

# Information Management System of Medical Material Supply Based on Blockchain Application

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**Abstract.** This study proposes to take the blockchain as a typical example of the new generation of information technology, explore the application of blockchain to improve the information management system of medical material supply, provide stronger support for major pandemics that may occur in the future, and provide a good environmental guarantee for social stability and sustainable economic development. At present, blockchain is considered to be a widely used cutting-edge technology. This paper first explains the concept and main technical characteristics of blockchain, and analyses the coupling relationship between the demand of major pandemic prevention & control for medical material supply and the advantages of blockchain technology. And then explores the improvement of information management system of medical material supply based on blockchain application under major pandemic. Finally, it formulates a series of operational measures of medical material supply system including blockchain application, so as to effectively improve the level of emergency logistics and provide stronger support for effectively coping with major pandemics.

**Keywords:** information management system; medical material; supply; blockchain application

## 1. Introduction

Responding to public health emergencies is a complex project. Among them, the guarantee and supply of emergency relief materials is a major issue related to people's life safety and social stability [1]. The supply of medical materials can provide a strong guarantee for the prevention & control of major pandemics. The outbreak of COVID-19 pneumonia in 2019 was a major pandemic. However, the operation in the pandemic prevention & control shows that the supply efficiency and information management of pandemic prevention medical materials need to be improved. At the same time, logistics and supply chain are the key application directions of blockchain technology and are ushering in new development opportunities [2]. Therefore, this study proposes to apply the blockchain design concept and advanced technology to improve the information

management system of medical material supply under major pandemic.

## 2. Literature Review

WANG Xu-hui and WANG Jia-hao (2020) studied the supply chain game under pandemic events, enriched the theory of supply chain optimization management, verified the stability of blockchain technology on the decision-making optimization of supply chain, and provided inspiration for the active self-rescue of the core enterprises in the supply chain under public health emergencies [3]. ZHU Ye (2020) proposed countermeasures to improve the transportation support capacity of emergency materials under the major emergency situation. The methods of constructing emergency logistics network based on existing resources were studied from the aspects of emergency logistics network structure, node setting, operation mechanism and cooperative operation [4]. XIANG Feng, DIND Gui-hua and JIAO Yue (2020) give suggestions on the construction of emergency supply chain system in China from the aspects of management system construction, plan system construction, production reserve system construction, emergency logistics system construction and information system construction [5]. ZHAO Jian-you, HAN Wan-li, ZHENG Wen-jie, and ZHAO Yang (2020) regard the demand urgency as the influencing factors of distribution, put forward the evaluation index system of the demand urgency of medical materials demand point, build the double objectives of priority distribution of demand points with the minimum total distribution cost and high demand urgency, and optimize the distribution path of medical materials, The analytic hierarchy process and genetic algorithm are used to solve the optimization model of emergency logistics distribution path of medical materials considering and not considering the urgency of demand [6]. M. Reilly (2011) proposed a rapid assessment plan for the demand of pandemic prevention materials under pandemic, and determined the logistics strategy for the type and quantity supply of medical materials [7]. In conclusion, the above research results have important value, but there are still deficiencies. There are few existing results on how to apply blockchain to improve the medical material supply under major pandemic and few studies on how to apply blockchain

technology to improve the information management system of medical material supply. Few literatures put forward specific operation measures for the medical material supply system under major pandemic.

### **3. Blockchain Concept and Main Technical Characteristics**

Blockchain technology originated from a founding paper "Bitcoin: A Peer-to-Peer E-Cash System" published by the scholar "Satoshi Nakamoto" in the cryptography mailing group in 2008 [8], but a recognized blockchain definition has not yet been formed. Blockchain technology is a new data management technology. The blockchain is composed of multiple interconnected blocks jointly held by multiple parties to form a distributed database, which can be used as a distributed ledger in transactions. Since this ledger is jointly maintained by many parties, the data in the blockchain cannot be tampered with. Any party holding the ledger cannot fully control the data in the blockchain, and the data will be updated in real time according to the transaction rules.

