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The Application of Blockchain in the Construction of Emergency Logistics System under Major Pandemic

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Abstract: Emergency logistics plays an increasingly important role in major pandemic prevention and control, and blockchain is considered to be a widely used cutting-edge technology. Exploring how to apply the advanced technology of blockchain to improve emergency logistics has important theoretical significance and practical value. The analysis of research status shows that there are few literatures on the application of blockchain in emergency logistics under major pandemic. This paper first analyzes the coupling relationship between the demand of pandemic prevention and control for emergency logistics and the advantages of blockchain technology, then explores the application of blockchain technology in the construction of emergency logistics system under pandemic from three dimensions of efficient operation, donation assistance and intelligent development, and finally puts forward three typical application modes and formulates a series of relevant measures, so as to effectively improve the level of emergency logistics and provide stronger support for effectively coping with pandemic.

1. Introduction

Coping with public health emergencies is a complex project, in which the guarantee and supply of emergency relief materials is a major issue related to people's life safety and social stability [1], which requires emergency logistics to provide strong support for public health emergencies. COVID-19 was a major pandemic. However, the operation of the emergency management system in the pandemic prevention and control shows that the operation efficiency and service level of emergency logistics need to be improved. At the same time, the field of logistics and supply chain is the key application direction of blockchain technology, and is ushering in new development opportunities [2]. Therefore, this study proposes the application of blockchain design concept and advanced technology to build and improve the emergency logistics system.

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 Guihua 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 analysis of the current situation of the research shows that few literatures have been used to study the application of blockchain in the field of emergency logistics in the case of pandemic.

3. Coupling Mechanism of Blockchain and Emergency Logistics under Major Pandemic

In a narrow sense, blockchain is a kind of data structure that combines data blocks in chronological order in a sequential way, and it can not be tampered with and forged by cryptography. In a broad sense, blockchain technology is a new distributed infrastructure and computing paradigm that uses blockchain data structure to verify and store data, uses distributed node consensus algorithm to generate and update data, uses cryptography to ensure the security of data transmission and access, and uses intelligent contracts composed of automated script code to program and operate data. [8] 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.

Emergency logistics refers to the special logistics activities aimed at providing emergency materials for unexpected natural disasters, public health emergencies and other emergencies, and aiming at maximizing time efficiency and minimizing disaster losses.[9] Emergency logistics has the characteristics of sudden or abnormal logistics, randomness of logistics demand, afterwards selectivity of logistics demand, imbalance of flow, urgency of logistics time constraint and social public welfare of emergency logistics.[10] The main needs of emergency logistics to deal with public health emergencies are fast and efficient, supply and demand matching, accurate traceability, information transparency, real-time response and so on. Based on the characteristics of blockchain, we should make full use of various technical advantages to build a typical application mode of blockchain in the fields of ensuring the efficient operation of emergency logistics, promoting the

donation of emergency logistics, and promoting the intelligent development of emergency logistics, so as to provide stronger support for the effective response to public health emergencies and ensure the rational allocation and efficient utilization of emergency materials. Taking the field of “applying blockchain to promote emergency logistics and assist donation”as an example, this paper analyzes the technical characteristics of blockchain, such as distributed ledger, consensus mechanism, asymmetric encryption, hash operation, time stamp, etc., so as to give full play to their technical advantages, such as decentralization, transparent and reliable information, anti-counterfeiting and anti tampering, permanent record traceability, high reliability of system, etc. Combined with the needs of emergency logistics in response to public health emergencies, such as accurate traceability of donated materials and matching of donation and recipient, the application mode of applying blockchain to promote emergency logistics to assist donation is proposed, so as to achieve the main goals of highly matching of material donation and recipient needs, transparency and openness of material donation information, and authenticity of material destination information.

4. The Application of Blockchain in the Construction of Emergency Logistics System under Major pandemic

4.1. Application of Blockchain to Ensure Efficient Operation of Emergency Logistics

Explore the application of blockchain design concept and advanced technology, improve the emergency logistics under major pandemic, realize the efficient coordination of logistics operations, efficiently match the supply and demand of materials, realize the accurate traceability of emergency materials, make the materials needed at the critical moment available, and realize the efficient saving of emergency logistics and orderly and powerful material support.

