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Integration of Container Transportation Information Resources Based on Blockchain Technology

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Abstract: *Previously, international waybills mostly used paper for data exchange, which had significant shortcomings. However, the realization of electronic paper waybills and data sharing through the Internet can effectively change this situation. Based on the analysis of the business requirements of the cross-border railway container transportation information sharing platform, the application fields of cross-border railway container transportation with blockchain as the core were identified, and the overall framework of the cross-border railway container information sharing system with blockchain as the core was proposed. The business management module, data management module, user management module, and node configuration module in the system were introduced in detail, providing a reference method for promoting information sharing of cross-border railway containers. This paper proposed the container transportation information integration based on blockchain technology. First, it explained the blockchain technology, transportation information and resource integration, and then carried out experimental analysis to compare the working efficiency of traditional information integration technology and current blockchain based technology. The results showed the progressiveness of blockchain based technology.*

Keywords: *Resource Integration, Transportation Information, Container, Blockchain Technology*

1. Introduction

Every business on the information sharing platform needs to be based on data and record metadata throughout the process, which is fundamental to achieving data tracking. Ensuring data security is a prerequisite for all participants to be willing to share data. Because blockchain data is distributed and stored in various nodes of the network, it is also necessary to achieve data consistency between different nodes.

Many scholars have proposed research on the digitization of container transportation information resource integration. Bavar F developed a cross docking center routing model for time windows and pricing routes. The model includes two objectives: reducing total costs and reducing freight costs (freight). The purpose of this model is to obtain the number of cross docking centers, the number of vehicles, and the best route in the distribution network. The results showed that the developed algorithm has very high efficiency in solving time and problem answers [1]. Based on this, Li Z studied the optimization problem of empty container transportation based on port participation for different new collaboration methods. On this basis, a new optimization method based on integer programming was proposed, which can effectively reduce the total cost of shipping containers. Finally, sensitivity analysis and other methods were used to verify the case and obtain the optimal empty container transportation method, which can effectively reduce the cost of empty container transportation, improve the efficiency of empty container transportation, and provide scientific basis for port shipping companies to carry out empty container intermodal transportation [2]. Bahadir M C believed that systematic dynamic models for the selection of capacity and transport planning policies for hub and spoke container networks maximize long-term benefits. This model was used to compare performance indicators such as capacity utilization, service level, and return on investment. Through comparison, it includes the interaction of container system processes from a broad perspective to balance capacity utilization and market share [3]. Although the above studies are relatively advanced, some have high technical costs and professional requirements for technical personnel, and their practical application is not universal.

The integration of container transportation information resources based on blockchain technology proposed in this article has low costs and low requirements for the level of staff. This research is of

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practical significance.

2. Blockchain Technology, Container Information, and Related Applications

2.1. Blockchain

Blockchain was first used for Bitcoin transactions. It is an electronic payment system based on cryptographic principles rather than credit. Therefore, without third-party intermediaries, both parties can directly make payments [4]. Using a time stamp server to generate electronic transaction vouchers in chronological order solves the problem of double payment. If a trusted node has more computing capacity than a cooperative attacker, then the node can ensure its security. Fundamentally, a blockchain is a shared database that can establish a distributed ledger and reach consensus with participants. Each block would record all data in the transaction process, and can be verified and tracked at any time. Each block would be stored using data encryption and linked to other blocks [5]. Hash signature, point to point communication, encryption, decryption, and other technologies are a comprehensive application, with the advantage of hash signature. Hash code, also known as hash code, is the addition of each data block using a password to obtain a unique hash code signature. In each block, any change in data would result in a change in the hash password. Each block contains the hash value of the previous block (except the first block). If the hash signature of a block is changed, it means that the data of that block has been modified.

Blockchain is a new type of network technology that would bring great changes to the sharing behavior of information resources in the network [6].

Blockchain, along with well-known AI, the Internet of Things, and machine learning, has become a representative of modern information technology. It has excellent application prospects in the container transportation industry, with the following irreplaceable advantages: (1) opening and sharing; (2) decentralization; (3) anonymity; (4) traceability; (5) immutability.

It can be used to integrate various relevant entities upstream and downstream of the container transportation industry chain, such as customers, ship owners and ports, and establish a shipping blockchain ecosystem [7]. Blockchain technology enables container sharing. On this basis, an international container sharing platform has been constructed to achieve mutual cooperation and sharing among container enterprises. The combination of blockchain technology and container transportation has made container investment a popular trend. On this basis, using blockchain technology, information such as the ownership, owner, or operator changes of each container are registered, enabling the circulation of physical containers and the popularization of new containers. Citizens can also establish investment institutions for “blockchain containers” on this basis to “invest” in containers [8]. The use of blockchain technology can greatly reduce the operating costs of containers and improve the effectiveness of environmental protection, whether for cargo owners, shipping companies, freight forwarders, or container rental companies. As a new type of technology, blockchain technology needs further improvement and improvement in terms of technical maturity, social acceptance, scenario application docking, standard system construction, legal supervision, and other aspects [9].

