authenticates and authorizes the source of the transaction to execute it. These include cryptographic signatures or other authentication methods.

➢ **Additional information**: This part of the transaction may contain additional data or parameters that are necessary to perform the actions.

➢ **Status and Timestamps**: Information about the status of the transaction (for example, whether it has been verified or executed) and timestamps that indicate when the transaction was created.

Blockchain transactions are not used only to transfer cryptocurrencies. They are also used for executing smart contracts, for voting, for verifying ownership, and for a number of other applications. These are collected into blocks and stored across all nodes in the network, creating an immutable history of all transactions. This principle of operation makes blockchain suitable for transparent and secure transactions in various fields.

A blockchain *node*, also known as a "blockchain node" or "network node", is a computer or device that participates in the blockchain network and plays an important role in the distribution and maintenance of blockchain data. A node is part of a decentralized blockchain network and performs the following functions:

➢ **Storage of the entire chain of blocks**: A node stores a copy of the entire chain of blocks (blockchain) or part of it. This information contains all the transactions and data that have been added to the blockchain since its inception.

➢ **Transaction Validation**: Nodes are used to validate and verify transactions before they are added to the blockchain. They make sure that transactions comply with network rules and that signatures and authentications are valid.

➢ **Propagation of new blocks**: When a new block is created in the blockchain network, the nodes work to propagate the information to the other nodes. This propagation process is also known as consensus and ensures that all nodes have the same version of the blockchain.

➢ **Maintaining network security**: Nodes help maintain network security by storing cryptographic keys, maintaining access to blockchain data, and tracking unwanted activity.

➢ **Participation in the consensus process**: In many blockchain networks, nodes participate in the consensus process, where they vote or agree on what blocks to add to the block chain.

➢ **Smart contract support** (if applicable): Nodes in blockchain networks that support smart contracts contain executable code to execute those contracts.

Nodes can be divided into different types such as **full** nodes, **light** nodes, **mining** nodes etc. Each type of node fulfills its specific role in the network and contributes to the operation and security of the blockchain system.

A *block* in a blockchain is the basic structural unit in which data is stored. It contains a group of transactions or records that are added to the blockchain network at a specific point in time. The block combines transactions into one structure and contains the following key elements:

➢ **Header**: The block header contains metadata and control information about the block, including a unique identifier (block number), the hash of the previous block in the chain (intersection with the previous block), a timestamp, and additional version data.

➢ **Transaction List**: This is the core of the block and contains information about all transactions that have been included in the block. These transactions can be the transfer of cryptocurrencies, the execution of smart contracts, or other actions depending on the specific blockchain network.

➢ **Block Hash**: This element is the result of hashing all the information in the block, including the header and the list of transactions. The block hash serves to identify the block and links it to the previous block in the chain, creating a sequence of blocks.

➢ **Proof of Work or Proof of Stake**: This element depends on the specific type of blockchain network. In proof-of-work (PoW)-based systems, blocks are created by solving complex mathematical problems, which requires the expenditure of computing power. In proof-of-stake (PoS)-based systems, blocks are created through the participation of nodes with staked cryptocurrencies and other resources.

➢ **Random Nonce**: This is a random numeric parameter that is used in the proof of work to adjust the complexity of solving the problem and ensure the uniqueness of the block hash.

When a block is created and verified, it is added to the blockchain, becoming part of the network's permanent transaction history. This ensures immutability and integrity of the data, making the possibility of manipulations with them very difficult. After this process, a new block is created, and the cycle continues by adding more blocks containing new transactions to the block chain.

A *chain* is a sequence of blocks that contain information about transactions or data recorded on the blockchain network. Each blockchain network consists of multiple blocks that connect and form the history of all transactions and events in the system. Some key features of the block chain are:

➢ **Sequence**: Blocks are arranged in sequence one after the other and each block is built on top of the next one. This order of blocks is maintained by linking each block to the previous one via a hash (cryptographic value) contained in the block header.

