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Exploring the Application of Blockchain and IoT Technology in Commodity Management

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Abstract: This study provides a detailed analysis of the application of blockchain and Internet of Things (IoT) technologies in various aspects of commodity management, addressing issues such as information asymmetry, data security and privacy challenges, insufficient supply chain transparency, and difficulties in regulation. The study also explores the challenges and strategies associated with the implementation of these technologies. Through this analysis, the article aims to provide theoretical support and practical reference for improving the efficiency and quality of commodity management, thereby promoting the digital transformation of commodity management.

Keywords: Blockchain; Internet of Things (IoT); Commodity management; Pricing; Supply chain

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1. Introduction

In the global economic system, commodities serve as basic raw materials and the efficiency and stability of their management play a crucial role in the development of various industries. From energy to metals and from agricultural products to chemical products, the smooth circulation of commodities affects the cost and efficiency of the entire industrial chain. However, with the increasing complexity of the market and the deepening of globalization, traditional commodity management models are facing many severe challenges. In recent years, the rapid development of blockchain and Internet of Things (IoT) technologies has provided new ideas and methods for solving these problems. Blockchain technology, with its decentralized, tamper-proof, and traceable characteristics, is expected to reshape the trust foundation of commodity management, while IoT technology, with its powerful data collection and transmission capabilities, can realize real-time monitoring and management of the entire lifecycle of commodities. Conducting in-depth research on the application of these two technologies in commodity management has important practical significance for enhancing industry competitiveness, optimizing resource allocation, and ensuring market stability.

2. Application of blockchain in commodity pricing

2.1. Achieving transparent pricing

The distributed ledger characteristic of blockchain technology provides strong support for transparent pricing of bulk commodities. The distributed ledger is maintained by multiple nodes, and all transaction data is publicly transparent and tamper-proof. In commodity trading, information such as the price, quantity, and transaction time of each transaction will be recorded on the distributed ledger, which can be viewed and verified by market participants. This allows the price formation process to be based on real and accurate transaction data, avoiding price distortions caused by information asymmetry or market manipulation. Participants can make price analysis and decisions based on these public data, improving the transparency and fairness of pricing, and making prices more reflective of the true value of commodities [1].

2.2. Automation of pricing mechanisms

The smart contract function of blockchain can automate the pricing mechanism of bulk commodities. A smart contract is an automatically executed contract that exists in the form of code on the blockchain, with its terms and conditions preset. In the commodity trading scenario, smart contracts can automatically perform pricing operations based on preset quality standards, quantity requirements, delivery time, and other conditions. When the transaction conditions are met, the smart contract automatically performs price calculations and transaction settlements according to the agreed price formula, without manual intervention. This not only improves pricing efficiency, reduces human errors and price disputes, but also enhances the accuracy and reliability of the pricing process [2].

2.3. Decentralized data sharing and supply chain traceability

The decentralized nature of blockchain breaks the traditional information islands and enables data sharing across various links in the commodity supply chain. In the blockchain network, there is no centralized control node, and all participants can equally record and access data. Data generated in each link, such as production data, transportation records, and warehousing information, will be encrypted and stored on the blockchain, and the consistency and accuracy of the data will be ensured through a consensus mechanism. At the same time, the traceability of the blockchain allows the entire process information of bulk commodities from the source of production to the sales terminal to be clearly recorded and queried. Through blockchain browsers or related applications, regulatory agencies, enterprises, and consumers can obtain detailed information about commodities, achieving transparent management of the supply chain [3].

2.4. Advantages in derivative pricing and cross-border payments

In terms of commodity derivative pricing, blockchain technology can provide more accurate and real-time data support. Derivative prices are closely related to underlying commodity prices. The underlying commodity transaction data, inventory information, and market supply and demand data recorded on the blockchain can reflect market dynamics in real-time, providing precise input parameters for the derivative pricing model. This helps to build a more reasonable derivative pricing model, improve the accuracy and rationality of pricing, and reduce market risks. In the field of cross-border payments, blockchain technology can solve the problems of tedious procedures, high costs, and long settlement cycles in traditional cross-border payments. The distributed ledger and encryption technology of the blockchain enable cross-border payments to be made directly between the two parties to the transaction, without relying on multiple intermediate financial institutions. The transaction parties transmit value through the blockchain platform, and smart contracts automatically execute payment terms, ensuring

payment security and accuracy. This significantly reduces the payment process and settlement time, lowers cross-border payment costs, and improves capital efficiency [4].

3. Application of Internet of Things technology in commodity management

3.1. Device identity authentication and data security

The application of Internet of Things (IoT) technology in the field of commodity management is particularly prominent in its device identity authentication mechanism and data security guarantees. This mechanism ensures the integrity and credibility of data in a complex supply chain environment. Under the extensive connectivity of the IoT, each device connected to the network is assigned a unique digital identity, which serves as their "network ID card". This identity not only ensures the traceability of the device but also lays a solid foundation for subsequent data interaction [5].

