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BLOCKCHAIN TECHNOLOGY IN LOGISTICS

The scientific work considers the role and prospects for the introduction of blockchain technologies in the logistics industry of Belarus. Blockchain, as a decentralized and unchangeable data storage system, can significantly increase the transparency, security and efficiency of supply chains, which is especially important for modern logistics. The paper discusses in detail the types of blockchain networks used in logistics (public, private and consortium blockchains), as well as the pros and cons of their use in the Belarusian economy and political situation. There is a significant potential for blockchain to attract investment and increase the competitiveness of logistics companies. However, limitations are also indicated, such as high initial costs and a shortage of qualified specialists.

Keywords*: blockchain, logistics, supply chains, smart contracts, transparency, immutability of data*

Blockchain is a distributed digital database or transaction ledger where information is stored in sequential blocks. Each block contains data, a hash of the previous block, and a timestamp, making the blockchain resistant to modifications. The main difference between blockchain technologies and traditional data storage systems is decentralization: data is stored not on a single server but across multiple nodes, which are equal participants in the network.

A key characteristic of blockchain is the immutability of data, meaning that changes to already recorded blocks are virtually impossible. This ensures a high level of security and trust in the system, as each transaction is confirmed by the network [1].

Blockchain technology enables previously unknown parties to collaboratively create and maintain a distributed database, ensuring transaction accuracy through consensus among independent verifiers. Originating from the work of Stuart Haber and W. Scott Stornetta in 1991 and gaining prominence with Satoshi Nakamoto's Bitcoin white paper in 2008, blockchain utilizes a system where copies of the database are distributed, allowing parties to make changes under collectively accepted rules.

Key advantages include anonymity, data immutability, and resistance to censorship. Once data is added, it cannot be altered or removed. Each block of transactions is verified through a Proof-of-Work mechanism, ensuring that fraudulent transactions cannot succeed. Public-key cryptography prevents double-spending, allowing for secure, trustless verification among participants without a central authority. This creates a reliable electronic timestamp and accurate record-keeping, fostering trust among parties [2].

This mechanism of work includes the three most important properties of the blockchain: it is decentralized, verified, and immutable, as shown in Fig. 1 [2].

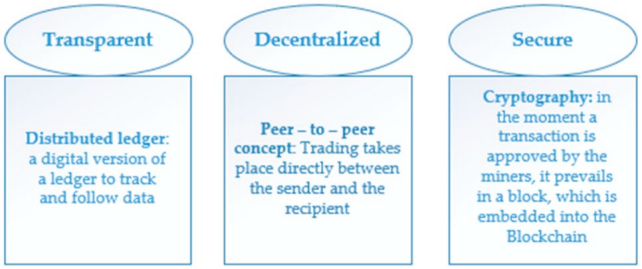

Fig.1. Basic properties of blockchain

The system is decentralized, operated by its members without a central authority. Transactions are shared within a peer-to-peer network, with each member maintaining a local copy of the

ledger. Transactions are verified using public-private key cryptography, ensuring only the owner can initiate them. Members can remain anonymous, as keys aren't linked to real identities. The blockchain's immutability relies on a consensus algorithm; if consensus on a new block is reached, it is added to the chain, linking to previous blocks through cryptographic hashes. Altering a transaction would require changing all subsequent blocks, making the system secure [3].

Logistics is an area where accuracy, transparency, and security are key aspects, and blockchain can significantly improve process efficiency. The application of blockchain technologies in logistics allows for supply chain optimization, better freight management, and ensures data authenticity and integrity.

Key areas of blockchain use in logistics include:

Supply Chain Management: Blockchain enables tracking of goods at each stage, from production to the end consumer. This significantly increases transparency and reduces the risk of counterfeiting.

Improvement of Document Management: Traditional logistics processes involve a large amount of paperwork, which can lead to delays and errors. Blockchain allows for the use of smart contracts that automate many processes, such as payment activation upon fulfillment of certain conditions.

Tracking Transportation and Storage Conditions: Blockchain records transport conditions, such as temperature and humidity, which is particularly relevant for the transportation of perishable goods.