➢ **Immutability**: Once recorded on a blockchain, information cannot be easily changed or deleted. This makes blockchain suitable for storing data that needs to be immutable and secure.

➢ **Decentralization**: A blockchain is typically stored and maintained by multiple network participants called

nodes. This decentralization contributes to the resilience and security of the network.

➢ **Replication**: Each node in the network contains a copy of the entire blockchain, which supports data replication and ensures that information is available in multiple locations and is not easily destroyed.

➢ **Publicity** (depends on the type of blockchain): In some blockchain networks, such as Bitcoin, the information in the blockchain is publicly available and anyone can view the chain of blocks. In other cases, blockchain networks can be private and access to information restricted.

The chain of blocks serves to store the history of transactions and events in the blockchain network. It provides transparency, immutability and security of data and is a key part of the functioning of this technology.

A *consensus protocol* is a mechanism that is used to determine the correct version of blocks and transactions that should be accepted on the blockchain network. This is an important part of how decentralized blockchain systems work, as there is no central authority to control and manage the network. Instead, a consensus protocol allows network participants to agree and agree on which blocks and transactions are considered valid and will be added to the block chain. Different blockchain networks use different consensus protocols, some of the most popular ones include:

➢ **Proof of Work (PoW)**: This protocol is used in blockchain networks like Bitcoin. Participants, called "miners," solve complex mathematical problems to create new blocks and verify transactions. The first miner to solve the task gets the right to create a new block and add it to the chain.

➢ **Proof of Stake (PoS)**: Instead of spending computing power, this protocol requires participants to stake cryptocurrency or other assets to be entitled to create new blocks. A larger stake amount usually gives participants a better chance of being selected to create blocks.

➢ **Proof of Authorship (Proof of Authority - PoA)**: In this protocol, participants authenticate themselves as trusted individuals or organizations that have the right to create new blocks. This method is used in private blockchain networks and is usually not decentralized.

➢ **Proof of Space (PoSpace)** and others: There are other consensus protocols such as PoSpace, PoI (Proof of Importance), PoC (Proof of Capacity) and others that use different methods to determine the correct version of blocks.

The choice of consensus protocol depends on the specific needs and goals of the blockchain network. Different protocols have different characteristics and advantages, aiming to achieve agreement and security in different conditions and environments.

A *network* in the context of blockchain refers to the combination of participants (nodes) that connect and cooperate to maintain and operate the blockchain system. There are four main types of blockchain architecture.

➢ **Public network** – in this P2P network, anyone can create a node and become a part of it without asking permission from anyone.

➢ **Private network** - In this case, a person, business or institution owns and controls all the nodes in the P2P network. With such a setup, only the blockchain owner can allow another person or entity to join the network.

➢ **Consortium network** - represents a collaboration of many entities. Each of them can have a node in the network, participate in decision-making and own shares in the company that controls its activity.

➢ **Hybrid network** – This is a blockchain architecture that has two tiers. The base level is a public P2P network. The second layer on top of that is a private blockchain that an entity builds.

It is important to emphasize that blockchain networks were developed for the purpose of decentralization and data protection, and are the main building block for the operation of this innovative technology.

2.4 Key characteristics of blockchain

The key characteristics of blockchain technology are many. Among them are Decentralization, Anonymity, Transparency, Immutability and others. The three most important features are presented in Fig. 2. These are decentralization, security and scalability.

Fig. 2. The three main pillars of blockchain

Decentralization in the context of blockchain refers to the distributed nature of the system, where there is no central authority or single controlling authority. This means that decisions and management of the network are made by multiple participants (nodes) who connect and work together to maintain and operate the blockchain system. Decentralization in blockchain plays an important role in increasing security, safety and transparency in networks, as well as providing ownership and control over user data and transactions. This concept is a fundamental attribute of many blockchain networks and applications, and is key to their functionality and benefits.