4.1.1. Realize the Efficient Cooperation of Logistics Operations

Efficient and fast is the key index of emergency logistics. With the application of blockchain and the integration of related technologies, a thorough logistics plan is formulated, and the emergency logistics means, standardized logistics operations and stable logistics services are taken as the basic support to improve the operation efficiency of medical material logistics. Around the above goals, we mainly take the following specific measures. (1) Around the officially recognized logistics (transshipment) center around the pandemic area, we build an emergency logistics socialized operation platform, and use the blockchain information system to provide strong support for the operation platform. (2) Adopt "blockchain + big data" technology to mine and analyze information, organically integrate "trunk, branch and terminal" logistics (trunk logistics of materials transported to pandemic areas, branch transportation between pandemic areas and terminal distribution within pandemic areas), carry out collaborative operation, and adopt "blockchain + artificial intelligence" technology to automatically complete transportation route planning and route optimization. (3) Using the blockchain distributed ledger technology to coordinate the allocation of materials, personnel, stations, vehicles and other resources, facilities and equipment, realize the efficient cooperation of logistics operations, and accelerate the intelligent and information operation of emergency logistics in pandemic areas. (4) At present, Shunfeng, Jingdong, Cainiao and some high-quality logistics platform enterprises have the operation conditions of the above-mentioned emergency logistics mode to varying degrees. They can consider to take over the logistics system as soon as possible through directional negotiation and authorize enterprises to take the lead, so as to realize the efficient operation of emergency logistics.

4.1.2. Efficient matching of material supply and demand

Traditional emergency logistics highly relies on the centralized command system, which not only has complicated information transmission level, but also has low risk resistance to operation failure or communication interruption. The decentralized distributed structure of blockchain can enable the parties involved in emergency logistics to realize point-to-point communication, instead of having to communicate information through a specific central organization, eliminating the complicated information transmission levels. This new decentralized organization has few obstacles and little friction, which makes the logistics information transmission of upstream and downstream of emergency material supply chain unimpeded The supply of materials accurately meets the demand of the pandemic area. In addition, traditional supply chain logistics system is prone to "data island" and "bullwhip effect". The data of the emergency logistics system based on blockchain is transparent, tamperable and traceable to all parties. The combination of the application with Internet of things technology can ensure the authenticity and reliability of information, thus eliminating information distortion, demand data variation amplification and other phenomena, The paper makes the material supply chain share the logistics information, effectively carry out logistics cooperation, effectively avoid "data island" and "bullwhip effect", and finally achieve the efficient matching of material supply and demand. In February 7, 2020, Alipay announced that the information service platform for pandemic prevention materials based on block chain technology was successfully launched. Information on demand, supply, transportation and other aspects of materials were audited and stored on the chain. The trust mechanism of the block chain can bring a credible connection. When the demand list is sent out by one party and the moment of material entering the logistics link, the information link is started. Every link where the materials are located and confirmed by the operator is shown in the chain. The medical materials support group of Zhejiang Province has launched the material demand list through the platform, including medical masks, protective clothing, working caps, etc.

4.1.3. Realize Accurate Traceability of Emergency Materials

There are high requirements for the quality and safety of medical materials to deal with the pandemic. In order to strictly eliminate fake and shoddy materials, accurate traceability is essential. The drug and food scandals in recent years are closely related to the lack of effective traceability mechanism. Due to the traditional logistics data isolation and complex system, it is impossible to accurately trace and recall the problem products in time. Traceability is an important feature of the blockchain, which coincides with the anti-counterfeiting demand of medical materials in emergency logistics. The data of emergency logistics system based on blockchain can not be tampered, and all logistics activity records of material supply chain are stored permanently. Where raw materials are purchased, where semi-finished products and finished products are produced, processed and packaged, which company is responsible for transportation, which logistics center is responsible for distribution, which cities, hospitals, relevant institutions and individuals are distributed, etc. All data generated from the above activities are obtained in real time, and the required materials can be accurately located and traced, The problem materials can be handled quickly and accurately, so as to ensure the safety and control of emergency materials, and fully meet the needs of medical materials in response to pandemic.

4.2. Application of Blockchain to Promote Emergency Logistics to Help Donation

Emergency supplies donated by society play an important role in major pandemic prevention and control. In the early stage of the pandemic prevention and control, the ability of donated materials management and emergency logistics operation is not suitable for the demand. In this paper, we propose the application mode of blockchain in promoting emergency logistics to help donate

materials under pandemic, so as to provide stronger support for better stimulating social goodwill and jointly promoting prevention and control work.