2.2. Container Information

Since the Ministry of Transport carried out the transportation pilot work, it has cultivated a number of large-scale, intensive, and networked container transportation enterprises with exemplary effects, which have played a good exemplary role. However, there is no doubt that container two-liner transportation has not been widely used. Although the government has introduced corresponding policies and subsidy measures, these subsidies only serve as a guide. In China, due to a single and traditional promotion platform, it is difficult for Chinese container transportation companies to achieve the goal of “small, scattered, and chaotic”. In the existing logistics management systems, due to the lack of management of the logistics management system, the application of the logistics management system is greatly limited [10].

With the rapid development of China's foreign trade and import and export trade, the port industry has put forward higher and higher demand for container tally on terminals. The current tally technology is no longer able to meet the production needs of large ports. In practical operations, disputes between shippers, ports, and consignees often occur due to the loss of goods for various reasons, but there is a

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lack of effective video recording evidence to effectively supervise them, which has a significant driving role in the research and development of intelligent digital tally technology for containers [11].

On this basis, this article conducts a detailed analysis of the operation process of the railway container logistics park, as shown in Figure 2. Currently, China's railway container logistics parks have not established an effective information management system, and can only rely on the container transportation information system ("container management system") to operate [12]. However, the container management system is mainly based on the transportation of containers in transit and manages them, while other container related businesses and logistics park management businesses are very small, and cannot fully cover all operational processes in the park. Therefore, throughout the process, the railway container logistics park is completed manually, as shown in Figure 1.

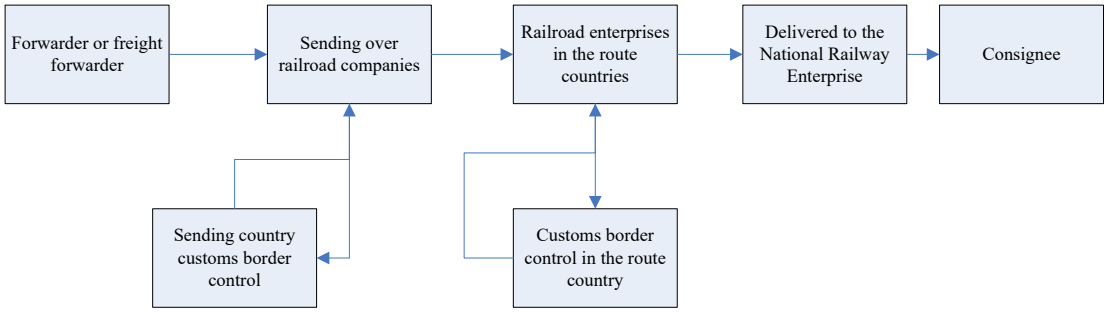

Figure 1: Railway Container Transport Information.