Security is another key feature in blockchain technology. It is mainly associated with cryptography and the various cryptographic methods used to secure data and transactions. For example, public and private keys are used to authenticate users and sign transactions. Hash functions are used to create unique identifiers for blocks and transactions that protect them from tampering.

Along with cryptography, blockchain networks use authentication and controlled access systems that ensure that only authorized users can transact and participate in the network, and smart contracts. These are executed automatically and according to code, which also reduces the risk of making mistakes. To improve security,

Blockchain networks can also include dispute resolution and arbitration mechanisms to regulate conflicts and inconsistencies in the system.

Scalability in blockchain refers to the system's ability to expand and support increasing numbers of transactions and participants without losing efficiency or security. Although blockchain technology offers many advantages, it faces a scalability challenge, meaning that as the number of transactions and users grow, issues with processing speed, capacity, and overall network performance may arise. To achieve scalability, the blockchain system can use various techniques and technologies:

- **Increasing the blocks or transaction size**: Increasing the block size in the blockchain allows a greater number of transactions to be included in a single block. This can increase network capacity and reduce transaction processing latency.
- **Increase the frequency of blocks**: Some blockchain networks can increase the frequency of the creation of new blocks. This means that a new block is created more often, allowing for faster transaction processing.
- **Network expansion**: Adding more nodes to the blockchain network can improve scalability as more participants can participate in maintaining the network and validating transactions.
- **Improved Consensus Algorithms**: Improved consensus algorithms can increase scalability by reducing the need to expend large amounts of computing power to create new blocks.
- **Scalability through sidechains**: Technologies such as sidechains allow the network to expand functionality and support additional transactions and applications outside of the main chain.

Scalability is an important factor in the development and use of blockchain systems, as it determines the network's ability to support growing numbers of participants and transactions, which is key for high-activity applications such as cryptocurrencies, supply chains, and more.
Further information about the basic concepts of blockchain can for instance be found in [7].

3 Blockchain in the food supply chain

Although blockchain technology is mainly associated with cryptocurrencies, it can be applied in several other areas - in education, healthcare, and energy markets, for building smart cities in combination with the concept of the Internet of Things, for authentication, in voting, can integrate with artificial intelligence (AI) and machine learning to improve data management and models for AI, etc. Gartner, Inc. [8] predicts that, by 2025, 20% of the top 10 global grocers by revenue will be using blockchain for food safety and traceability to create visibility to production, quality and freshness. Research by Global X [9] shows that in Europe blockchain technology is most significantly developed in the banking and financial sector. At the same time, however, the greatest potential for the development of blockchain technology is in logistics and supply chain, in particular food supply. This is largely due to the European Commission's Farm to Fork strategy. It is also influenced by the ideas of increasing the sustainability of supply chains and transparency in the value chain of the food industry, which are key objectives of the Green Deal.

Currently, however, only part of the EU countries have started to apply blockchain technology in food supply chain enterprises. Some successful examples are Norway, Portugal, Spain, Italy, etc. In 2020, the Norwegian Seafood Association and the Scandinavian IT infrastructure company Atea launched a national seafood tracing network Norwegian Seafood Trust [10]. This network uses IBM's blockchain technology to share supply chain data in Norway's maritime industry. From 2021, the companies Nova Sea and BioMar will join it.

The Blockchain for Agri-food project [11] has been launched in the Netherlands, which is funded by the Dutch Ministry of Agriculture, Nature and Food Quality and aims to improve agri-food supply chains.

In Portugal, the agricultural sector is applying blockchain to track food products, noting that this increases their safety. Portuguese enterprise Veracruz Almonds collaborates with Arabyka to apply block chain in the supply chain [12]. Also, supply chain company Sense Finity [13] is introducing a blockchain-based food provenance certification solution. The solution is available to track the distribution of food with sensors and trackers. Blockchain offers data immutability and is based on Hyperledger.

Spanish food giant Campofrío [14] is also using blockchain technology to provide transparency in some of its food products.

