

# Big Data Evaluation Technology in the Implementation Strategy of Green Supply Chain Management for Manufacturing Enterprises

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**Abstract:** Implementing green supply chain, also known as Environmentally Conscious Supply Chain (ECSC) management in enterprises, can not only improve their environmental performance, but also improve their economic performance. The two can achieve a “win-win situation”. Driven by big data, the value behavior of manufacturing enterprises is developing towards digitization and networking, which would provide them with new business models and new economic growth points. In the big data environment, fund management has shifted from ex post control to every process in the process. Big data technology can optimize various business processes such as enterprise research and development and production, green supply chain, and marketing, and innovate business management models to achieve the goal of reducing costs and increasing efficiency. Based on the analysis of transaction costs and the theory of inter organizational cost management, this article regarded a cooperative enterprise in the supply chain as an organization, using big data technology to reduce costs and improve enterprise efficiency. The variance in the big data environment was 0.898, while the traditional green procurement practice variance was 0.955. For the operation mode of manufacturing industry, this article provided a new practical solution for ECSC management of manufacturing enterprises.

**Keywords:** Green Supply Chain Management, Big Data, Manufacturing Enterprises, Green Procurement

## 1. Introduction

In the context of global economic integration, ECSC management strategies have gradually become a winning tool for enterprises around the world. With China’s accession to the World Trade Organization and the increasingly fierce competition in the environmental protection industry, Chinese manufacturing enterprises would face greater challenges in the future international market if they no longer adopt the development strategy of the environmental protection industry. Existing research has mostly focused on how enterprises implement ECSC management. However, due to the huge initial investment and long return cycle, it is difficult for enterprises to achieve economic benefits. This article intends to start with possible influencing factors, through research, analysis, and empirical testing of various enterprises, and ultimately determine the motivation for ECSC management in China’s manufacturing industry, so as to consciously encourage and guide manufacturing enterprises to carry out ECSC management.

The concept of “green supply chain” has been developed from the actual operation of modern logistics enterprises. Saberi S proposed a multi-phase supply chain model with freight forwarder network [1]. Sirisawat P believed that the company has realized the importance of green supply chain management [2]. Bai C aimed to evaluate the deletion decision of green products through a mixed multi-stage and multi-criteria evaluation method [3]. Xiao R believed that enterprises must pay attention to the environment while pursuing economic benefits. However, due to the shortcomings of the market economy, it is difficult for enterprises to spontaneously carry out green supply chain management [4]. Their research lacks necessary exploration of performance issues in green supply chain management.

Due to the fact that green supply chains often require a large amount of resource investment, which does not have a significant impact on company performance, this can lead to a lack of motivation for companies to implement green supply chains, the need to combine a ECSC, and thus achieve the goal

of sustainable development of enterprises.

## 2. Evaluation Methods for Green Supply Chain Management in Manufacturing Enterprises

### 2.1 Green Supply Chain Management

The rapid development of science and technology in the 21st century has led to the rapid development of productivity in the world, and industrialization and urbanization have developed rapidly worldwide. Manufacturing provides a large amount of material to meet the needs of daily life. At present, the natural resources that human beings possess are continuously decreasing or even depleting, while the environmental pollution problem is also increasing, which may pose a threat to the body at any time. In the context of increasing environmental awareness, enterprises at important nodes in the supply chain have formulated and implemented strict internal environmental management standards, but their upstream and downstream enterprises may not necessarily implement the same standards, resulting in a lack of systematic and overall environmental management in the ECSC. Therefore, it is impossible to achieve the true environmental protection goal [5-6]. In this situation, fully utilize their available resources, better create more material wealth, and effectively reduce negative environmental factors in the entire supply chain is a valuable issue [7]. In this process, this article gradually incorporates the concept of environmental protection into the “ECSC” [8-9].

In ECSC management, the degree of environmental impact  $Q_w$  is:

$$Q_w = \alpha|\beta(-C - B) + (1 - B)| + (1 - \alpha)\theta \quad (1)$$

The resource efficiency  $Q_y$  in the ECSC management process of manufacturing enterprises is:

$$Q_y = \alpha|\beta(C + B) + \delta(1 - B)| + (1 - \alpha)\theta - \beta\pi \quad (2)$$

Currently, the relevant concepts of green supply chain are mostly targeted at suppliers, and they are not discussed as an organic whole [10]. In a green supply chain, product flow, information flow, and capital flow all flow efficiently in a system composed of suppliers, enterprises, and customers. Green products are produced using green design, procurement, production, packaging, and recycling techniques, thereby improving the effective use of natural resources [11-12]. In other words, the core concept of “green supply chain” is to adopt a new design concept, from raw materials to the production and processing of products to the recycling and reuse of products after customer consumption, which requires environmentally friendly design. In addition, it is necessary to closely cooperate with upstream and downstream related companies in the supply chain to achieve optimal environmental management [13]. “Green supply chain” is defined as a closed loop, incorporating the concept of “greening” into the original supply chain management process [14-15]. The framework of a ECSC system is shown in Figure 1.

