

# Application of Blockchain Technology in Green Supply Chain

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**Abstract:** Consumer awareness of green environmental protection is the main driving force for manufacturers to produce green products, cultivate consumers' environment-friendly consumption concept, improve consumers' green preference, and actively guide consumers to buy green and low-carbon products. Green trust is an important factor leading consumers to buy green products, the application of blockchain technology can improve the transparency of green information, maintain the green brand image, and then enhance green trust, increase the sales of green products.

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## 1. Research Background

Along with the continuous progress of our country's economy and society, green development has become a national strategy. In 2021, the two sessions of the National People's Congress will for the first time include carbon peaking and carbon neutrality in the government work report, ensuring the realization of the overall goals of carbon peaking by 2030 and carbon neutrality by 2060[1]. The report to the Party's 20th National Congress in 2022 lists the widespread formation of green production and life styles as one of the overall goals by 2035. Consumers' awareness of environmental protection has also increased, showing green preferences and tend to buy green products. Whether a product is green has become an important factor affecting consumers' purchasing decisions[2]. According to Pricewaterhouse coopers' Global Consumer Insights 2022 Survey, 45 percent of Chinese respondents are willing to pay more than average for products made from environmentally friendly materials, and 50 percent are willing to pay more than average for products whose sources are traceable or transparent[3].

In the environment of national policy guidance and consumer awareness of environmental protection, increasing investment in research and development of green emission reduction technologies, expanding the supply of green products, and improving resource utilization efficiency have become the development trend of most enterprises. In terms of green supply chain, production enterprises need to invest a lot of money to adopt green emission reduction technology. Only when consumers' willingness to buy green and low-carbon products is high enough can they make up for the investment cost of green research and development of enterprises[4]. However, in the actual operation process, the production and processing information of green and low-carbon products is often opaque and difficult to verify, and some enterprises or e-commerce platforms "greenwash" ordinary products in order to expand product sales and seek higher profits. For a long time in the past, consumers have doubts about green products in the market, and consumers' green trust is reduced, thus affecting consumers' green purchase intention[5]. Therefore, the accuracy and traceability of green information have an important impact on the green investment decision of each main body of the supply chain.

Commodity traceability technology has been widely used

in various industries and fields, but there are still problems such as data easy to tamper, data dispersion in circulation, and difficult government supervision<sup>[6]</sup>. However, blockchain technology can overcome these drawbacks of traditional traceability technology. As a brand new information computing paradigm, blockchain technology has been extended to digital finance, supply chain management, e-government, Internet of things and many other fields, and is considered to be a new generation of core disruptive technology after steam engine, electricity and the Internet<sup>[7]</sup>. Blockchain technology is a decentralized, open and transparent database<sup>[8]</sup>. Its core advantage is that it can guarantee mutual trust among various entities and reduce the cost of restoring and maintaining trust<sup>[9][10]</sup>. It can effectively promote the green development of manufacturing and build a green supply chain<sup>[11][12]</sup>. The government should also be committed to building a high-quality blockchain-supported platform for the entire industrial chain, and introduce relevant policies to encourage enterprises to conduct transactions on the platform. In March 2021, the 14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of 2035 Vision Goals approved by the two Sessions of the National People's Congress clearly listed blockchain as a key industry of the digital economy.

Online retail has maintained a strong growth momentum in the past few years, with more and more consumers switching from traditional offline purchases to online shopping. The resale model of e-commerce platforms as distributors and the platform market model as market intermediaries are prevalent in the operation of e-commerce platforms, and more and more green product manufacturers are exploring online sales channels. Domestic and foreign e-commerce giants are also trying to layout blockchain technology, especially in the blockchain traceability aspect of active exploration and practice. A number of e-commerce platforms, such as eBay, Tmall International and JD.com, have adopted blockchain for green product traceability to build customer trust and improve the image of product quality on e-commerce platforms. According to the report, after the implementation of the blockchain traceability service, the sales volume and re-purchase rate of green products, health care products and infant milk powder and other brands on JD platform have been greatly improved, fully demonstrating the significant role of blockchain traceability in improving consumer satisfaction and expanding market demand<sup>[13]</sup>.

