Academic Journal of Management and Social Sciences
ISSN: 2958-4396 | Vol. 6, No. 1, 2024

Exploration of Carbon Emission Statistics and Management in the Supply Chain of Automobile Industry based on Blockchain Technology

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Abstract: This paper discusses the carbon emission statistics and management of the supply chain in the automobile industry based on Blockchain technology. It first analyzes the importance and challenges of carbon emission statistics in the supply chain of the automotive industry. Then, it introduces the basic principles and characteristics of Blockchain technology and describes its potential application in supply chain management. Then, a solution for carbon emission statistics and management in the supply chain of the automotive industry based on Blockchain technology is proposed, including the establishment of a Blockchain-based carbon emission data sharing platform, the realization of data transmission and verification in each link of the supply chain, and the establishment of a smart contract to achieve the carbon emission reduction target. Finally, the possible challenges and future development direction of the solution are discussed.

Keywords: Blockchain Technology; Automotive Industry Supply Chain; Carbon Emission Statistics and Management.

1. Introduction

1.1. Background

The automotive industry is a significant source of global greenhouse gas emissions, and carbon dioxide emissions in particular play an important role in climate change. Reducing carbon emissions from the automotive sector has become an urgent task globally. However, the automotive industry has a complex supply chain involving multiple links, such as parts manufacturing, transportation, production, etc. In November 2023, the National Development and Reform Commission and other departments of the National Development and Reform Commission, in accordance with the requirements of the deployment of the "Carbon Peak Action Program by 2030" put forward the "Opinions on Accelerating the Blockchain Management System of the Products"[1] , which can be seen that it is very difficult to accurately and timely statistics and management of carbon emission, and for the carbon emission system of statistics and management system to be established is very urgent. management system is very urgent.

1.2. Potential Application of Blockchain Technology in Carbon Emissions Management

Blockchain technology is characterized by decentralization, non-tampering, and transparency, making it a potential solution to address carbon emission statistics and management in the automotive industry [2]. Through the establishment of a Blockchain-based carbon emission data sharing platform, real-time data transmission and verification can be realized between various links in the supply chain to ensure the accuracy and credibility of the data. At the same time, through the use of smart contracts, carbon emission reduction targets can be automated to ensure the compliance of each link in the supply chain. In addition, Blockchain technology can provide a complete traceability system to track and verify the authenticity of carbon emission data, promoting transparency and cooperation within the industry.

Although Blockchain technology has great potential in carbon emission management, it also faces some challenges, such as technology maturity, data privacy protection and compliance. In the future, further research and exploration should be conducted on how to overcome these challenges and practically apply Blockchain technology in supply chain carbon emission statistics and management in the automotive industry [3].

2. Overview of Blockchain Technology

2.1. Fundamentals of Blockchain Technology

Blockchain technology is the technology underlying a decentralized, distributed ledger. Its core principle is to pack transaction data into blocks in chronological order and link each block to the previous block through a kind of cryptography to form a tamper-proof chain structure. Blockchain technology has the characteristics of openness and transparency, decentralization, non-tampering and traceability [4].

2.2. Advantages of Blockchain Technology

(1) Decentralization: Blockchain technology adopts a distributed network architecture that does not rely on a central node for management and control, which can reduce the risk of a single point of failure and improve the stability and security of the system.

(2) Data security: Blockchain uses encryption algorithms (e.g. SHA-256) to encrypt and protect the data, ensuring the security of the data [5]. In addition, the distributed nature of Blockchain makes it difficult for attackers to tamper with the data, which further improves the security of the data.

(3) Traceability: Each transaction in the Blockchain contains the hash value of the previous transaction, forming a chain structure. This makes the data in the Blockchain highly traceable, which is conducive to revealing the true intentions

and behaviors of both parties to the transaction.

(4) Transparency: Data in the Blockchain is open to all participants, facilitating monitoring and auditing. This helps to increase the transparency and fairness of the entire system.

(5) Reduce transaction costs: Blockchain technology can eliminate intermediary links, reduce transaction costs and improve transaction efficiency.