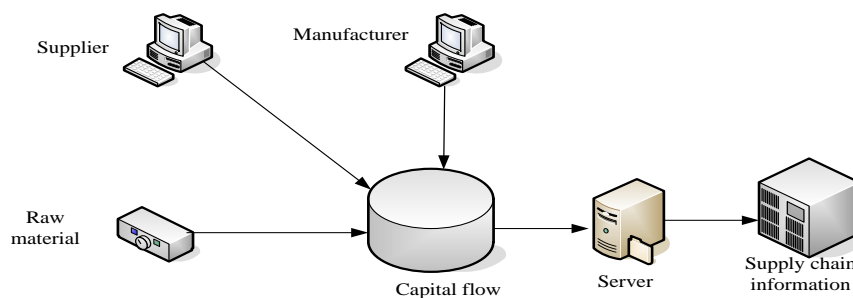


Figure 1: Framework structure of an ECSC system

At this point, the sales model for innovation diffusion in green supply chain management is [16]:

$$m_x = \beta \sqrt{(1 + n) \left(1 + \frac{N(T)}{m}\right)} \quad (3)$$

### 2.2 Impact of Big Data on Green Supply Chain Management

(1) Research and development and production

In the big data environment, manufacturing enterprises can use big data and other related

technologies to effectively manage a large amount of real-time data and achieve the maximum effective use of research and development resources [17-18].

Using research and development collaboration between platforms can accurately grasp the research and development process, improve research and development efficiency, reduce costs, shorten research and development cycles, and achieve the goal of reducing research and development costs and improving research and development efficiency [19]. Industrial production has become increasingly intelligent and autonomous. On the premise of meeting the personalized needs of users, industry can shorten the time from design to manufacturing, improve the production efficiency of research and development, and thereby reduce the production cost of research and development [20].

## (2) Marketing

Marketing in the big data environment is more convenient and targeted. In the current market, with the homogenization of products, marketing capabilities would have a certain impact on the competitiveness of manufacturing enterprises. From the perspective of users, this has also improved their shopping experience and two-way satisfaction with marketing.

More integration with technologies such as big data enhances two-way communication between users and businesses. Users can use online platforms to inform businesses of their needs. Businesses serve each user to understand their needs, enhance their control over users, and achieve accurate marketing. The application of big data technology in ECSC is shown in Figure 2.

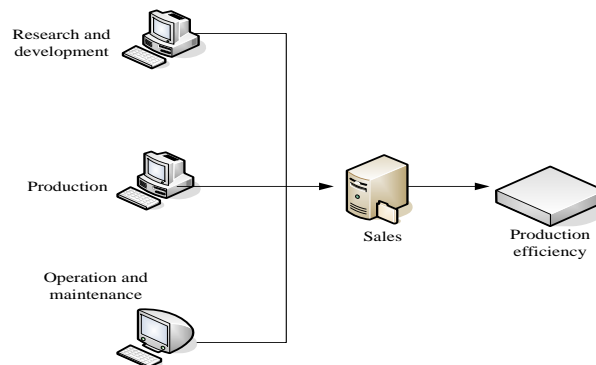


Figure 2: Application of big data technology in green supply chain

## 3. Implementation Strategy of Green Supply Chain Management for Manufacturing Enterprises

### 3.1 Implementation Background

Traditional supply chain cost management is limited to the analysis of cash flow, which cannot provide effective improvement plans, and there is a problem of separating finance and operation. Driven by big data, the value activities of manufacturing enterprises are showing a trend of data and networking. Big data technology can optimize various business processes such as enterprise research and development and production, green supply chain, and marketing, innovate business management models, and ultimately achieve the effect of reducing costs and increasing efficiency.

### 3.2 Implementation Strategy

In the context of big data, this article, based on the value chain theory of strategic planning and management, combined with the analysis of transaction costs, and based on the theory of inter-organizational cost management, treats enterprises with cooperative relationships in the supply chain as an organization, using big data technology to achieve cost reduction, efficiency improvement, and ECSC management.

