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EFFICIENCY OF BLOCKCHAIN PLATFORMS FOR SUPPLY CHAIN MANAGEMENT

Asanova N.
bachelor's degree, Kyrgyz-Russian Slavic University
(Bishkek, Kyrgyzstan)

ЭФФЕКТИВНОСТЬ БЛОКЧЕЙН-ПЛАТФОРМ ДЛЯ УПРАВЛЕНИЯ ЛОГИСТИЧЕСКИМИ ЦЕПОЧКАМИ

Асанова Н.К.
бакалавр, Кыргызско-Российский Славянский университет
(Бишкек, Кыргызстан)

Abstract

The article examines the potential of blockchain platforms for managing and optimizing supply chains. Key benefits of blockchain, such as transparency, reliability, and process automation through smart contracts, are discussed. Successful applications of blockchain by companies like Maersk and Walmart for tracking shipments and ensuring product safety are presented. A Solidity smart contract example demonstrates the automation of logistics operations. The conclusion highlights the significance of blockchain for managing logistics processes, optimizing costs, and securing supply chains.

Keywords: blockchain, logistics, smart contracts, supply chain management, automation.

Аннотация

В статье рассматриваются возможности блокчейн-платформ для управления логистическими цепочками и повышения их эффективности. Описаны основные преимущества блокчейна, включая прозрачность, надежность и автоматизацию процессов с помощью смарт-контрактов. Приведены примеры успешного применения блокчейна компаниями Maersk и Walmart для отслеживания грузов и обеспечения безопасности продуктов. Пример смарт-контракта на языке Solidity иллюстрирует автоматизацию логистических операций. В заключении подчеркивается значимость блокчейна для управления логистическими процессами, оптимизации затрат и обеспечения безопасности цепочек поставок.

Ключевые слова: блокчейн, логистика, смарт-контракты, управление цепочками поставок, автоматизация.

Introduction

The technologies of the Internet of Things (IoT) are increasingly being applied in logistics, providing high levels of transparency and control at every stage from production to the end consumer. With the growing complexity of logistics processes and the involvement of multiple parties such as manufacturers, suppliers, transport companies, and retailers, the need for effective management and monitoring systems has risen. In this context, blockchain technology offers promising opportunities to enhance transparency, reliability, and data security, helping to reduce risks and build trust among participants in the logistics chain.

One of the main advantages of blockchain is its ability to ensure immutability of records, making it a valuable tool for tracking the provenance of goods and preventing counterfeiting.

Blockchain platforms allow real-time recording of data on each stage of the movement of goods, which reduces the risk of errors and simplifies the verification of authenticity. Each transaction in the blockchain is recorded in a distributed ledger, making it accessible to all participants in the logistics chain, thereby increasing transparency and enabling quick detection of violations.

The aim of this article is to explore the effectiveness of blockchain platforms for managing logistics chains. The article will examine the main advantages and challenges of using blockchain in this field, as well as present examples of successful implementations and analyses of results confirming its impact on process optimization and reduction of operational costs.

Main part

Blockchain technology in logistics chain management provides a number of unique opportunities for increasing efficiency and optimizing processes. One of the key aspects is the ability to track the movement of goods in real time. Each participant in the chain can access current information about the location and status of the cargo at any moment, allowing for quicker responses to unforeseen delays or violations of transportation conditions. This is particularly important for perishable goods such as food and pharmaceuticals, where delays can lead to significant losses [1].

The use of smart contracts supported by blockchain platforms presents another advantage for logistics. Smart contracts are self-executing contracts where the terms of the agreement are programmed and automatically executed when certain events occur. In the logistics chain, this can include automatic payment confirmation after the cargo delivery is verified or automatic status updates for the cargo upon passing a specific point in the route [2-4]. Smart contracts reduce the likelihood of errors, simplify interactions between parties, and accelerate transaction execution.

The implementation of blockchain also contributes to lowering operational costs by eliminating intermediaries and automating processes. Traditional logistics management methods often require multiple parties to verify data and use paper documents, increasing costs and processing time. In contrast, blockchain provides a single data repository accessible to all participants, eliminating the need for numerous verifications and duplication of information. This enables companies to reduce administrative process costs and improve efficiency in partner interactions.