4.2.1. The Material Donation is Highly Consistent with the Needs of the Recipients

In the event of major pandemic, all sectors of society actively donate various materials, but in the process of raising, receiving, distributing and tracing, it is easy to produce unreasonable allocation of donation resources and low efficiency problems, such as opaque information on material receiving and receiving, unreasonable material distribution process, unclear emergency level of materials, unclear distribution priority, and excessive or false collection of some materials, Thus, the demand for donation and assistance is low in terms of category and time. One of the important reasons is that traditional technology means are difficult to share and open real-time information of cross domain and cross department resources in resource allocation. In view of the above problems, we can establish a sub platform based on the social operation platform of emergency logistics built earlier - the material donation platform based on block chain, realize the data integration and information matching of donated materials from all sectors of the society, and share cross chain data and social cooperation. On this basis, the following specific measures are taken around the above objectives. (1) The donors release material demand through the blockchain platform, and donors complete the material donation through the platform. (2) Combined with advanced technologies such as big data and artificial intelligence, the aided demand and material donation are automatically matched. (3) Reasonably divide the emergency level of material demand, arrange the logistics activities such as receiving, distributing, transporting and transferring according to the priority. (4) The origin, logistics trend, detention place, distribution place and distribution of materials are recorded in real time on the chain, and data is stored at multiple points and timely released to the society. The material donation platform based on block chain builds a charity bridge between donors and recipients, which enables donors to understand the needs of the recipients, and also enables the recipients to accurately express their actual needs and achieve accurate matching between donors, materials and recipients. Novel coronavirus pneumonia protection information exchange platform, officially launched by Wuhan University, was launched by the team of Wuhan University in February 2, 2020. This platform effectively utilizes the technology of block chaining to track the source and the irreversible advantages, so as to realize the precise docking of the two sides.

4.2.2. Realize the Transparency of Material Donation Information

In the face of donated materials, receiving and distributing institutions, especially charity organizations, must timely open and update relevant data and ensure transparency of information, otherwise it will easily cause public dissatisfaction or doubt, even encounter trust crisis, which will have a negative impact on the pandemic prevention and control. Therefore, the blockchain information system can be embedded in the material donation platform, and the technology characteristics such as block chain decentralization and everyone's account keeping can be used to realize the transparent and open material data. Measure 1, keep accounts together and sun the data. Blockchain can ensure that everyone can obtain complete information through subversive way of common accounting. All nodes in decentralized system are peer-to-peer nodes. All members receive and send messages in the network equally, and each participant can observe all the behaviors of nodes in the system. Therefore, each participant records the observed information about the name, quantity and value of the donated materials, and inputs the relevant information of the donor, intermediate organization, and the recipient, as well as the relevant information of the material donation, reception, storage, distribution, transportation, signing and receiving and collecting, so as

to expose the donation data in the sun and make the material information transparent and open. Measures 2, effective self certification and public trust. Charity organizations and their partners collect the information of stock certificates on the blockchain at any time, actively and timely disclose the donated materials data and conduct effective self certification, avoid the trust crisis caused by the information disclosure is not timely and data transmission distortion, and can also prevent rumors and stop rumors in time in this way, thus enhancing the public trust of charity organizations. In September 2017, the public welfare project "dream angel seeking journey" officially launched on the Beijing East public goods collection platform was the first case of China applying blockchain technology to trace donated materials, and applied blockchain technology creatively to collect, integrate, record and display the process, batch and information of donated materials, Send the public welfare project link with the blockchain traceability certificate to each donor, and you can inquire the real destination of the donation at any time, and effectively guarantee the credibility of the platform project.

4.2.3. Ensure the Authenticity of the Information about the Whereabouts of the Donated Materials

In the past, the data of donated materials and the information of logistics destination were maintained by charitable organizations and their designated partners. In theory, when the donated materials are handled abnormally and the account information is not conducive to itself, the relevant responsible party has the opportunity to tamper with the data, or even delete the information. If the external accountability is carried out, it will waste considerable human, material and time costs. Blockchain information system can strictly prevent the records of donated materials from being tampered, and ensure the authenticity of the information about the whereabouts of materials. The specific measures mainly include the following three aspects. (1) Tampering prevention. Each donation (i.e. "transaction" on the blockchain) can be verified and added to the blockchain in the whole network. Consensus algorithms such as pbft can ensure that donation information cannot be tampered once it is written. Although the recorded content is allowed to be edited, the whole editing process is completely recorded in the form of "log", and the "log" cannot be modified. (2) Effective accountability. Record every donation completely on the blockchain, and trace all the historical activity records related to the materials in a certain state (such as being embezzled) on the blockchain as a reliable basis for public supervision and traceability. In this sense, the blockchain is also a "responsibility chain", which can be investigated according to the complete data on the blockchain. (3) Ensure that the information is true. The private key in the public-private key system is issued to each participant as the unique identity on the blockchain, and the participant carries out digital signature on each link, so as to effectively prevent such adverse phenomena as false claim or indiscriminate distribution of materials. With the popularization and application of Internet of things technology, "blockchain + Internet of things" technology can be adopted to ensure the authenticity and credibility of material information. To sum up, the blockchain information system fully guarantees the logistics security of every donation recorded on the chain, strictly prevents the dark box operation, and clearly displays and releases the authenticity of information such as the logistics link, logistics obstacles, timely delivery and quantity of distribution categories, so as to effectively eliminate the doubts of donors and the public, It is conducive to maintain and stimulate social goodwill, enhance social mutual trust, and gather the strength of the whole society to do a good job of pandemic prevention and control in public health incidents.

