Application Research of Blockchain and New Technologies in Logistics and Supply Chain Information Systems under Major Pandemic

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Abstract: The logistics and supply chain management of pandemic prevention materials is an important support to deal with major pandemic, and the information system is the nerve center of logistics and supply chain under major pandemic. Imperfect information system is one of the important reasons for the poor operation of logistics and supply chain in pandemic prevention and control. It is of great significance and practical value to explore how to apply blockchain, Internet of things, big data, cloud computing and other new generation advanced information technologies to improve the information system of logistics and supply chain. The analysis of the research status shows that there is little literature to explore the application of blockchain and new technologies to improve the logistics and supply chain information system under major pandemic. This study explores the application of new technologies including blockchain, internet of things, big data, and cloud computing in the logistics and supply chain information system under major pandemic, put forward typical application modes and scenarios, and strive to effectively improve the level of logistics and supply chain information management, so as to provide stronger support for effectively responding to major 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] However, in the process of COVID-19 pandemic prevention and control, there are many prominent problems in the operation of logistics and supply chain, and the imperfect information system is one of the important reasons. Information system is the nerve center of logistics and supply chain management under major pandemic, and new technologies such as blockchain, Internet of things, big data and cloud computing are considered to be a new generation of information technology widely used. This study organically combines the application of new technologies with the improvement of logistics and supply chain information system under major

pandemic, effectively improves the level of logistics and supply chain information management, and aims to provide stronger support for coping with major pandemic, and it has academic value and practical significance.

2. Literature Review

WANG Xu-hui et al. (2020) conducted research on supply chain decision-making under the background of major pandemic, developed the theory of supply chain optimization management, and discussed the application of blockchain technology in supply chain decision-making optimization, which provides a reference for supply chain core enterprises to carry out active self-help in the process of major pandemic prevention and control. [2] ZHU Ye (2020) proposed strategies to deal with the transportation support capacity of emergency materials for major emergencies, and proposed methods to quickly build emergency logistics networks based on existing resources from the aspects of optimization of emergency logistics network structure, setting of logistics nodes and improvement of logistics operation mechanism. [3] Taking covid pandemic prevention and control as an example, XIANG Feng et al. (2020) put forward the ideas and strategies for the construction of emergency supply chain system in China, including management system, plan system, production reserve system, emergency logistics system, information system and so on. [4] ZHAO Jian-you et al. (2020) focused on the problems existing in the distribution of urban emergency medical materials under major pandemic, constructed the evaluation index system of demand urgency of medical materials demand points, optimized the distribution path of medical materials, and established the optimization model of emergency logistics distribution path of medical materials. [5] M. Reilly (2011) proposed a rapid assessment plan for the demand of pandemic prevention materials under major pandemic, and determined the logistics strategy for the type and quantity supply of medical materials. [6]

To sum up, the analysis of the existing research status shows that there is little literature on the application of blockchain and new technologies in logistics and supply chain information system under major pandemic. This study organically combines the application of new technologies with the improvement of logistics and supply chain information system under major pandemic, and tries to effectively improve the level of logistics and supply chain information management, so as to provide stronger support for dealing with major pandemic.

3. Application of Blockchain in Pandemic Prevention Material Logistics and Supply Chain Information System

3.1 Main Technologies and Advantages of Blockchain

In a narrow sense, blockchain is a data structure that combines data blocks in chronological order, and a distributed ledger that cannot be tampered with and forged in a cryptographic way. Broadly speaking, blockchain technology is a new distributed infrastructure and computing paradigm that uses block chain 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 contract composed of automatic script code to program and operate data [7]. 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, timestamp, smart contract, etc. it has the characteristics and advantages of decentralization, information transparency and credibility, anti-counterfeiting and tampering, permanent record traceability, high reliability of the system, automatic performance and so on.

3.2 Application of Blockchain in Pandemic Prevention Material Logistics and Supply Chain Information System

In major pandemic prevention and control activities, in order to ensure the smooth logistics operation of pandemic prevention material supply chain, the efficient operation of information system is very important. Taking the traceability and quality monitoring of pandemic prevention materials in supply chain logistics activities as an example, this study focuses on blockchain technology and integrates the application of relevant technologies to build a pandemic prevention material supply chain quality monitoring information system, which is composed of information collection, management data, smart contract, business operation and other information subsystems.

