

Analysis of the Development of Green Logistics Based on Blockchain

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Abstract: There has been a wave of technological change and industrial transformation at home and abroad, and blockchain technology has played a non-negligible role in the change. "Blockchain + logistics" has become a hot topic in society. Blockchain technology is a typical decentralized technology, which can effectively make up for the weak links in the logistics industry, so as to provide strong technical support for the development of green logistics. Therefore, this article analyzes the development of blockchain in green logistics, and discusses them one by one from the aspects of transportation, distribution, recycling logistics, and supply chain.

Keywords: Blockchain; Green Logistics; Transportation & Distribution; Supply Chain.

1. Introduction

The logistics industry is capital-intensive and labor-intensive. In order to survive in a volatile and fierce market, many logistics companies have focused on controlling costs to maximize profits and remain competitive over the past few decades. However, with the depletion of resources and the increasing environmental burden, the logistics industry has raised concerns about the sustainable development of supply chain logistics, i.e., green logistics[1]. (Lai, K.H., 2012). Green logistics refers to the planning, control, and implementation of logistics processes to minimize environmental hazards by incorporating modern logistics technologies[2]. (Chhabra, D., 1966). The shift to green logistics means that the logistics industry is increasingly emphasizing the importance of integrating economic and environmental aspects into logistics. Although in the past sustainability was seen as a cost to the logistics industry, today it is seen as a key driver of efficiency and profitability. In fact, the logistics industry must effectively and efficiently manage logistics activities and processes to reduce costs in order to reduce negative environmental and social impacts. This has prompted logistics companies to be willing to explore green logistics. Green logistics can realize the comprehensive integration of logistics resources, reduce energy consumption and reduce environmental pollution, which is a new direction to promote the sustainable development of the logistics industry. Blockchain technology has gradually matured and fully commercialized, and its application in logistics management can improve the greening degree of each logistics link and promote the sustainable development of green logistics, which shows that it is of great practical significance to carry out research on this issue.

2. Research Status

Sarkis et al. classified the research status of green logistics and green supply chain in detail by classifying the global supply chain management literature, pointed out the research directions, and provided future opportunities for other researchers[3]. (Sarkis, J., 2011). Sheu et al. optimized the operation of logistics distribution and proposed an integrated logistics operation model in a given green supply chain that

could increase the total net profit according to government policies[4]. (Sheu, J.B., 2005). Cole et al. examined blockchain from the perspective of operations and supply chain management to identify potential research directions and provide an agenda for future research on six key topics[5]. (Cole, R.). Pournader et al. introduced the current status of blockchain applications in supply chain, logistics, and transportation management, and discussed future research on blockchain technology and its application in industry and services[6]. (Pournader, M., 2020). Wang et al. proposed that blockchain technology is still in its infancy, but its application in the supply chain is gaining more and more attention, and examined the ways in which blockchain technology may affect future supply chain practices and policies[7]. (Wang, Y.L., 2019). Kshetri proposes that the advent of blockchain will transform supply chain activities. They also examined how blockchain can impact key supply chain management goals[8]. (Kshetri, N., 2018).

3. The Application of Blockchain in Green Logistics

3.1. The application of blockchain technology in green logistics and transportation

Transportation is the main source of logistics to achieve the third source of profits, and the realization of green and sustainable transportation system plays a very important role in improving the utility of green logistics. In the process of modern transportation, real-time tracking of the location of goods and other dynamic information has long become a must for the service. Transportation companies need certified safety data to help them continuously improve their business. As a result, many shipping companies have already invested in tracking technology. Traditional systems such as GPS and GIS in use today are susceptible to malicious manipulation and adversely affect the entire transportation system. China's transportation industry is generally scattered, small scale, large number, poor socialization integration and other characteristics, these problems are particularly significant in road transportation. With the development of EDI technology, the cumbersome information exchange in the transportation process has shifted from traditional paper-based documents to paperless documents, which also provides convenience for

blockchain technology to better simplify the transmission and exchange of information and data in the transportation system on the premise of ensuring the accuracy of information and data. Blockchain technology can play the following roles in green logistics and transportation:

Tracking logistics: Blockchain can be used to establish a transparent and secure logistics information platform to track and record the source, destination, and transportation process of goods, thereby improving the transparency and credibility of logistics information.