Therefore, considering the green preference and green trust of consumers, it is of great significance to study the selection strategy of green supply chain sales mode considering blockchain technology.

## **2. Green Supply Chain**

### **2.1. Overview of green supply chain**

The concept of green supply chain was first proposed by the Manufacturing Research Association of Michigan State University in 1996 in a study of "Environmentally responsible Manufacturing (ERM)", also known as environmentally aware supply chain or environmental supply chain, which is a modern management model that comprehensively considers environmental impact and resource efficiency throughout the supply chain.

In a broad sense, green supply chain refers to requiring suppliers to manage their products related to the environment, and also to incorporate environmental protection principles into the supplier management mechanism. The purpose is to make their products more environmentally friendly and enhance the competitiveness of the market. At present, we generally believe that the green supply chain refers to the supply chain effect caused by the green products proposed by the European Union after entering the 21st century.

For enterprises, joining the green supply chain is not only a behavior with significant social benefits, but also an effective means to achieve significant economic benefits. Green supply chain can avoid the waste of resources, enhance the social responsibility of enterprises, bring good reputation and brand image of green products to enterprises, and expand the product market. The saving of production raw materials reduces the life cycle cost of the final product, so that the final consumer only needs to pay a lower price to get a safer and more environmentally friendly product. In addition, the achievement of green production in the upstream of the supply chain can be amplified in the subsequent process of the supply chain. Enterprises that implement green supply chain management are not only more likely to meet environmental standards themselves, but also can promote other enterprises in the supply chain to meet environmental standards. Green supply chain through the establishment of long-term member cooperation to achieve both commercial profits and environmental purposes.

By introducing the theory of green supply chain, this paper can clarify the optimal profit level of green manufacturers and e-commerce platforms in the development process of green supply chain. At the same time, considering the application of blockchain technology, it can clarify the choice of enterprises on the chain and sales mode, and the impact of blockchain technology on the development of enterprises.

### **2.2. The influence of consumer green preference on green input decision of supply chain**

In recent years, concepts such as energy saving, environmental protection, recycling and reuse have been incorporated into the consumption concept, and green and low-carbon consumption has gradually become a new consumption trend[14]. Consumer green preference means that consumers take the greenness of products as an important consideration in the process of product selection, and favor green products in the actual purchase behavior[15]. When the consumer group with green preference reaches a certain scale,

it will directly lead to a change in the demand for green products in the market. With the increasing awareness of environmental protection, consumers are more inclined to buy products that are conducive to environmental improvement. When manufacturers take environmental factors into account when making production decisions, it will be more advantageous for their products to obtain market access[16]. PWC research shows that consumers are willing to pay more for low-carbon products. At present, many scholars have considered the factors of consumers' green preference in the study of green supply chain. Wang[17] We found that a more stringent carbon cap-and-trade system and higher consumer preference for green can encourage manufacturers to reduce emissions, but the preference to improve consumer green is more easily accepted by enterprises at the node of the supply chain, because it always benefits manufacturers and retailers; Sun[18] Considering the lag of emission reduction technology and consumers' green preference, et al. analyzed the carbon emission transfer and emission reduction among enterprises within the supply chain. The research results show that only when the lag time of emission reduction technology is within a certain range, the improvement of consumers' green preference will significantly affect the supply chain profits. Lou Gaoxiang[19] The study of et al. found that with the increase of consumers' low-carbon preference, manufacturers have a higher ability to bear the difficulty of emission reduction and invest more in the research and development of emission reduction technologies. Fan[20] Et al. constructed a green supply chain model considering retailer altruism, and found that in dynamic Stackelberg game, moderate consumer green preference is beneficial to decision makers, while excessive consumer green preference is unfavorable to decision makers. Huang Zuqing[21] Based on the Hotelling model, et al. studied the impact of consumers' green preference on pricing strategies of new and old products and supply chain profits in the closed-loop supply chain, and found that consumers' green preference has a positive impact on the price of green new products and a negative impact on the price of green waste products. Sun Jianan and Xiao Zhongdong[22] The optimal emission reduction boundary of green supply chain is studied, and the results show that manufacturers will complete green product certification by upgrading green innovation technology to enhance consumers' trust in green products.