First, in the information collection layer, integrate the application of RFID, GPS, GIS, bar code, sensor and other information technologies to realize that the collected pandemic prevention material information runs through the core links of the supply chain, such as production and quality inspection, inventory control and sales, logistics distribution and so on.

Second, in the management data layer, the distributed ledger is mainly integrated with blockchain technologies such as hash operation, consensus algorithm and time stamp. All participants in the pandemic prevention material supply chain (the Certification Group on the blockchain) jointly account the data of products, inventory, purchase and sales, logistics and so on. The data is stored in the blockchain system in a distributed manner. The data cannot be tampered with and cannot be deleted. Once the pandemic prevention materials have quality problems, accurate traceability and timely accountability can be carried out within the whole chain.

In the third layer, it will automatically check whether the quality of various materials meets the requirements of the contract and delivery conditions of the intelligent logistics system based on the temperature and timeliness information, and automatically check whether the quality of various materials meets the requirements of the contract and delivery conditions of the intelligent logistics system, then update and upload the information to the information system in time.

Fourth, at the business operation level, apply blockchain technology to dynamically and transparently supervise the whole process of pandemic prevention material supply chain logistics, break down the information barriers among suppliers, manufacturers, logistics providers, medical and health institutions, retailers and other participants, improve the coordination degree of the whole chain and the credit degree of participants, and reduce the risk of rupture of pandemic prevention material supply chain. Application mode of blockchain in pandemic prevention material logistics and supply chain information system is shown in Figure 1.

4. Application of Internet of Things in Logistics and Supply Chain Information System under Major Pandemic

Worldwide, covid-19 pandemic prevention and control activities generally have problems such as insufficient reserve and production of emergency materials, failure to timely put emergency materials in place, asymmetric emergency logistics information and so on, and failure to transport emergency materials to disaster areas in a timely and accurate manner. Therefore, the Internet of things can be applied to establish an emergency supply chain logistics information system. The middle note of the supply chain should be unified command and centralized scheduling for the emergency supplies needed for pandemic prevention and control. The main links include reserve, production, procurement, transportation, storage, loading, transportation, packaging, circulation processing, distribution, recovery and information processing, so as to improve the response speed of emergency supply chain logistics.

Under the command of the emergency management center and the cooperation of the disaster area management station of emergency materials, the emergency logistics information system

collects information, including emergency material production enterprises and sales enterprises, postal enterprises and logistics enterprises, waste recycling and treatment enterprises and other organizations, forming an emergency material flow joint cooperation mode. Emergency logistics information system based on internet of things application as shown in Figure 2.
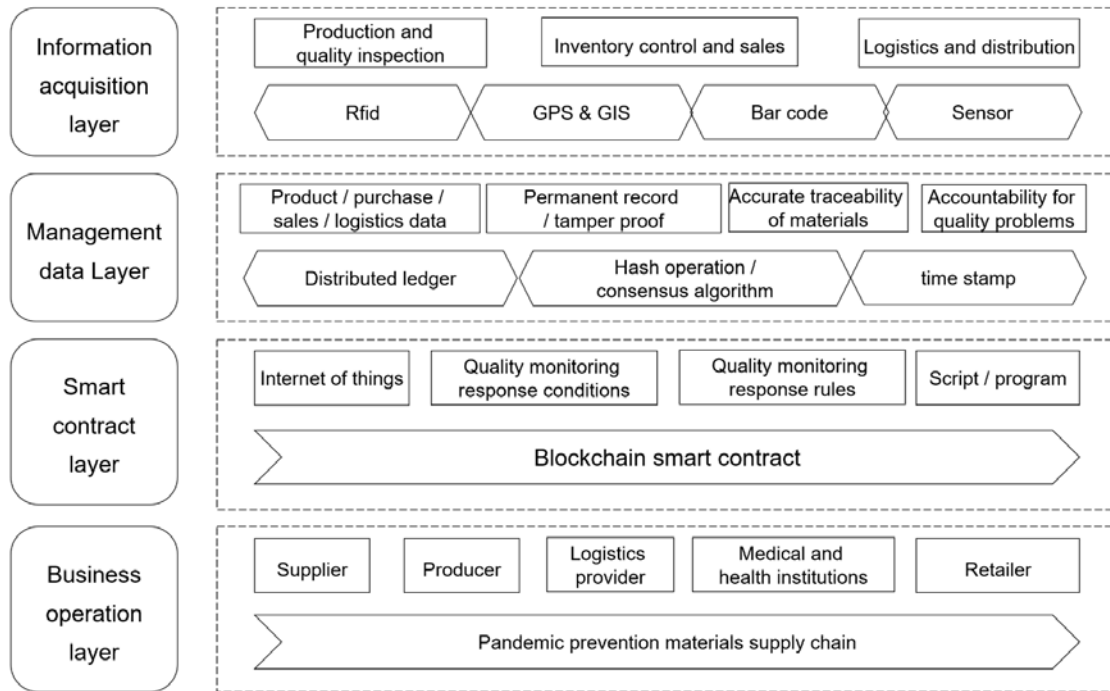