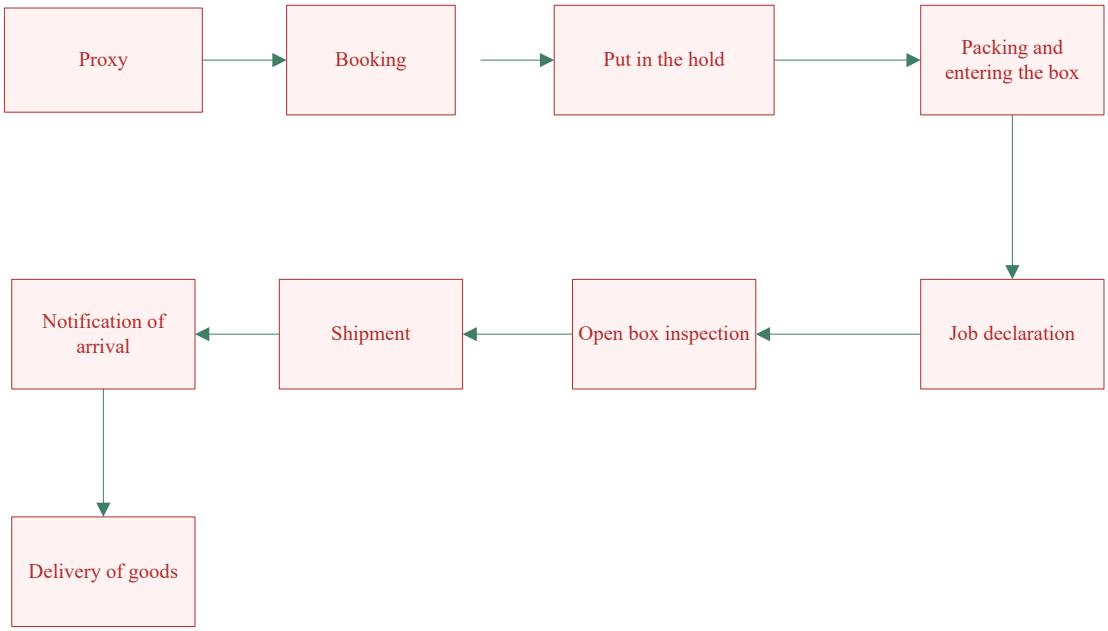

Figure 2: Cargo container operation process.

In container ports, due to the huge amount of information exchange and flow within them, especially the rapid changes in information on export containers, there is a need to handle a large number of customs clearance, ship exchange, transit ports, changes in container companies, and changes in destination ports between ports, all of which require cumbersome procedures, which has a significant impact on the operational efficiency of the port:

The modification of container information requires manually stamping a business seal on the paper document, which is time-consuming and laborious; (2) Business activities such as the preparation, invoicing, review, and change of container documents involve cumbersome procedures; (3) Due to objective reasons such as construction period, climate, etc., the changes in container documents are much greater than before, which has had a significant impact on the timeliness and transmission quality of messages, causing customers to take longer to process documents, delays in loading goods, and even cases of out of container. Therefore, resource integration of container information is very important for container business operations [13].

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2.3. Data Management

The beginning of various businesses of information platforms mainly relies on data. Recording container data is the key to achieving data tracking. Because blockchain technology data is distributed and stored in various nodes of the network, it is necessary to achieve data consistency among different nodes. Each participating location requires a blockchain network site for storing data and processing related businesses. Participants include railway enterprise A, railway enterprise B, and railway enterprise C. Figure 3 shows that each site records and backs up data.

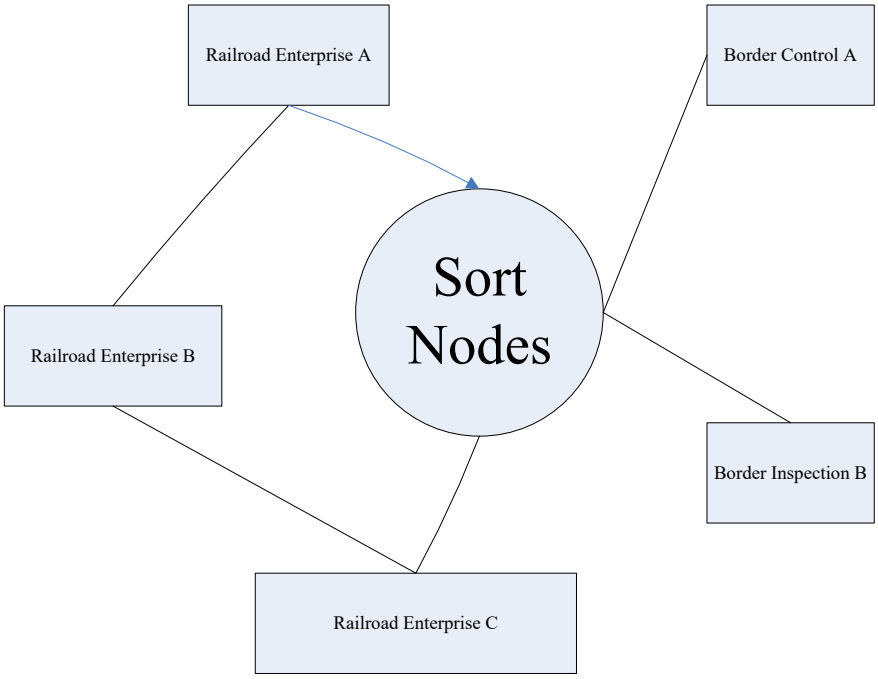

Figure 3: Container information platform.