2.3. Advantages of Blockchain Technology in Carbon Emission Management

Blockchain technology can ensure the truthfulness, transparency and traceability of carbon emission data, which is conducive to improving the credibility of carbon emission data. Secondly, Blockchain technology has high data security, which can effectively prevent the tampering and leakage of carbon emission data. Blockchain technology can also reduce the risk of centralization in the management of carbon emissions and improve the stability and security of the system [6]. Thirdly, Blockchain technology can realize automatic trading and settlement of carbon emission rights, and improve the efficiency and convenience of carbon emission trading. Finally, Blockchain technology can encourage more enterprises and individuals to participate in carbon emission management through incentive mechanism, and jointly realize the goal of low-carbon economic development. The application of Blockchain technology in carbon emission management has great potential to help improve data transparency, safeguard data security, reduce transaction costs, and incentivize more participants to jointly achieve the goal of low-carbon development.

3. Carbon Emission Status and Problems in the Supply Chain of the Automotive Industry

3.1. Sources of Carbon Emissions in the Automotive Industry Supply Chain

Carbon emissions from the supply chain of the automotive industry mainly come from the following aspects: first, in the mining and processing of raw materials, such as the mining and refining processes of metallic materials such as iron, steel and aluminum, as well as the processing of non-metallic materials such as plastics and rubber. Second, in the production of parts and components and the manufacture of complete vehicles, including the production process of parts and components such as engines, transmissions and braking systems, the energy consumption in the process of automobile assembly, and the emissions of chemical products such as solvents and adhesives used. In the use phase, automobiles also produce tailpipe emissions, including carbon dioxide and nitrogen oxides, during use.

3.2. Dilemma of Monitoring and Statistics of Carbon Emission Data

The lack of unified carbon emission calculation standards and data collection methods has led to large deviations in the carbon emission data of various enterprises, and there may be concealment and omission in the statistical process of carbon emission data of some enterprises. The real-time monitoring and statistical capacity of carbon emission data of some enterprises is insufficient, making it difficult to reflect the carbon emission status of enterprises in a timely manner[7] . Finally, in the supply chain, the attribution of carbon emission data is more complicated, involving the integration and distribution of carbon emission data in different links.

3.3. Challenges of Carbon Emissions Data Management

The most important problem in carbon emission data management is the lack of a unified and comprehensive carbon emission data management system, which leads to inefficiency in data management; in addition, how to ensure the accuracy and completeness of carbon emission data is an important challenge for data management.

In the process of carbon emission data management, it is also necessary to think about how to protect the commercial secrets of enterprises while ensuring data sharing, and how to effectively visualize and analyze the huge amount of carbon emission data, to enable enterprises to understand the status of carbon emission in a timely manner and formulate corresponding emission reduction strategies [8]. Finally, as governments pay more and more attention to carbon emission management, how to adjust the data management strategy in time to adapt to the new policy requirements in the context of regulatory changes. Fourth, the carbon emission statistics and management program for the supply chain of the automotive industry based on Blockchain technology is also a major challenge.

4. Carbon Emission Statistics and Management Scheme for Supply Chain of Automobile Industry Based on Blockchain Technology

(1) Build a Blockchain tracking system: through Blockchain technology, build a transparent, fair and reliable Blockchain tracking system to realize the real-time monitoring and tracking of carbon emission data of each link in the supply chain of the automotive industry.

(2) System architecture design: The system is constructed using key technologies such as blocks, nodes and consensus algorithms. Blocks are used to store carbon emission data, nodes are responsible for verifying and disseminating the data, and the consensus algorithm ensures the security and consistency of the data.

(3) Data collection and processing: Utilizing technologies such as IoT devices and sensors to collect real-time data on carbon emissions in the automotive industry supply chain. For example, monitoring carbon emissions from factory emissions, energy consumption, transportation links, etc.

(4) Storage and analysis of carbon emission data: Adopting distributed storage technology, carbon emission data are stored on the Blockchain to ensure the security and non-tampering of the data. At the same time, data analysis algorithms are used to mine and analyze the Blockchain data to provide decision-making support for enterprises and the government.