4.3. Application of Blockchain to Promote the Development of Emergency Logistics Intelligence

4.3.1. Automatic Real-Time Response to Emergencies

Using blockchain smart contract and other related technologies, we can give full play to its technical advantages such as automatic contract execution, preset data storage and automatic transaction processing, so as to realize automatic real-time response to emergencies. In the embedded smart contract system, the type, degree, intensity and scope of the emergency are preset as the trigger conditions, and the response rules are preset. When an emergency occurs, the system takes the integrated real-time information as the data source to dynamically obtain the progress information of the event. Then, according to the preset trigger conditions, it makes real-time automatic response, starts the corresponding emergency logistics plan in time, organizes logistics activities such as material collection, fund-raising, procurement, requisition and deployment at the first time, evaluates the material demand automatically according to the development of the situation, dynamically adjusts and updates the adopted emergency logistics plan, and outputs the next implementation plan, Ensure the orderly and powerful supply of emergency materials, store the whole process data permanently, and realize the transparency and traceability of logistics information.

4.3.2. Automatically Fulfill the Logistics Performance of Personal Material Orders

In the process of major pandemic prevention and control, in addition to the huge demand for medical materials at the rescue points in the pandemic area, every individual in the public also has a large and urgent demand for prevention and control materials such as masks, alcohol and disinfectants. At the same time, the daily material supply to maintain the life in the pandemic area is also important. Therefore, the production, marketing and supply of related materials, the sales volume of B2C, especially the e-commerce transaction volume, will increase significantly. At this time, the logistics performance efficiency of transaction orders is very important, and the intelligent emergency logistics system based on blockchain can provide strong support for this. By using the intelligent contract technology, the procurement and order submission of the required materials are transformed into preset trigger conditions, and the agreement actions such as logistics delivery and payment are transformed into preset response conditions, and then the response rules are preset to start the intelligent emergency logistics. In the delivery phase, once the terms of the order contract are implemented and the previously set delivery conditions are met (such as the information that the consignee confirms the successful delivery), the system can automatically fulfill the smart contract. In the settlement phase, a "logistics currency" similar to the "bitcoin" of the blockchain can be set up in advance to realize automatic settlement, and all consignees can exchange "logistics currency" in advance to pay freight and settle automatically. In addition, the combination of the Internet of things technology can further improve the intelligent level of emergency logistics. For example, the pallets (or packing boxes) carrying materials are incorporated into the Internet of things. When the materials are delivered, the associated pallets will automatically send the delivery confirmation, delivery time and cargo status information to the system, and the system will automatically check the actual delivery, Check whether the goods are delivered in accordance with the conditions stipulated in the contract (such as temperature, humidity, etc.), and then determine whether the payment is made. The whole process can effectively improve the efficiency of order contract execution and significantly reduce the default risk of both parties.

5. Conclusion

Emergency logistics provides increasingly important support for major pandemic prevention and control, and there is a close coupling relationship between emergency logistics and blockchain

technology. In view of the main problems of emergency logistics in the prevention and control of COVID-19 pandemic, we can apply blockchain technology to improve the emergency logistics under major pandemic from three dimensions, build typical application modes and put forward three measures. First, the application of blockchain ensures the efficient operation of emergency logistics, so as to realize the efficient coordination of logistics operations, efficient matching of material supply and demand, and accurate traceability of emergency materials. The second is to apply blockchain to promote emergency logistics to assist donation, so as to highly meet the needs of material donation and recipients, realize the transparency and openness of material donation information, and ensure the authenticity of material destination information. The third is to apply blockchain to promote the development of emergency logistics intelligence, so as to automatically respond to emergencies in real time and automatically fulfill the logistics performance of personal material orders.

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