Before data interaction, the IoT platform utilizes advanced encryption technology to authenticate devices. This process ensures that only authorized devices can access the network and upload data. This strict identity authentication mechanism acts as a solid line of defense, effectively blocking access from unauthorized devices, thus preventing data tampering and forgery. The implementation of this mechanism greatly enhances the reliability of data sources, providing a strong guarantee for the accuracy of data in commodity management [6].

IoT technology also employs various data encryption techniques to ensure secure data transmission and storage. During data transmission, whether through wired or wireless means, the IoT uses symmetric or asymmetric encryption algorithms to encrypt the data. This encryption method ensures that even if the data is intercepted during transmission, it cannot be easily decrypted, thus maintaining data confidentiality. In terms of data storage, the IoT platform encrypts data stored in the cloud or locally. Only authorized entities with the corresponding decryption key can access and read this data, further enhancing data security.

3.2. Data sharing and exchange mechanisms

IoT technology has established efficient data sharing and exchange mechanisms, enabling real-time data circulation across various stages of commodity management. Serving as a data aggregation and management center, the IoT platform connects IoT devices throughout the supply chain. These devices collect various types of data such as temperature, humidity, location, and status in real-time, uploading it to the IoT platform. Through standardized data interfaces and protocols, the platform integrates and processes data from different formats and sources, subsequently sharing it with authorized participants. For instance, manufacturing enterprises can share production data with transportation and warehousing companies, while transportation enterprises can share cargo location and status data with sales companies and regulatory bodies. This data-sharing mechanism breaks down information barriers, enhances collaboration efficiency across supply chain stages, and enables participants to make decisions based on real-time, accurate data.

3.3. Application of smart contracts in automated operations

The integration of IoT and blockchain allows smart contracts to play a crucial role in automating commodity management operations. Smart contracts can automatically trigger corresponding actions based on data collected by IoT devices. In warehouse management, IoT devices continuously monitor environmental parameters such as temperature, humidity, and air quality within the warehouse. When monitored data exceeds preset ranges, smart contracts automatically activate ventilation systems, air conditioning units, or dehumidifiers to adjust

the warehouse environment, ensuring safe storage of goods. In the supply chain logistics stage, when IoT devices detect that goods have reached their designated location and passed quality inspection, smart contracts automatically execute payment operations, completing the delivery process. This automation reduces manual intervention, improves management efficiency, lowers operational risks, and enhances the intelligence and automation level of the supply chain [7].

4. Technical application challenges and coping strategies

4.1. Challenges of Technology Integration

The significant differences in the technical architectures of blockchain and the Internet of Things (IoT) pose numerous challenges for their integration. Blockchain operates based on a distributed ledger and consensus mechanism, emphasizing data consistency and immutability. Conversely, the IoT focuses on device perception and data transmission, requiring real-time capabilities and the ability to handle large amounts of data. Regarding data format, blockchain data structures are typically organized in blocks with specific encryption and storage methods. However, the IoT collects data in various formats, lacking a unified standard, making direct data interaction between the two technologies difficult.

In terms of communication protocols, there are compatibility issues between the peer-to-peer (P2P) communication protocol commonly used in blockchain and the various IoT communication protocols such as Wi-Fi and Bluetooth. This creates obstacles for communication between devices and blockchain nodes. Additionally, blockchain data processing speeds are relatively slow. For instance, the Bitcoin blockchain has a limited number of transactions it can process per second, whereas the IoT needs to handle large amounts of real-time data generated by numerous devices. This makes it challenging to synchronize data transmission and processing efficiency between the two technologies. To address these challenges, the industry needs to establish unified technical standards, regulating data formats and communication protocols for blockchain and the IoT to facilitate interconnection and interoperability. Simultaneously, the development of compatible middleware can serve as a bridge between the two, enabling effective data conversion and transmission, enhancing the feasibility of technology integration.

4.2. Security and privacy risks

With the application of blockchain and IoT technologies in commodity management, security and privacy risks are increasingly prominent. While blockchain smart contracts offer the advantage of automated execution, they also carry the risk of vulnerabilities. Once the code of a smart contract is written, it is difficult to modify. If there are vulnerabilities and they are exploited by hackers, it could lead to severe consequences such as tampered transaction data or stolen funds. IoT devices also face security risks due to their limited computing and storage capabilities, making it difficult to implement complex security protection mechanisms. These devices can be easily hijacked, resulting in data theft.

Regarding data privacy protection, as the scope of data sharing expands, protecting the privacy of businesses and users while ensuring data circulation has become a significant challenge. To address these issues, it is essential to strengthen security audits, regularly detect and fix vulnerabilities in blockchain smart contracts, and enhance the security of smart contracts. For IoT devices, multiple encryption techniques and access control mechanisms, such as device identity authentication and encrypted data transmission, should be employed to prevent device

attacks and data leaks. In terms of data privacy protection, technologies like homomorphic encryption and zero-knowledge proofs can enable data computation and sharing in an encrypted state, ensuring that data privacy is not compromised. Simultaneously, establishing and improving relevant laws and regulations to clarify the boundaries of data usage and privacy protection is crucial to provide legal safeguards for technology application.