Examples of blockchain application in logistics chains

The application of blockchain technology in logistics can be illustrated by companies such as Maersk and Walmart, which actively use blockchain to optimize processes and enhance transparency. In collaboration with IBM, Maersk has implemented the TradeLens blockchain platform, which enables real-time tracking of container shipments and provides a unified information space for all participants in the logistics chain — from manufacturers and suppliers to customs authorities and end customers. TradeLens consolidates transportation data at all stages and allows partners to exchange information promptly, thereby reducing delays and mitigating risks associated with documentation errors [5-7]. Walmart uses blockchain to track the provenance of food products, which is especially important for ensuring food safety and increasing consumer trust. With the blockchain platform developed in collaboration with IBM, Walmart can trace a product's journey from farm to store, allowing for rapid identification of the source of a problem in the event of discovering substandard goods or outbreaks of illness [8, 9]. This significantly reduces the time needed to find a problem and minimizes losses while providing transparency for consumers who want to know the origin and storage conditions of the products. Another example is DHL, which uses blockchain to improve warehouse inventory management and cargo tracking. Blockchain allows for the recording of data on the condition and location of goods, simplifying the inventory process and preventing losses or theft. Blockchain ensures the immutability of records and access to information for all participants in the logistics network, minimizing errors associated with data updates and enabling quick responses to changes [10].

These examples confirm that blockchain can significantly enhance the efficiency of logistics processes, improve transparency, and reduce risks associated with delays, errors, and fraud.

Solidity example code for a smart contract in logistics using Solidity

Smart contracts allow for the automation of processes in logistics chains by executing programmed conditions without the need for third-party involvement. For example, in logistics, a

smart contract can automatically confirm the completion of delivery and transfer payment to the supplier after cargo delivery confirmation [11].

Below is an example of a simple smart contract written in Solidity that models the cargo tracking process and automatic payment transfer upon delivery confirmation.

```
// SPDX-License-Identifier: MIT
pragma solidity ^0.8.0;

contract LogisticsSmartContract {
    address public sender;          // Sender's address
    address public receiver;        // Receiver's address
    address public logisticsCompany; // Logistics company's address
    uint public paymentAmount;      // Payment amount
    bool public isDelivered;        // Delivery status

    // Events for tracking cargo status
    event Shipped();
    event Delivered();
    event PaymentTransferred(address receiver, uint amount);

    constructor(address _receiver, address _logisticsCompany, uint _paymentAmount) {
        sender = msg.sender;
        receiver = _receiver;
        logisticsCompany = _logisticsCompany;
        paymentAmount = _paymentAmount;
        isDelivered = false;
    }

    // Function to ship the cargo
    function ship() public onlySender {
        emit Shipped();
    }

    // Function to confirm delivery by the logistics company
    function confirmDelivery() public onlyLogisticsCompany {
        isDelivered = true;
        emit Delivered();
        transferPayment();
    }

    // Function to transfer payment to the receiver after delivery confirmation
    function transferPayment() internal {
        require(isDelivered, "Delivery not confirmed");
        payable(receiver).transfer(paymentAmount);
        emit PaymentTransferred(receiver, paymentAmount);
    }

    // Restriction for calling function only by the sender
    modifier onlySender() {
        require(msg.sender == sender, "Only sender can call this function");
        _;
    }
```

```
    // Restriction for calling function only by the logistics company
    modifier onlyLogisticsCompany() {
        require(msg.sender == logisticsCompany, "Only logistics company can call this function");
        _;
    }

    // Function to receive funds into the contract balance
    receive() external payable {}
}
```

Conclusion

The application of blockchain technology in logistics chains offers significant advantages such as transparency, reliability, and the potential for process automation. Blockchain allows for the recording of each stage of cargo movement in a distributed ledger, ensuring immutability of records and data accessibility for all participants in the chain. This reduces the risks of loss, errors, and fraud, enhancing the overall efficiency of logistics processes. The use of smart contracts, as illustrated in the example, simplifies interactions between parties by automating operations and minimizing delays associated with data verification and confirmation. Smart contracts ensure the execution of transaction conditions automatically, increasing accuracy and reducing the time spent on administrative procedures. This automation is crucial for speeding up processes and cutting operational costs. Thus, blockchain platforms can significantly transform the approach to managing logistics chains, providing a higher level of transparency, reliability, and efficiency. Successful implementation examples of blockchain, such as the projects by Maersk and Walmart, confirm that distributed ledger technologies can become the foundation for building digital ecosystems where interaction and trust among partners are achieved through automation and data immutability.

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