Figure 1: Application mode of blockchain in pandemic prevention material logistics and supply chain information system
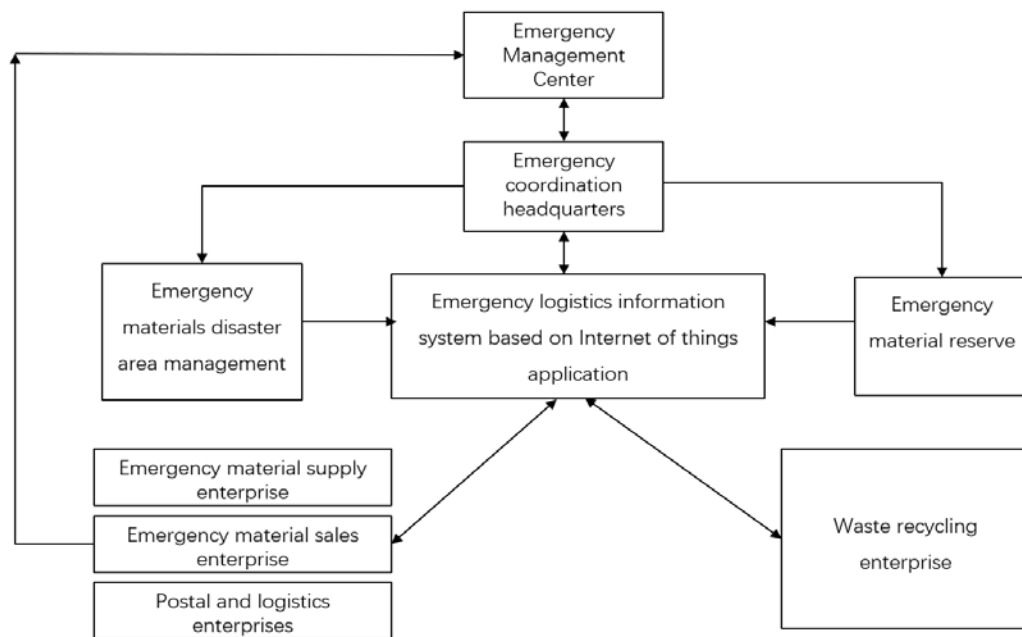

Figure 2: Emergency logistics information system based on internet of things application

All members of the emergency supply chain logistics system should improve the relevant software and hardware environment with the support of Internet of things enterprises. The emergency material reserve warehouse, the warehouses of emergency material production enterprises and sales enterprises shall be equipped with RFID reading and writing devices, wireless networks and corresponding storage systems to ensure the accurate outbound quantity of materials and upload them to the emergency supply chain logistics information system; Logistics enterprises are equipped with GPS, GIS and other on-board systems for trucks carrying out emergency material transportation tasks, so that they can track the running dynamics and trajectory of these vehicles in the logistics information system. Using 5G, big data and other technologies, the emergency logistics information system can efficiently obtain, transmit, analyze and process data, and make intelligent decisions, so as to quickly formulate the optimal emergency material plan in case of major pandemic.