(5) Sharing and traceability of carbon emissions data: Sharing and traceability of carbon emissions data in the supply chain can be realized through cross-chain communication technology and digital identity technology. Cross-chain communication technology makes it possible to exchange data between different Blockchain systems, while digital identity technology ensures the traceability of data sources.

5. Advantages and Challenges of Supply Chain Carbon Emission Management in the Automotive Industry Based on Blockchain Technology

In terms of advantages, Blockchain technology ensures the accuracy and credibility of carbon emissions data through its decentralized and non-tamperable features. Participants share data on the Blockchain, avoiding the possibility of data tampering and false reporting. At the same time, Blockchain technology enables information sharing across supply chain segments, helping enterprises identify and optimize carbon emission-intensive segments so as to achieve collaborative emission reduction. Through smart contracts, enterprises can automatically monitor and adjust carbon emission behaviors to improve the effect of emission reduction. Third, Blockchain technology can simplify the monitoring, reporting and verification process of carbon emissions and reduce third-party auditing costs. In addition, through automation and information management, enterprises can control carbon emissions more efficiently and reduce management costs. Blockchain technology can help enterprises understand and follow changes in regulatory policies in real time and adapt to different compliance requirements. Meanwhile, Blockchain technology can improve the regulatory efficiency of the regulatory authorities and ensure the consistency and fairness of policy implementation [9].

However, the supply chain carbon emission management of the automobile industry based on Blockchain technology also faces the following challenges. Although Blockchain technology has been widely used in finance, logistics and other fields, its application in supply chain carbon emission management in the automotive industry is still in its infancy, and the maturity of the technology needs to be improved. In addition, deploying Blockchain technology requires high initial investment, including hardware equipment, technology development and talent training, which may hinder some small and medium-sized enterprises (SMEs) from participating in Blockchain applications. Meanwhile, the supply chain of the automotive industry involves many links and participants, and it is difficult to realize cross-industry and cross-country collaboration. How to break the information silos and realize data sharing and collaborative emission reduction is an urgent problem to be solved. In conclusion, the carbon emission management of the automotive industry supply chain based on Blockchain technology has obvious advantages, but it also faces a series of challenges. By strengthening technical research and development, improving laws, regulations and standards, and promoting cross-industry collaboration, it is expected to gradually overcome these challenges and realize the application and development of Blockchain technology in supply chain carbon emission management of the automotive industry.

6. Conclusion and Outlook

6.1. Impact of Blockchain Technology Based Supply Chain Carbon Emission Management in Automotive Industry on the Industry

Blockchain technology-based supply chain carbon emissions management in the automotive industry can improve data transparency, reduce enterprise operating costs, promote the development of green industry and facilitate carbon emissions reduction. Blockchain technology has the characteristics of decentralization, data tampering and traceability, which is conducive to ensuring the accuracy and authenticity of carbon emission data. By uploading the carbon emission data of each link of the supply chain onto the Blockchain, enterprises can realize real-time tracking and monitoring of the carbon emissions of the entire supply chain and improve data transparency. By monitoring, evaluating and supervising the carbon emissions of the supply chain, the government and enterprises can more accurately formulate carbon emission reduction targets and policies, which will in turn promote the reduction of carbon emissions in the entire automotive industry.

6.2. Technology Development Trends and Challenges

With the continuous development and maturity of Blockchain technology, its application in carbon emission management in the supply chain of the automotive industry will become more and more extensive. In addition, the combination of Blockchain technology with Internet of Things, big data, artificial intelligence and other technologies will further enhance the efficiency and accuracy of carbon emission management. Although Blockchain technology has been widely used in finance, logistics and other fields, its application in supply chain carbon emission management in the automobile industry is still in the primary stage, and the maturity of the technology needs to be improved. Finally, in the Blockchain system, there is a contradiction between the openness and transparency of data and privacy protection. How to protect corporate and personal privacy while ensuring data transparency is a problem that needs to be solved by Blockchain technology in carbon emission management.

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