Types of Blockchain Technologies Used in Logistics

Various types of blockchain networks are used in logistics, depending on the goals and participants in the process:

Public Blockchains: Open to everyone, in such networks, anyone can become a participant and add transactions. The most well-known example is the Bitcoin blockchain. In logistics, public blockchains can be used to create open and transparent supply chains that are available for verification by all interested parties.

Private Blockchains: Access to such networks is restricted to a specific group of participants, making them more suitable for large corporations and consortiums. In logistics, private blockchains are used to enhance security and data control.

Consortium Blockchains: This is a hybrid option where the network is managed by a group of companies. Such blockchains are used in logistics to create cooperative supply chains, where several participants (e.g., suppliers, transport companies, and distributors) jointly manage processes [4].

The supply chain consists of organizations involved in producing and delivering products and services to customers. Industry 4.0 enhances supply chain processes through automation and intelligence, improving flexibility, speed, productivity, and sustainability. Logistics 4.0 supports this by optimizing processes and enabling better monitoring through IoT and big data, which facilitate real-time tracking of goods.

Blockchain technology plays a crucial role in supply chain management by securely documenting transactions and providing complete visibility of product movement. It helps reduce delays, errors, and costs while increasing trust among stakeholders. Blockchain's decentralized and immutable nature allows for effective tracking of assets, orders, and documents, while maintaining participant confidentiality.

Overall, integrating blockchain into supply chains can significantly improve transparency, efficiency, and collaboration, ultimately enhancing decision-making and customer confidence [5].

Blockchain can help digitally trace and authenticate food products from an ecosystem of suppliers to store shelves and ultimately to costumers (Fig. 2) [6]. IBM, Walmart and Nestle are aspiring to use blockchain for more transparent, authentic and trustworthy global food supply chain. Several existing applications combine blockchain and food technology, with the primary idea being to solve food safety issues. Their motivations are consistent with the objective of building a safe, sustainable and transparent food supply chain.

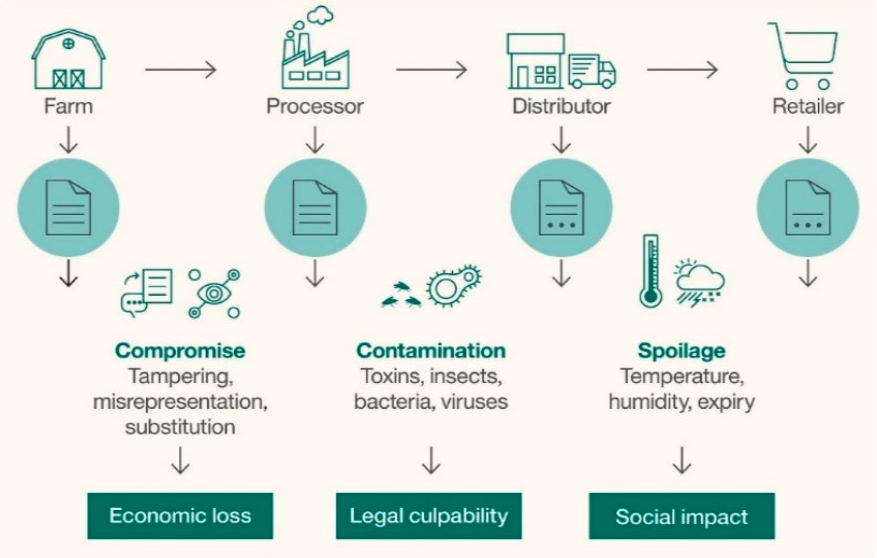

Fig.2. IBM blockchain supply chain

The cloud-based IBM blockchain platform delivers end-to-end capabilities that clients need to quickly activate and successfully develop, operate, govern and secure their own business networks. IBM and Maersk see the adoption of blockchains as one way to achieve this improvement; by providing a single view of all transactions taking place among a complex network of parties, blockchain can help eliminate considerable resource waste. Blockchain can help all parties involved in shipping to increase sustainability, reduce or eliminate fraud and errors, improve inventory management, minimize courier costs, reduce delays caused by paperwork, waste and identify issues faster. This could increase worldwide GDP by almost 5% and total trade volume by 15 % [7].