The traditional centralized transaction model has some disadvantages, such as high trust requirements, poor reliability, high risk, high cost and low efficiency. Due to the technical characteristics of blockchain, the transaction mode based on blockchain can avoid the shortcomings of the above traditional modes. The outstanding advantage of blockchain is that it can be decentralized, which is one of the essential characteristics of blockchain technology.

Without a central processing node, blockchain technology realizes the distributed recording and storage of all data, ensuring the authenticity of data records. There is no trust basis between nodes using blockchain for transactions. Blockchain technology realizes point-to-point transactions without trust basis by using encryption algorithm, timestamp, tree structure, consensus mechanism and reward mechanism [9], and reduces the trust cost. The information in the blockchain ledger cannot be tampered with. The data of the blockchain can only be recorded after being reviewed by most nodes of the whole network [10].

### **4. Coupling Mechanism of Blockchain and Emergency Logistics under Major Pandemic**

In a broader sense, blockchain is not only a technology, but also a new design concept, a new application mode and a new organizational form. The main technologies of blockchain mainly include distributed ledger / P2P network, consensus mechanism, asymmetric encryption / digital signature, hash operation, time stamp, intelligent contract, etc. It has the characteristics and advantages of decentralization, transparent and reliable information, anti-counterfeiting and tampering, permanent record traceability, high reliability of the system, automatic performance, etc.

The core requirements for the supply of emergency medical materials in major pandemic situations are fast and efficient, supply and demand matching, traceability, information transparency, real-time response, etc.

According to the characteristics of blockchain and making full use of the technical advantages of blockchain, in order to ensure the efficient operation of supply information management system, promote emergency medical material donation and promote the intelligent development of material supply, we can explore the construction of information management system of medical material supply based on blockchain application, so as to provide strong support for effective response to major pandemic situations, Ensure the rational allocation and efficient utilization of emergency medical materials.

For example, at the application operation level, explore how to apply blockchain to promote material supply and assist in emergency medical material donation. Firstly, analyze the core technologies of the blockchain, such as distributed ledger, consensus mechanism, asymmetric encryption, timestamp, etc., give full play to the technical advantages, such as decentralization, transparent and reliable information, anti-counterfeiting and tampering, traceability of permanent records, high reliability of the system, combined with the demand for emergency medical material supply for major pandemic prevention & control, such as accurate material matching, traceability Information transparency, etc., put forward the application mode of applying blockchain to promote the donation of emergency medical materials, so as to achieve a high matching between the supply and demand of material donors and recipients, transparent and open material donation information and true material destination information.

### **5. Operation Measures of Medical Material Supply System Including Blockchain Application**

So far, one of the core revelations of COVID-19 pandemic prevention & control - real-time and transparent medical material supply information is a valuable resource in the process of dealing with the pandemic. From a macro perspective, the transparency of cross-border supply chain information of medical materials is an important basis for scientific decision-making of relevant government departments. From a micro perspective, the transparency of medical material procurement information provides a strong support for real-time tracking of transportation process, timely discovery and removal of logistics bottlenecks. However, due to the centralized structure of the supply chain and its information system, the core organizations controlling data often do not have sufficient willingness to share data to the greatest extent. At the same time, due to the need to enhance data standardization and operational interaction, realizing real-time transparency of information is still facing challenges objectively. Therefore, it is necessary to establish a more secure supply information management system to realize data sharing platform and real-time and transparent information.

Although there is no platform or system that can meet the information transparency needs of all pandemic prevention & control actions at this stage, the research and practice projects to improve the information

transparency of the supply chain and promote logistics data sharing have made important progress in the field of medical material supply. Here, this study applies blockchain to build information management system of medical material supply for major pandemic. When selecting strategic partners in the fields of medical materials and emergency logistics services, relevant government departments should put forward clear requirements for the application ability of blockchain and its information technology level, and take the realization of real-time transparency of medical material supply information as a clear common goal, so as to provide important support for improving the medical material supply system and making scientific decisions in response to the pandemic. As a blueprint and vision, the information management system based on blockchain application runs through all public and company cooperation processes in the fields related to medical material supply. The system makes use of the technical characteristics of blockchain, such as distributed ledger, consensus mechanism, asymmetric encryption, hash operation, timestamp and so on, so as to give full play to their decentralization, information transparency and credibility, anti-counterfeiting and anti-tampering. With the technical advantages of permanent record traceability and high reliability of the system, the information management system of medical material supply is built based on the blockchain application to meet the relevant needs of accurate traceability and supply-demand fit of medical materials in response to major pandemic, so as to achieve a high fit between material supply and pandemic prevention needs, transparent and open material circulation information. Ensure the authenticity of material destination information and other main objectives.