5. Application of Big Data in Emergency Logistics and Supply Chain Information System under Major Pandemic

In the pandemic prevention and control work, the shortage of medical resources is one of the most serious and common problems. Medical resources cannot be supplied in time, which leads to many medical staff and patients in trouble, and the anxiety of the public also follows. In order to effectively solve the problem of shortage of medical materials, this study proposes to apply big data technology to realize intelligent supply chain management and improve the emergency logistics information system. Relying on the information storage and integration advantages of big data platform and integrating the upstream and downstream data of the supply chain involved in production factors, we can gather the mature information resources collected by various departments, realize the orderly collection of pandemic prevention material demand and ensure the normal production and supply. With the help of intelligent supply chain management under big data, we can realize the data interconnection of the whole supply chain of pandemic prevention materials, promote the openness and transparency of material production, transfer, storage and supply, realize coordination and linkage, and comprehensively ensure the effective supply of pandemic prevention materials. The application of big data technology in logistics and supply chain information system mainly includes the following three modes:

5.1 Apply Big Data Technology to Integrate Supply Chain Data

The biggest advantage of digital supply chain is information sharing and integration. The intelligent supply chain logistics information system based on big data technology integrates the front-end procurement, inventory management, goods flow and other data of the supply chain, which can balance the information between the upstream and downstream of the whole supply chain and avoid the waste of transportation resources. Emergency logistics refers to special logistics activities aimed at providing emergency materials required for emergencies such as sudden natural disasters and sudden public health events, and aiming at maximizing time efficiency and minimizing disaster losses [8]. Emergency logistics is a logistics situation based on the changeable supply and demand in a complex environment. Without the integrated information of big data, it will cause serious waste of transportation capacity, and even cause the phenomenon of "extreme surplus of materials in place A and serious shortage of materials in place B". Failure to supply materials in time will further threaten the personal safety of people in disasters. The pandemic prevention and control command center can cooperate with professional emergency logistics enterprises to establish an emergency material supply chain information system, build a supply chain integration platform based on big data, and integrate the supply and demand information between the logistics center and each

demand point. Provide logistics distribution service support for the logistics management module of the platform in the form of API, and connect the intelligent manufacturing screen with the help of big data analysis and intelligent scheduling algorithm to realize the information docking with the national platform system. Emergency logistics enterprises can release their own real-time capacity information and the real-time demand information of emergency demand points to the data center, which integrates the supply and demand data, matches the transportation mode, and feeds back the processing results to each logistics company. Logistics enterprises use special vehicles or less than carload transportation to transport emergency materials.

5.2 Apply Big Data Technology to Optimize Material Logistics Transportation Route

The advantage of big data information system lies not only in the connectivity of data, but also in intelligent analysis and decision-making. Once a major pandemic occurs, emergency logistics enterprises can conduct two-way communication of key data through digital thread in the digital twin model, assess the operation risk affected by the pandemic, collect real-time quality data from transportation facilities and equipment in combination with big data technology, cover these data information on the digital twin model, and use OWL Ontology language to realize the construction of urban ontology in this field, Finally, the reconstruction of physical entities is realized, so as to further evaluate the road conditions of trunk lines and branches in and out of Wuhan. At the same time, logistics enterprises can evaluate the road conditions according to the severity and scope of the pandemic, calculate the business capacity by using the internal real-time computing platform, and formulate transportation emergency adjustment plans in advance to ensure the timeliness of logistics. It can be seen that big data can assist intelligent planning and complete new route planning in a short time, so as to ensure logistics to transport materials and packages from all over the country to the place where the pandemic occurs; For package express delivery that does not need to enter the place where the pandemic occurs, other transportation hubs will be selected for transshipment, so as to alleviate the road pressure.

5.3 Apply Big Data Technology to Realize Intelligent Warehouse Management

Big data can improve the efficiency of warehouse management. Digital management makes the management mode no longer the traditional manual inventory, but an efficient automatic information storage, evaluation and prediction mode. Through the warehouse data stored in the information database, evaluate the existing resources and future order demand of the warehouse by integrating various factors, especially the protective clothing, goggles, masks, etc. whose demand increases sharply under the pandemic, and notify the front-line warehouse for resource reserve in advance. For example, "Cloud Warehouse" pharmaceutical logistics information system can be established. The key technology is to adopt the Internet and big data architecture. Functionally, it can support multiple business formats, categories, owners, account sets, warehouse areas and diversified operation modes. It has a high degree of utilization of storage resources, and can complete docking and real-time data interaction with different systems. For the orders that cannot be met by the reserve warehouse in the pandemic area, the warehouse dispatching system will automatically transfer the supply orders to other warehouses outside the pandemic area in time, so as to ensure that the urgently needed items for pandemic prevention such as masks and protective clothing are sent to the cities in urgent need of meeting the demand at the first time, give priority to ensuring the material supply in hospitals, supermarkets and other places, realize intelligent order composition in the warehouse, and improve the timeliness of material delivery.