Development of Blockchain Technologies in Belarus. In Belarus, blockchain technologies are developing due to state support and the growing interest from businesses. In 2018, Decree No. 8 "On the Development of the Digital Economy" was signed, which created a legal framework for the use of blockchain and smart contracts. This gave impetus to the development of blockchain startups and attracted foreign investment to the country's IT sector.

Belarusian logistics is actively integrating into global supply chains, and the introduction of blockchain can become an important factor in increasing the sector's competitiveness. There are initiatives to create platforms for tracking and managing logistics processes using blockchain, which can speed up the processing and transmission of information between participants. However, the implementation of blockchain technologies in Belarusian logistics is still in its early stages. One reason is the lack of business awareness of the technology’s benefits and the significant investment required for its implementation.

Next, we will consider the pros and cons of implementing blockchain technologies in the economic and political conditions of Belarus indicated in Table.

Pros and cons of implementing blockchain technologies in the economic and political conditions of Belarus

Pros	Cons
Increased Transparency and Trust: In conditions of economic uncertainty, transparent supply chains and smart contracts can improve the business environment by minimizing the risk of fraud.	High Initial Costs: Implementing blockchain requires significant financial investments, which may be challenging for small and medium-sized enterprises in an unstable economic environment.
Cost Reduction: Automation of processes using smart contracts can reduce the time required to complete transactions and decrease administrative expenses.	Lack of Qualified Personnel: High-level specialists are required to work with blockchain technologies, but there are still relatively few of them in Belarus.
Attracting Investments: The development of innovative technologies such as blockchain can attract foreign investors and strengthen the country's position in international trade.	Political Instability: The political situation in the country may hinder the implementation of new technologies, as business conditions can change suddenly, creating uncertainty for long-term projects.

Blockchain technology provides a decentralized and transparent platform for secure transactions in various industries, notably logistics. Its features enhance trust through transparency, enabling secure operations and effective tracking of data, goods, and financial resources. Beyond financial services, blockchain is applicable in risk management, the Internet of Things, and public services, helping to address issues like fraud. In logistics, it can reduce delays, costs, and errors by enabling accurate tracking and traceability within supply chains, particularly in the agri-food sector. The IBM blockchain platform supports businesses in developing secure networks. Overall, blockchain can improve logistics by minimizing fraud, cutting costs, and enhancing inventory management, while addressing sustainability challenges. However, successful implementation of this technology in logistics processes requires significant investments, as well as political and economic stability.

The paper concludes by discussing both the potential benefits and obstacles of implementing blockchain in logistics, highlighting its vast potential for further development and research.

References

1. What is a blockchain // Investopedia. – URL: https://www.investopedia.com/terms/b/blockchain.asp (date of access: 17.10.2024).

2. Blockchain technology // MDPI. – URL: https://www.mdpi.com/2071-1050/11/4/1185 (date of access: 17.10.2024).

3. Hackius, N. Blockchain in Logistics and Supply Chain: Trick or Treat? / N. Hackius, M. Petersen. – URL: https://tore.tuhh.de/dspace-cris-server/api/core/bitstreams/be2bb683-abb0-41a4-bc3c-26081e768f63/content (date of access: 17.10.2024).

4. Sadouskaya K. Key areas of blockchain use in logistics and types // K. Sadouskaya. – URL: https://www.theseus.fi/bitstream/handle/10024/126096/Adoption%20of%20Blockchain%20Technology%20in%20Supply%20Chain%20and%20Logistics.pdf?sequence=1 (date of access: 21.10.2024).

5. Hackius, N. Perspective of blockchain technology in logistics / N. Hackius, M. Petersen // Blockchain in Logistics and Supply Chain: Trick or Treat? – URL: https://tore.tuhh.de/dspace-cris-server/api/core/bitstreams/be2bb683-abb0-41a4-bc3c-26081e768f63/content (date of access: 20.10.2024).

6. Blockchain for Supply Chain // IBM (International Business Machines). – URL: https://www.ibm.com/us-en (date of access: 21.10.2024).

7. IBM blockchain platform. – URL: https://www3.weforum.org/docs/WEF_SCT_EnablingTrade_Report_ 2013.pdf (date of access: 21.10.2024).

8. Blockchain in Belarus. – URL: https://www.nbrb.by/bv/pdf/articles/10451.pdf (date of access: 21.10.2024).