Taking the application field of medical material quality control as an example, since the outbreak of COVID-19 pandemic, the demand for anti-pandemic medical materials has increased rapidly, and the demand for high-end materials has also increased significantly, thus putting forward high requirements for the quality of supply materials. Since the blockchain is a decentralized database, using the blockchain distributed ledger technology, when the data of medical materials are registered in the blockchain, it is difficult to tamper or delete. All information, including forced deletion, will be permanently recorded in the blockchain distributed ledger. Therefore, blockchain technology can be applied to strictly control the quality of medical materials, and track, trace and hold accountable the products with quality problems.

The structure of information management system of medical material supply based on blockchain application includes information collection layer, management data layer, intelligent contract layer and business operation layer. The information collection layer adopts RFID, GPS, bar code, sensor and other technologies and equipment to collect medical material information through production

and quality inspection, purchase and sales, logistics distribution and other links. Based on the collected information, the management data layer mines the product quantity, purchase and sales transaction data, asset data and logistics distribution data according to the management needs, and then permanently records and stores them in the blockchain database. The smart contract layer encapsulates various script codes and algorithms, generates smart contracts in the blockchain system, and then provides them to all participating enterprises in the medical material supply chain (including suppliers, manufacturers, logistics enterprises, hospitals, health institutions, retail stores, etc.) in the business operation layer. All enterprises can enter and query relevant data in the system. All participating enterprises in the whole chain record data and information in the same system to clarify their respective responsibilities, which provides a strong guarantee for effective tracking of unqualified medical materials and traceability. Obviously, the technical characteristics and advantages of blockchain can enable the medical material supply chain to realize information transparency and data authenticity, break the information barrier between participating enterprises in the supply chain, and help reduce the comprehensive cost and risk of medical material supply.

## 6. Operational Measures of Medical Material Supply System Including Blockchain Application

It is very important to formulate the operational measures of emergency medical material supply system. In the event of a major pandemic in the future, the emergency medical material supply system can quickly change from the previous "passive mode" to the new "active mode" when a pandemic event occurs. In addition to the command and dispatching center, other committees can also be established to effectively manage emergency response and pandemic prevention & control. First, the functions, composition, responsibilities, decision-making and reporting mechanism of the command and dispatching center or committee should be scientifically formulated in advance. On this basis, in order to ensure the effective operation of the medical material supply system under major pandemic events in the future, it is necessary to formulate the comparison table of operational measures of the medical material supply system, which is based on the six pillars of the command center, major pandemic emergency plan, strategic partnership, infrastructure and logistics system, and supply information management system based on blockchain, determine the key tasks of each pillar and formulate the main specific measures of each task, so as to promote the actual operation of the medical material supply system. The operational measures of medical material supply system under major pandemic are shown in Table 1.