6.   Application of Cloud Computing in Material Donation and Pandemic Prevention and Control Information System under Major Pandemic

6.1 Cloud Computing Technology and Its Main Advantages

Cloud computing technology is based on the Internet. With strong computing power and resource sorting ability, it has extremely flexible scalability. It has a certain development foundation in different industries. Cloud computing technology can also play an important role in the process of pandemic prevention and control. First, meet the requirements of special scenes. During the pandemic period, the traditional business model of various industries can no longer maintain the good survival of enterprises. The emergence of cloud computing technology can bring changes to enterprises, make their online operations more flexible, develop new business models, and facilitate people's lives. Second, support the deployment of multiple technologies. Cloud computing technology is the basis of multiple information technologies. Therefore, relying on the cloud computing technology platform, multiple technologies can be carried out smoothly in different scenarios. At the same time, the continuous development of cloud computing technology can improve the efficiency of other technologies and improve the application effect. During the pandemic, cloud computing combined with Internet of things, big data, 5g and other technologies to produce a variety of online clouds. Third, provide flexible services. Cloud computing technology has rich reserves and can effectively deal with ordinary emergencies. At the same time, as a virtual resource, cloud computing can be supplemented more quickly to meet sudden needs in time. Therefore, compared with physical devices, the application of cloud computing is more flexible in time and space, and users can choose the amount of resources they need at the time they need; Simultaneous interpreting and virtualization of cloud computing makes the customer more flexible than traditional data storage.

6.2 Application of Cloud Computing in Pandemic Prevention Material Donation Information System

During the covid-19 pandemic, there were many scattered donated materials from all directions, but the original emergency logistics and supply chain system was difficult to comprehensively collect the information of material donation, resulting in the inability of emergency managers to make optimal decisions based on the actual information. In this context, cloud computing technology can be applied to build the donated materials information system. The donation material information system based on cloud computing can provide the functions of information registration, summary and form generation according to the characteristics of large and scattered donation information, improve the efficiency of information transmission, quickly generate visual analysis results, and help all departments effectively control the pandemic. Giving full play to the advantages of "cloud" storage, the donated material information system based on cloud computing can also monitor the update of material information in real time and continuously contribute to pandemic prevention through automatic statistics.

6.3 Application of Cloud Computing in Pandemic Prevention and Control Information System

In the face of the pandemic, the timely transmission of government measures and notices for the people who fight the pandemic at home is the basis for ensuring people's normal life. The information collection and release platform and pandemic prevention monitoring platform based on cloud computing technology can play an important role in the collection and release of pandemic

prevention and control information. In the early stage of covid outbreak, the central and local governments and departments at all levels used the information collection and release platform to collect personnel information, report the pandemic, diagnosis and treatment guidelines and other information. After the pandemic stabilized, especially in the stage of returning to work all over the country, due to the continuous surge of human flow and a large number of various data, the pressure of pandemic prevention and control also increased. Departments at all levels apply cloud computing pandemic prevention monitoring platform to collect all kinds of data in multiple dimensions, so that everyone can have electronic health card and electronic pass code.

7. Summary

Information system is the nerve center of logistics and supply chain management under major pandemic. The application of new generation information technology to improve the information system will help to significantly improve the information management level of material logistics and supply chain for major pandemic prevention and control. Blockchain, Internet of things, big data and cloud computing are typical new generation information technologies, which can play an irreplaceable advantage and role in pandemic prevention and control activities. In the context of major pandemic prevention and control, exploring how to apply new technologies to improve the information system of logistics and supply chain has important academic significance and application value. Taking blockchain, Internet of things, big data and cloud computing as examples, this study puts forward the application mode of new technology in the information system of pandemic prevention and control material logistics and supply chain, explores typical application scenarios, and puts forward a series of implementation measures, so as to provide reference and reference for improving the information management level of logistics and supply chain and coping with major pandemic.

Acknowledgements

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