In general, there are not many large-scale industrial blockchain applications in Sweden. However, there is one particularly noteworthy project. Axfoundation, along with Martin & Servera, SKL Kommentus, Sustainable Procurement [15] (a collaboration between Sweden's provinces), and Kairos Future, collaborated to map the potential of blockchain in the nation's food industry.

In Italy, the Consortium of Red Sicilian Oranges [16] is using blockchain to implement a tool to combat food fraud and allow consumers to recognize the authenticity of citrus fruits by simply scanning the IGP mark attached to each box or grid of oranges with a smartphone. Through this application, it is possible to check the field where the fruit was produced, the date of collection, and the methods of storage and distribution. Barilla [17], on the other hand, uses blockchain technology to guarantee the origin, and quality of products and raw materials, from field to table. The first application was developed for Italian fresh basil.

3.1 Features of EU Food Supply Chain Legislation

For the transport and logistics of food within the European Union (EU), there are various directives and legislative acts that are applied to ensure the safety and quality of food during its transport and storage. Some of the key rules in this area include:

Hygiene standards for food transport: The EU has strict rules for the hygiene and safety of food during

transport. These standards include requirements for food storage at certain temperatures and conditions, isolated cargo spaces, and means of maintaining hygiene.

Regulation (EC) No. 852/2004 on food hygiene [18]: This regulation establishes general principles and requirements for food safety, which also include hygiene standards for food transport. It contains provisions related to the cleanliness of means of transport and packaging, as well as the storage and transportation of food at certain temperatures.

Regulation (EC) No. 853/2004 on specific hygiene rules for food of animal origin [19]: This regulation sets additional standards and requirements for the transport of food of animal origin, including meat, milk, and fish.

Regulation (EU) No 37/2010 on pharmaceutical products for animals intended for use in food production and consumption [20]: This regulation concerns the requirements for the transport of pharmaceutical products used in animal husbandry and food production, including controls, marking, and conditions of transport.

Legislation on food containers and packaging: The EU has rules on the security of containers and packaging used to transport food to ensure that they do not pose a risk of contamination or food contamination.

These rules and directives are implemented to ensure that the transport and logistics of food in the EU are carried out according to high standards of hygiene and consumer safety. They apply to every step in the supply chain, including vehicles, warehouses, and distribution centers.

3.2 Blockchain technology helps comply with EU food supply directives

Blockchain technology can be extremely useful for compliance with EU food supply chain rules and directives in various aspects:

Transparency and traceability: Blockchain provides transparency to the entire supply chain, from the manufacturer to the end user. All data and events related to food transport and storage can be recorded on a blockchain. This allows all participants in the chain to see and track every step and transaction.

Decentralized Control: Blockchain is a decentralized technology that has no central controlling authority. This makes manipulation or misuse of the data more difficult and reduces the risk of fraud.

Smart Contracts: Blockchain can use smart contracts, which are automated programs pre-set to execute contracts and rules. For example, a smart contract can monitor the temperature of goods during transport and generate automatic warnings if it exceeds a certain value.

Identification and authentication: Blockchain can contain identification and authentication information for supply chain participants, including manufacturers, transport companies, and warehouses. This allows regulatory and food inspection authorities to monitor and validate the activities of each participant.

Expiration and Expiry Tracking: Blockchain can automate the tracking of food expiration dates and expiration alerts. This aspect is extremely important for compliance with food safety regulations.

Fight against smuggling and counterfeiting: Blockchain can be used to fight against smuggling and counterfeiting of food, as it provides a system of traceability and verification of the origin of products.

Use of geographical indications and labeling: Blockchain can facilitate the use of geographical indications and labeling for foods of special origin, such as organic and traditional products.

The combination of these functionalities makes blockchain technology a powerful tool to support compliance with EU rules and directives for food transport and logistics. It can facilitate the work of regulatory bodies, improve food traceability, and ensure greater safety and quality of products that are offered on the market.