Reduce energy consumption: The optimization and intelligent management of logistics processes through blockchain technology can reduce the waste of manpower and time in the logistics process, and reduce energy consumption and carbon emissions.

Promote sustainable development models: Blockchain technology can promote cooperation between producers, logistics service providers and consumers, promote green and low-carbon logistics models, and promote sustainable development.

Ensure logistics security: Blockchain technology can ensure the security of logistics information, prevent logistics data leakage and tampering, and reduce logistics risks.

3.2. The application of blockchain technology in green logistics packaging

In recent years, China's e-commerce industry has been high-speed and vigorously developing, which has led to the rapid growth of e-commerce express business, which has led to a large increase in packaging materials used in China's logistics packaging. In recent years, green logistics and green packaging have been fully implemented online and offline, but due to the lack of a bridge between online and offline, the implementation effect has not met expectations, and the promotion of green packaging plans has been very slow. Among them, Suning Logistics has also made certain efforts, such as optimizing the material, structure, and sealing methods of shared green packaging to improve flexibility and convenience. With the introduction of the express green packaging standard, foldable green packaging came into being, which can be more flexible to adapt to the size of various commodities, and the material is more green and lightweight. The application of smart contracts in blockchain technology, data cannot be tampered with and other technical characteristics can solve the existing problems in green packaging recycling.

The application of blockchain technology in green logistics packaging has the following aspects:

Product traceability: The blockchain can record the source, production process and transportation path of each packaging material, so that consumers can trace it back to every link, ensuring the quality and safety of the product.

Energy conservation and emission reduction: Blockchain can record every shipment and packaging of goods, save energy and resources, and play a role in energy conservation, emission reduction and carbon footprint reduction.

Economic benefits: Blockchain can optimize the logistics supply chain, improve efficiency, save costs, and make enterprises more competitive.

Environmental awareness: Blockchain can promote enterprises to comply with environmental regulations, adopt sustainable green packaging materials, and improve corporate social responsibility.

In short, the application of blockchain technology in green

logistics packaging can improve logistics efficiency, reduce logistics costs, and promote the construction of environmentally friendly logistics.

3.3. The application of blockchain technology in green logistics and distribution

The application of blockchain technology can build a trust network and realize the convenient circulation of materials in different scenarios and modes. With the support of digital signature technology, the distribution status of materials can be monitored in real time, thus ensuring the accuracy of materials during logistics. In addition, there are two mechanisms for digital signatures: signature and verification, in which the signature mechanism can upload information such as the type and quantity of materials and the temperature of the vehicle to the chain in real time, and transmit it to the access point in the form of a private chain. The connection point uses a verification mechanism to confirm that the signature has been received, and then transmits information such as the location and time of the connection to the vehicle in the form of a code. It can be seen that based on the digital signature verification mechanism, the two parties can ensure the accuracy of material distribution, and can distribute materials to the best location, optimize the management structure and improve distribution efficiency, and ensure the timeliness of material distribution while saving energy loss.

The company's key technology based on blockchain technology assigns key storage responsibilities to each node, which has significantly enhanced anti-interference ability compared with the traditional centralized public key system, and can ensure the security of data through the organic combination of data encryption and encapsulation. The application of this technology to the material distribution of green logistics means that the private key of the entrusting party, the transporter, the consignee and other parties will not be forged.

Blockchain technology can play the following roles in green logistics and distribution:

Track and trace: Through blockchain technology, the whole process of logistics and transportation can be tracked and traced to ensure the safety and reliability of goods from source to terminal.

Data sharing: Blockchain technology can promote the sharing of logistics information, improve logistics efficiency and transparency, and reduce the waste of energy and resources.

Smart contracts: With smart contracts, logistics business can be automated and intelligent, distribution routes and transportation methods can be optimized, and carbon emissions and environmental pollution can be reduced.