**Table 1.** Operational measures of emergency medical material supply system including blockchain application

Six Pillars	Key Tasks	Major Measures
Command Center and Organizational Structure	Set up command center	Establish an authoritative, flexible and reliable command center
	Establish organizational structure	Scientific construction of organizational structure of medical material supply system
Emergency plan for major pandemic	Requirement identification	Determine the key material demand category and establish demand monitoring and forecasting model
	Source seeking	Predetermine the list of medical supplies and logistics service providers
	Purchasing	Establish medical material safety stock to ensure purchase in advance at pre agreed price
	Logistics	Strictly select logistics service providers meeting the requirements of comprehensive qualification in advance
	Allocation	Establish medical material supply cooperation model and distribution principle
Strategic partnership	Public-Private strategic partnership	Reach a tripartite agreement between medical material manufacturers, logistics service providers and the government in advance
	Public-Public strategic partnership	Establish a network of transnational intergovernmental strategic partners, formulate cooperation models and implement policies
Safety stock and capacity of production	Safety stock reserve	Construct three-tier reserve and continuous inventory management system of medical material safety stock
	Production capacity guarantee	Improve domestic and local medical material production capacity and cross industry production capacity
Infrastructure and logistics system	Improve logistics infrastructure	In view of the multiple needs of various pandemic prevention & control scenarios for the logistics system, strengthen the construction of logistics infrastructure
	Improve the operation efficiency of logistics system	Select logistics strategic partners, formulate emergency logistics strategy and logistics operation mode, and prepare sufficient transportation resources and capacity
Supply information management system based on blockchain	Data sharing	Establish information management system of medical material supply based on blockchain
	Data collection	Timely and accurately collect medical material data based on blockchain application

## 7. Conclusion

The supply of medical materials has provided more and more important support for major pandemic prevention & control. Under major pandemic situations, there is a close coupling relationship between emergency medical material supply and blockchain technology. In view of the main problems in material supply in pandemic prevention & control, blockchain technology can be applied to improve the information management system of medical material supply under major pandemic situations. Firstly, the application of blockchain can ensure the efficient operation of the supply information management system, so as to realize the efficient coordination of medical material supply, the efficient matching of material supply and demand and the accurate tracing of materials. Secondly, the application of blockchain to build an information management system of medical material supply can promote the donation of medical materials, fully meet the needs of material donors and recipients, realize the transparency and openness of material donation information, and ensure the authenticity of material destination information. In addition, the system can promote the intelligent development of medical material supply.

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## References

- [1] Xu, Q.; Ma, Z.J.; Li, H.J. Location-Routing Problem in Emergency Logistics for Public Emergencies. *Journal of Huazhong University of Science and Technology (Social Science Edition)*. 2008; Volume 6, pp. 36-40.
- [2] He, L.M. Promoting the High Quality Development of Logistics Supply Chain with Blockchain Innovation. *China Logistics & Purchasing*. 2019; Volume 22, pp. 8-10.
- [3] Wang, X.H.; Wang, J.H. Optimization of Supply Chain Decision Making Driven by Blockchain Technology within the Public Health Emergencies. *Logistics Research*. 2020; Volume 1, pp. 42-59.
- [4] Zhu, Y. Strategies of Emergency Material Transportation under Public Health Emergencies. *Urban Transport of China*. 2020; Volume 18, no. 5, pp. 102-109.
- [5] Xiang, F.; Ding, G.H.; Jiao, Y. Construction of Emergency Supply Chain System for Public Health Emergencies in China: Taking the New Coronavirus Pneumonia Pandemic as an Example. *Business Economic Review*. 2020; Volume 21, no. 3, pp. 51-63.
- [6] Zhao, J.Y.; Han, W.L.; Zheng, W.J.; Zhao, Y. Distribution of Emergency Medical Supplies in Cities under Major Public

- Health Emergency. *Journal of Traffic and Transportation Engineering*. 2020; Volume 20, no. 03, pp. 168-177.
- [7] Reilly, M. Disaster Assessment and Gathering Medical Intelligence Following a Major Public Health or Complex Humanitarian Emergency. *Prehospital and Disaster Medicine*. 2011; Volume 26, no. 1, pp. 81-88.
- [8] Nakamoto, S. Bitcoin: a peer-to-peer electronic cash system [Online] available: <https://bitcoin.org/bitcoin.pdf>, 2009.
- [9] Shen, X.; Pei, Q.Q.; Liu, X.F. Survey of Blockchain. *Chinese Journal of Network and Information Security*. 2016; Volume 2, no. 11, pp. 11-20.
- [10] Li, D.; Wei, J.W. Theory, Application Fields and Challenge of the Blockchain Technology. *Telecommunications Science*. 2016; Volume 32, no. 12, pp. 20-25.