3.3 Leading blockchain companies offering food supply chain solutions

In the food supply chain blockchain solutions market, there are several leading companies providing innovative products and services. Here are some of them:

IBM Food Trust [21]: IBM Food Trust™ is the first blockchain food safety solution that allows transaction partners to confidently and securely share food information, creating a more transparent and trustworthy global food supply chain. IBM Food Trust is the leading blockchain platform specializing in food supply chain management and monitoring. It is used by large companies such as Walmart and Carrefour.

VeChain [22]: VeChain uses the VeChainThor public blockchain to ensure scalable smart contracts in industry supply chain management. VechainThor blockchain is the leading enterprise-grade, Layer-1 blockchain, spearheading the sustainability revolution with a low-carbon, highly scalable smart contract platform. It is intended to serve as the foundation for a sustainable and scalable blockchain ecosystem. VeChain offers blockchain solutions for food supply chain management that focus on product authenticity and traceability. It is used in various industries, including food and wine.

TE-Food [23]: TE-FOOD provides all tools and applications for complete supply chains to implement successful traceability for their desired scope. TE-FOOD enables supply chain-wide collaboration with end-to-end operational visibility and process control. This blockchain startup focuses on food and the supply chain, providing traceability and authentication of food origins. TE-Food works with various farmers and food producers.

BlockApps [24]: BlockApps is a startup offering various blockchain applications. One of them TraceHarvest is the first blockchain solution of its kind to track and trace the full lifecycle of agricultural products starting at the seed source. This application was developed in collaboration with Bayer, leading technology innovator in the agriculture industry. Another application of the company is Strato Mercata is a blockchain solution uniquely equipped to build a productive, efficient, and sustainable network for the agriculture and food industry.

Ripe.io [25]: Ripe.io uses blockchain to build transparency and traceability in agriculture and the food

supply chain by collecting data on the origin and quality of products.

These companies provide a variety of solutions aimed at improving the management and traceability of food in the supply chain, thereby helping to ensure greater product safety and quality, as well as complying with relevant regulations and standards.

3.4 Companies using blockchain food supply chain software

Several major companies in the food industry are already using blockchain applications to improve supply chain management. Among them are:

Walmart: Walmart is one of the pioneers in using blockchain technology to manage its supply chain. They use the IBM Food Trust. The system allows food products to be tracked from the farm to the store shelf, enabling faster and more accurate identification of contaminated products. This not only promotes food safety but also reduces food waste by ensuring that only affected products are recalled and not entire batches.

Carrefour: Carrefour also uses IBM Food Trust to track different types of food in its supply chain. Walmart initially began using the technology to track lettuce and spinach in 2018, but it covers all products. Furthermore, Carrefour became the first retailer to use blockchain technology with its own branded organic products. Using the app, users scan the QR code on a label and access information about a product's life cycle.

Nestlé: Nestlé is working with both IBM Food Trust and VeChain to facilitate the tracking and management of various products, including milk.

Coca-Cola: In 2019, Coca-Cola announced that it would use blockchain technology to improve transparency and sustainability in its supply chain. Its blockchain solution was developed by German software firm SAP.

Unilever: Unilever uses blockchain to secure the following ingredients in some of its products to ensure authenticity and provenance. In addition, SAP and Unilever are working together to increase traceability and transparency in Unilever's global supply chain of palm oil, paper and paperboard, tea, soy, and cocoa.

Conclusions

This article introduces blockchain technology in detail. It also describes the main EU directives related to the safety and quality of food products during their transport and storage. The article also presents the main aspects in which blockchain technology could improve the food supply chain. In conclusion, it can be said that the insufficient development and application of blockchain technology is mainly due to two factors. The first is insufficient knowledge of this technology. This, in turn, prevents the benefits of its application from being realized. Not by chance, one of the main measures that the EU is taking is the increased study of disciplines related to blockchain technology, free seminars and training for businesses. The second factor is related to the financial investment. At this stage, only large companies can afford to invest in blockchain applications.

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