Energy management: Blockchain technology can help monitor and manage energy usage, optimize energy consumption, improve energy efficiency, and reduce environmental pollution.

3.4. Application of blockchain technology in green reverse logistics

The rise of green reverse logistics stems from people's general concern for environmental issues. After World War II, the rapid development of the world's productive forces has also had a serious impact on the earth's ecological environment, including the worse quality of the world's environment, unclean air quality, and the proliferation of industrial waste and waste products.

The massive consumption of resources has a great impact on human life and economic development. The best way to achieve green reverse logistics is recycling. It is a recyclable system, which can not only fully recover various renewable resources, but also reduce the cost of waste treatment, so as to obtain huge economic benefits. In addition, due to the reduction of the amount of garbage, the pollution to the environment is also reduced, and the ecological environment is protected, thus promoting the ecological balance.

Reverse logistics is a system of utilization, remanufacturing, and recycling. It can not only make full use of resources, but also effectively protect the ecological environment, bringing huge economic and social benefits.

Blockchain technology has the ability to "reduce costs and increase efficiency", and is an important source of profit for enterprises with high efficiency and low cost. Blockchain technology can record the whole process of commodity value transfer completely and "immutable", which makes the record of goods in the circulation process unique, ensures that a "point-to-point" recovery and recall mode can be formed in the reverse logistics process, forms the supervision and control of the reverse transmission process by all employees on the chain, reduces the cost of "secondary collection" of information when enterprises carry out reverse logistics, and realizes the real-time synchronization of all nodes on the chain, which can greatly improve the efficiency of reverse logistics and reduce the cost of drug circulation.

Blockchain technology can play a variety of roles in green reverse logistics, including:

Track and verify the origin of products: Blockchain can record the origin and history of products, helping to ensure product traceability and prevent counterfeit products from entering the reverse logistics system, thereby safeguarding environmental and consumer safety.

Optimize supply chain management: Blockchain can improve the transparency and efficiency of supply chains. Businesses can leverage blockchain to manage and track the distribution and disposal of waste and recyclables for better resource recovery and reuse.

Improve reverse logistics processes: Blockchain can support smart contracts to automate transactions and agreements in reverse logistics processes, improving logistics and transportation efficiency, reducing human error and costs.

3.5. The application of blockchain technology in green supply chains

The rise of green reverse logistics stems from people's general concern for environmental issues. After World War II, the rapid development of the world's productive forces has also had a serious impact on the earth's ecological environment, including the worse quality of the world's environment, unclean air quality, and the proliferation of industrial waste and waste products.

3.5.1. Choice of supplier

Supplier and supplier selection is seen by industry and academia as a key issue for the long-term success of supply chains. Careful selection and evaluation of suppliers is a necessary initial step in ensuring the sustainability of the supply chain. This upstream part of the supply chain has the most far-reaching impact on the sustainability of the entire supply chain. Problems in the upstream supply chain can easily be hidden from purchasing organizations, further exposing their risks and affecting the resilience of the supply chain. Supplier selection and evaluation in the context of

sustainability is a multidimensional and complex issue. Often, the selection and evaluation of suppliers relies on information. This information is not easily accessible, certified and audited, especially in non-economic, social and environmental, sustainability aspects.

The use of blockchain technology can effectively alleviate this major obstacle to sustainable information limitations. Supplier historical performance and sustainability data is available on the blockchain. This accurate and secure data on suppliers' environmental performance helps companies improve their supplier selection process based on green performance value. The use of blockchain can not only facilitate the supplier selection process, but also provide information about the entire supply chain across multiple tiers and sub-suppliers. Shared information on the blockchain provides companies with the opportunity to help their suppliers choose suppliers at different levels of the supply chain. This will help reduce the risk to key companies. Removing middlemen is also an important outcome that can enhance the supplier selection process in the supply chain and reduce costs. Supply chain sustainability database systems currently exist, such as the Business Social Compliance Initiative (BSCI) database for voluntary supplier social and environmental audits in the textile supply chain. These databases are provided to BSCI participants in some form. One of the limitations of BSCI, like other voluntary databases, is the validity and credibility of its data and audits. Blockchain technology and processes can help address some of these credibility and validity issues, with the potential to meet the requirements of third parties and non-governmental organizations (NGOs). These databases can be used for supplier monitoring, development, and selection.