The mapping rules for the data source are set, and the guest is designed as a triple P:

$$\mathrm{P} = \{\mathrm{M}, S, N\} \tag{1}$$

M represents a local ontology set, S represents a data source set, and N is a mapping rule set between M and S, which defines N:

$$\mathrm{N} = \{[\mathrm{N}_1, \mathrm{S}_1, O_1], [\mathrm{N}_2, \mathrm{S}_2, O_{21}], [\mathrm{N}_3, \mathrm{S}_3, O_3], \ldots\ldots\} \tag{2}$$

2.4. Information Resource Integration

Information resources refer to all documents, materials, images, data, and other information used by an entity in the course of business activities. Together with energy and material, they are referred to as the three major resources of modern society. Information resource integration is a transliteration of English (information integration). Currently, there is no unified conclusion on the understanding of information resource integration, and people usually divide it into “wide” and “narrow” [14]. In a narrow sense, the integration of information resources refers to the combination of heterogeneous, dispersed, and diverse information resources in a logical or physical form within a certain range to facilitate the management, utilization, and service of information resources. In a broad sense, from the perspective of users, it is possible to turn scattered things into centralized things, or to turn disordered things into orderly things. It includes the process of information management such as information collection, organization, processing, and services [15].

The idea of integrating social resources through information platforms has been used by people for many years, and there are many specific models. Some are successful, and others are not ideal, or even have no success at all. The characteristics of the operation mode of St-Anda Logistics are the control and utilization of logistics by the operating entities of the enterprise. It is a comprehensive logistics information platform and forms a unique third-party logistics service based on this platform. The

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functional operation of many simple logistics information exchange platforms is often not perfect for the integration of social logistics resources and the integrated operation and management of logistics [16].

The significance of information resource integration

The integration of digital information resources is the optimal reconstruction of information resources. According to the given requirements, information objects, structures, and relationships of each relatively independent information resource system are re fused, allocated, and reassembled. For example, a new combination of information resources is reorganized. The restructured information resources can better serve operations and generate greater benefits [17]. In practical applications, whether container information resources can effectively absorb and use digital information resources of transportation information is an urgent issue to be solved in improving the efficiency of container work. Information resource integration urgently requires the use of innovative technical methods to better serve the timeliness, complexity, intersection, and diversity of information resources, in order to better serve the sharing and development of information resources. On this basis, container information management introduces a new Internet technology, blockchain, to manage information resources in a standardized manner, guide their standardization and normalization in technology and business, and make them a “third state”, with both internal and external functions to make up for the shortcomings of the current information resource sharing mode in terms of performance, efficiency, and security [18]. The optimized container information management platform improves service efficiency, reduces operating costs, enhances the convenience and efficiency of the system's promotional information resources, addresses the shortcomings of traditional information resource integration, and enables information resources to develop towards a digital and advanced level of resource sharing system. The container information platform based on blockchain technology collects information resources and reconstructs new resource information [19].

3. Simulation and Experimental Evaluation of Blockchain Based Container Information Resource Integration

The data in this article was taken from the Chinese port website and was derived from the national port cargo container throughput in December 2022, as shown in Table 1.

Table 1: Port cargo container throughput.

Port	Container through put	
	Instan to the present month	Year-on-yeargrowth
Liaoning	2374	-11.1
Hebei	3253	7.3
Shandong	7850	-0.8
Jiangsu	1600	-6.1
Chekiang	4241	-0.2
Fujian	2075	-0.7
Guangdong	5700	-4.3
Guangxi	1461	0.4
Henan	337	1.2
Inland river	4446	-5.7
Heilongjiang	0.1	1
Shanghai	3474	-4
Jiangsu	1600	-6.1
Anhui	95	2
Jiangxi	43	5.7
Hunan	24	-11.4

The above data were used to simulate and model the overall sea rail intermodal transport. The simulation parameters for sea rail intermodal transportation before and after the integration of information resources based on blockchain were set, as shown in Table 2.

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Table 2: Comparison of data simulation.

	Before information resource integration	After the integration of the information resources based on the blockchain
Parameter time of goods takeover, production documents and charging module	(25,30)	(12,15)
Parameter time for cargo handover to eliminate information islands	(20,25)	(15,21)

Analysis of experimental results: from the above experimental data, it can be seen that container information integration based on blockchain technology has reduced time in cargo takeover, manufacturing documents, charging modules, and cargo handover operations.

4. Conclusions

In order to further improve the informatization level of container logistics, this article optimized its information management system, and had important significance in promoting the development of China's container logistics parks towards modernization and high-tech. This article discussed how to realize the information management of container logistics parks. Based on the above analysis, this article conducted simulation from the perspective of blockchain technology and container loading and unloading truck operation time, studied the information management of container logistics, and realized the intelligent operation process of freight yard vehicles, container yards, and container loading and unloading trucks, thereby improving the management level of the Railway Container Logistics Park and improving the operational efficiency of the container logistics park. Finally, the experimental analysis data in this article further proved that container information can be better integrated based on blockchain technology, which was of great research significance.

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