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state, ensuring that data privacy is not compromised. At the same time, establishing and refining relevant laws and regulations to define the boundaries of data usage and privacy protection is essential for ensuring legal safeguards in technology applications.

5.3. Cost-benefit balance

The initial application of blockchain and IoT technologies requires significant capital investment. In terms of equipment procurement, IoT devices have high acquisition costs and need to be continuously updated to meet technological advancements and business needs. Meanwhile, setting up and maintaining blockchain nodes also demands certain hardware and software investments. For system development, considerable manpower and time are required for the development and integration of blockchain and IoT systems to achieve their collaborative work. Regarding technical training, to enable employees to skillfully use the new technologies, enterprises need to organize professional training, which also increases costs. However, in the short term, the benefits brought by technology application may not be apparent and enterprises may face an imbalance between costs and benefits. For instance, the running-in period of the new system may temporarily reduce business efficiency and it takes time for the cost reduction and efficiency improvement brought by technology application to become evident. To achieve a cost-benefit balance, enterprises should conduct a comprehensive cost-benefit analysis, reasonably select technology application solutions based on their actual needs and business scale, optimize technology selection, and reduce unnecessary cost inputs. Simultaneously, they should develop a long-term technology application plan, evaluate the benefits of technology application from a long-term perspective, such as cost reduction, efficiency improvement, and enhanced market competitiveness, to achieve a balance between costs and benefits. Additionally, enterprises can reduce costs and increase efficiency by sharing technical resources and jointly developing applications with partners.

5.4. Talent shortage and skill improvement

Currently, there is a shortage of professionals in blockchain and IoT, and the skills of existing staff within enterprises are difficult to meet the needs of technology application. Blockchain technology involves knowledge in multiple fields, such as cryptography, distributed systems, and consensus algorithms, while IoT technology covers various aspects, such as sensor technology, communication technology, and data analysis. Compound talents who understand both blockchain and IoT technologies and are familiar with the commodity management business are even more scarce. This talent shortage restricts the promotion and application of technology. Therefore, it is necessary to strengthen school-enterprise cooperation, and universities and vocational colleges should offer relevant majors and courses to cultivate blockchain and IoT technical talents. Enterprises should carry out on-the-job training to improve the technical level and business capabilities of existing employees, encourage employees to learn new technologies and master new skills to adapt to the business changes brought by technology application [9]. Meanwhile, enterprises can introduce external professional talents to enrich the technical team and improve the enterprise's technological innovation ability and application level. In addition, industry associations can organize professional training and technical exchange activities to promote talent cultivation and technology dissemination [10].

6. Conclusion

Blockchain and IoT technologies have brought innovative solutions to commodity management, effectively

addressing many challenges faced in current commodity management. In the future, with the continuous development and improvement of technology, blockchain and IoT technologies are expected to play a greater role in the field of commodity management, pushing the commodity market towards a more efficient, transparent, and safe direction. Enterprises and regulatory agencies should actively keep pace with technological advancements, increasing investment in research, development, and the application of new technologies to strengthen their competitiveness and regulatory capabilities in the global commodity market. Simultaneously, the academic community also needs to further study the application effects and optimization strategies of these two technologies in commodity management to provide stronger theoretical support for practice.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Tan Z, Zhao W, 2017, Application and Development of Blockchain Technology in China's Commodity Trading Market. Business Observation, 2017(5): 48–51.

[2] Liu Z, Zhang G, 2021, "Blockchain + Internet of Things" Boosts Food Supply Chain Traceability. Agricultural Engineering, 11(02): 51–55.

[3] Zou D, Jia Q, 2020, Review of the Application Progress of Blockchain in the Field of Commodity Trading. Business Economics Research, 2020(10): 154–157.

[4] Du H, Wu J, Li C, 2021, Optimization of Commodity Listing Transaction Mode Based on Consortium Blockchain. Innovation and Technology, 21(3): 69–77.

[5] Zhang L, Wu X, Li S, et al., 2023, Application of Blockchain + Internet of Things Technology in the Traceability of Agricultural Products in Western Hunan. Economic Research Guide, 2023(10): 42–44.

[6] Fan Y, Wu S, Gao X, 2023, Integration of Information Technology and Commodity Lifecycle Inspection. Quality and Certification, 2023(11): 57–59.

[7] Jiang Y, Yao X, Li B, 2020, Application of Internet of Things and Blockchain Technology in Improving Supply Chain Financial Risk Management. Business Exhibition Economy, 2020(6): 51–54.

[8] Fu Y, Kuang Z, 2023, Application of Blockchain Technology in China's Customs Supervision: Practical Problems and Implementation Paths. Customs and Economic and Trade Research, 44(2): 30–42.

[9] Zhu H, Chen L, 2019, Research on Commodity Spot Warehouse Receipt Financing and Trading Based on Blockchain Technology. Network Space Security, 10(11): 26–31 + 47.

[10] Zhu H, 2020, Research on the Digital Transformation of Commodity Trading Based on the Free Trade Zone Strategy. Future and Development, 44(05): 92–98 + 91.

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