3.5.2. Supplier development

Blockchain technology can help improve supplier development programs. The amount invested in the supplier development program can be recorded on the blockchain platform. The type of knowledge exchanged and the type of organizational support provided to the vendor can be tracked through smart contracts. The recorded information provides the basis for performance measurement of the supplier's development program. It is possible to compare the performance before and after the implementation of the training program on the blockchain. Through smart contracts, companies can ensure that they trade with suppliers who participate in the Supplier Development Program. This can also be used as a principle for selecting suppliers.

Environmental performance measurement and benchmarking systems are invaluable for identifying suppliers who may have problems in the supply chain. There will be a direct green supplier and sub-supplier development issues. These traditionally invisible entities in the supply chain can be the most environmentally risky and underperforming members of the supply chain. Visibility downstream in the supply chain can more effectively identify potential sub-suppliers who may need green development and support.

3.5.3. Procurement in the supply chain

Product and material data and movements can be maintained on the blockchain instead of supplier data. Each product can have several transaction characteristics recorded on the blockchain, as well as historical data of the product. These transactions may state the origin, quality, quantity, owner, and time of the product. This data provides the ability to track green quality, recyclability, and carbon footprint.

Environmental information ensures that customers are aware of the safe and sustainable production and transportation of goods. As a result, customers who are able to access this information will have the opportunity to choose sustainable products.

To ensure sustainable sourcing, companies can track the resource journey of rare and high-value products. The ability to track the origin of products to address biodiversity issues and the contribution of products to resource depletion are two cases that demonstrate the role of blockchain in ensuring product sustainability. Using blockchain technology, a product life cycle analysis can be done using actual product data.

3.5.4. Eco-design and LCA

Eco-design, which focuses on the development of new products where environmental standards play a prominent role, is influenced by blockchain in many ways. Blockchain facilitates the easy dissemination of information to multiple parties, the collection and verification of information, the control of the environmental quality of materials, the time management of new product development projects, and the coordination of participants.

In some of these cases, specific tests need to be completed. For example, in a cradle-to-cradle design model, hazardous material weighting schemes are used for various materials. After the verification process, this information can be easily stored and accessed by multiple partners. This practice lends itself well to blockchain technology, where scalability issues associated with a large number of transactions do not become characteristic of material verification. That said, the process takes time and requires a limited number of validations. Once these materials are verified, they can be used for trade and marketing.

LCA's integrated eco-design system benefits from the accuracy of the information. LCA material inventories and impacts are constantly changing, and there are many uncertainties. These systems are subject to significant environmental information uncertainties. LCA tools may have different underlying information, different levels of granularity, missing data, or even inaccurate information. The validity, reliability, and transparency of blockchain can reduce the uncertainty of information and provide better modeling inputs and outputs for eco-design and LCA tools.

Information standards for technical standards for product data based on LCA data have been proposed. It is only natural to extend these arguments to blockchain as a messaging tool for which an appropriate model has been developed. The same benefits of using these industry standards and protocols are generated through blockchain technologies and systems, especially with the overall goal of reducing LCA information

uncertainty. The benefits of adopting blockchain in these design systems include reduced LCA data collection time, improved data quality, traceability of data sources, use of actual data from suppliers instead of generic sources, and storage of environmental information at the end of a product's life cycle to better manage its recycling and disposal.

4. Summary

The application of blockchain technology in the development of green logistics can effectively solve the problems existing at the key nodes of the logistics industry. With the technical advantages of blockchain technology, such as the permanent tamper-proof database, it can comprehensively improve the management quality and efficiency of logistics and transportation, distribution, packaging, industrial chain, etc., and trace the source of products from the source, so as to effectively reduce energy consumption and carbon emissions, improve the efficiency of resource recovery, help improve the green degree of the logistics industry, and promote the construction of ecological civilization.

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