## **3. The Application of Blockchain Technology in Green Supply Chain**

### **3.1. Overview of blockchain technology**

Blockchain technology originated from bitcoin. In November 2008, Satoshi Nakamoto first proposed the concept of Bitcoin in his published "Bitcoin: a peer-to-peer electronic cash system". Two months later, the theory stepped into practice. In January 2009, the Genesis block with serial number 0 was born, followed by the block with serial number 1. And the Genesis block with serial number 0 is connected to form a chain, marking the birth of the blockchain.

In the narrow sense, blockchain is a chain data structure that combines data blocks in a sequential manner in accordance with the chronological order, and a distributed ledger that cannot be tampered with or falsified by cryptography. In a broad sense, blockchain technology is the use of block chain data structure to verify and store data, the use of distributed node consensus algorithm to generate and

update data, the use of cryptography to ensure the security of data transmission and access, the use of automated script code composed of smart contracts, programming and operating data of a new distributed infrastructure and computing paradigm.

Blockchain technology has great potential application value in the fields of finance, Internet of Things and logistics, digital copyright and so on. The application of blockchain technology in the financial industry can eliminate the need for third-party intermediaries and achieve direct point-to-point docking, thus greatly reducing costs and quickly completing transactions and payments. Apply blockchain technology to the Internet of Things and logistics. Through blockchain technology, logistics costs can be reduced, the production and delivery of goods can be traced, and the efficiency of supply chain management can be improved. Applying blockchain technology in the field of digital copyright, works can be authenticated through blockchain technology to prove the existence of works such as text, video and audio, and ensure the authenticity and uniqueness of ownership.

### 3.2. Application of blockchain technology to enhance green trust

Blockchain technology has the characteristics of decentralization, immutability and traceability, which can realize the information interaction of the supply chain, improve the transparency of information, realize product traceability, effectively improve the transparency of the supply chain, solve the green trust problem of consumers in the purchase of green low-carbon products, and promote the investment of enterprises in green emission reduction. Consumer trust means that consumers recognize and trust the products or services of a company or a brand, which comes from the continuous enhancement of consumer satisfaction. Chen et al. [23] first put forward the concept of green trust: trust is consumers' belief and expectation of green products, and they tend to rely on the green products based on their green and environmental protection properties. Green trust reflects consumers' recognition of enterprises' green marketing, and is of great significance to the establishment of corporate image and the formation of a good reputation[24]. Most scholars have studied the effect of green trust on purchase intention: Suhartanto et al.[25] incorporated the green trust model into the green purchase intention model to assess young customers' re-purchase intention for green plastic products. Wasaya[26]The study of et al found that green trust, green perceived risk and green perceived quality significantly predicted green purchase intention, and

environmental awareness significantly moderated the relationship between green purchase intention and its predictors. Dhir[27]By analyzing the cross-sectional data of 387 Japanese consumers, we found that green trust, environmental attitude and label satisfaction are positively correlated with green clothing purchasing behavior. Some scholars have studied the mediating role of green trust. Li et al.[28] studied the influence mechanism of environmental values on the purchase intention of green products, and the research results showed that green trust plays a positive moderating role in environmental concern and purchase intention of green products. Sheng Guanghua and Xie Fang[29]It is found that internal control psychological control source can positively regulate green purchase intention through green trust. Few scholars have studied green trust in the supply chain game model. Lin Qiang[30]Considering the situation that consumers do not fully trust green products, we construct a green supply chain game model considering blockchain technology, and explore the necessary conditions for the application of blockchain under the conditions of environmental and economic value objectives. Cao Yu[31]The study of environmental labeling strategy selection in green supply chain shows that the green effort level of manufacturers and retailers will increase with the increase of consumers' green trust. Li Jian et al.[32] Finding that the information sharing mechanism of "blockchain + collaborative emission reduction" effectively improves the collaborative emission reduction efficiency of upstream and downstream enterprises in the supply chain; Linhu West[33]it is pointed out that blockchain technology can reduce the information asymmetry and transaction cost of green production of supply chain enterprises, and promote enterprises to spontaneously transform to green production. The above research is only aimed at the impact of blockchain technology applied to green product traceability under a single sales model. Yao Fengmin et al[34]The impact of the application of blockchain technology on the sales mode is compared, but due to the exogenous commission ratio in the sales mode and the non-consideration of the blockchain cost of the e-commerce enterprises in the resale mode, the interaction between the application of blockchain technology and the two sides of the enterprises is not fully reflected. When comparing the conditions of the application of blockchain in the two models, only the factor of blockchain cost is considered.

This paper considers that blockchain technology enhances green preferences by increasing green trust, which in turn affects consumer purchase preferences. This is shown in Figure 1.

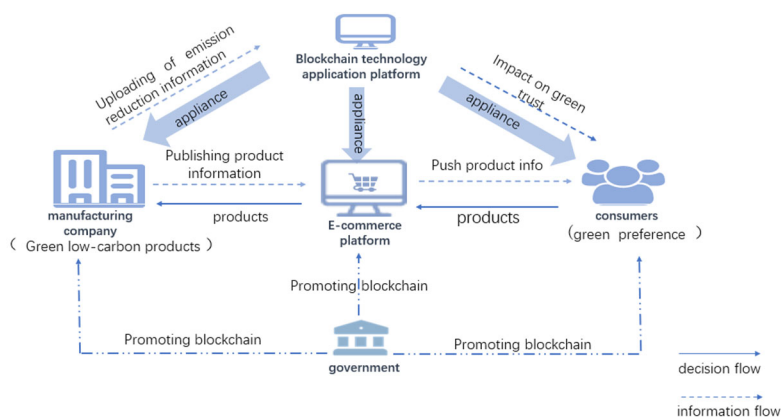


Figure 1. Mechanism of application of blockchain technology in green supply chain

## 4. Conclusion

In terms of the research on consumers' green preference in green supply chain, the existing research shows that the increase of consumers' green preference will lead to the increase of enterprises' green R&D investment. However, most of the existing literature simplifies the product market demand as a linear function of consumers' green preference, but in fact, it is a complicated process for consumers to transform from green preference to green purchasing behavior. In order to gain the favorable impression of green and low-carbon products in the market, manufacturers lie about the green information of products, which leads to the green trust problem of consumers for green and low-carbon products in the market. The empirical study shows that green trust has a very important effect on consumers' purchase intention of green and low-carbon products. However, there is a lack of quantitative research on consumers' green trust in existing literature. Some scholars have considered the factor of consumer green trust in the study of low-carbon supply chain, but the research is not deep enough.

In terms of blockchain technology research, early studies mostly focused on the development of computer database, and few literatures studied the application of blockchain technology in green supply chain. The researches related to low-carbon supply chain mainly analyzed the impact of blockchain technology on supply chain operation and green input based on empirical analysis. At present, many scholars have made research on the application of blockchain technology to supply chain finance, but the research on green supply chain under blockchain technology has the following shortcomings: First, it does not consider the impact of the introduction cost of blockchain on its introduction strategy. At present, most scholars' researches on blockchain technology and green supply chain mainly focus on subsidy strategies, pricing decisions and green input decisions of governments and enterprises, focusing on the changes in supply chain decisions after the use of blockchain. Some literatures also confirm that the traceability mechanism of blockchain technology can effectively reduce the problem of information asymmetry among enterprises and consumers' trust in products. However, after the application of green blockchain technology in green supply, there will be a large blockchain cost, which will have a great impact on the decision of introducing blockchain technology in enterprises. The existing literature lacks the research on the decision of introducing blockchain in enterprises. The introduction of blockchain technology can also encourage enterprises to increase green investment. The government should increase policy support, control the unit cost of blockchain technology within a reasonable range, encourage enterprises to actively apply blockchain technology, promote enterprises' green emission reduction and increase consumers' demand for green products.

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