## 4. Implementation Results of Green Supply Chain Management

At present, ECSC is in a period of rapid development, but people pay more attention to its risk and performance evaluation, while relatively little attention is paid to its integration. ECSC is a means of transforming the manufacturing industry from traditional linear production to circular economy. It can

not only help enterprises improve economic performance, but also solve environmental problems for enterprises. It plays a crucial role in the green development of the product manufacturing industry. Through supply chain integration, enterprises can effectively collaborate with upstream and downstream partners, thereby making the ECSC more stable. This ability is a necessary condition for enterprises to deal with uncertainties and risks in green supply chains. Efficient integration with supply chain partners would help achieve the smooth operation of green supply chains and enhance the core competitiveness of enterprises. Therefore, research on ECSC integration capability in product production process is conducive to the rapid development of enterprise green supply chain.

From the average importance score of each indicator in the sample, it can be seen that the majority of the indicators have an average value greater than 4, indicating that enterprises have faced various pressures. The average value of the impact factors of the “National Environmental Protection Regulations” reached 4.8, indicating that most samples consider the cost factor as an important factor in implementing ECSC management for enterprises. The mean value of the influencing factors for “corporate personal interest requirements” is the smallest, at 3.2, indicating that the interests of relevant enterprises and individuals do not have a import influence on the content of ECSC management implemented by enterprises, that is, internal and potential factors have not yet had an import influence on the content of ECSC management implemented by enterprises. The average value above 4.5 includes “national environmental regulations”, “green procurement costs for enterprises”, and “environmentally friendly design and manufacturing marketing costs”. The descriptive analysis results of the importance of each indicator of the sample are shown in Figure 3 (“enterprise green procurement costs” and “environmentally friendly design and manufacturing marketing costs” are shown in Figure 3 (a), and “national environmental regulations” and “requirements for the interests of individual enterprises” are shown in Figure 3 (b)).

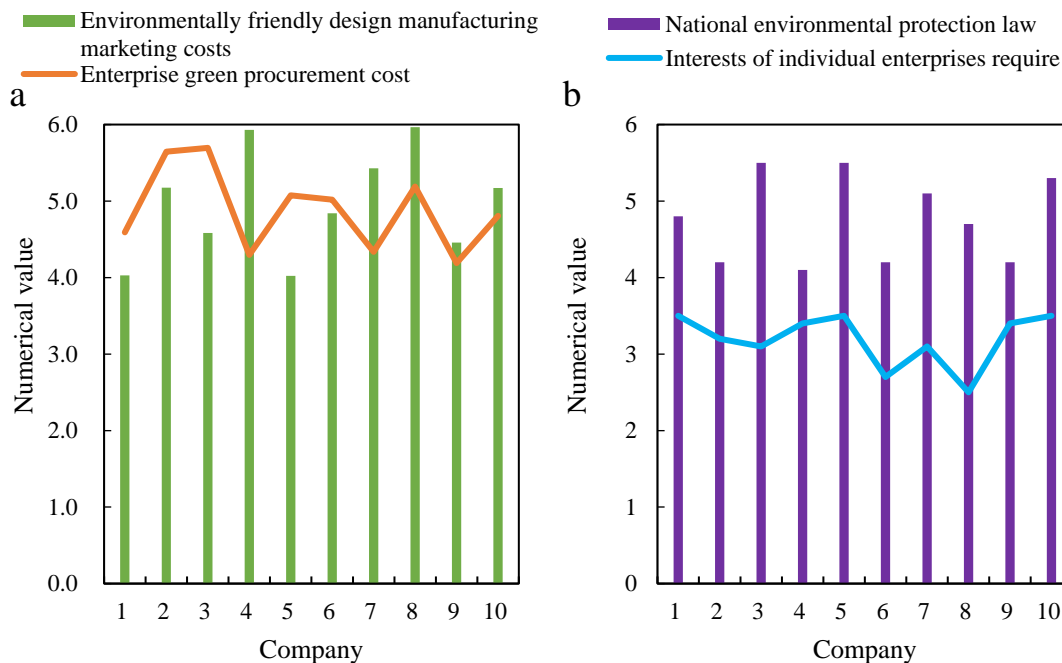


Figure 3: Descriptive analysis results of the importance of each indicator in the sample

Due to the continuous changes in the external environment, there are certain risks in the implementation of ECSC by enterprises. The implementation process of a ECSC is very complex, such as procurement, operations, services, and other links that require environmental investment, so the risks it faces are also diverse. Supply chain integration is an effective management method that can effectively control various risks faced by enterprises in the business process. It refers to the joint efforts of enterprises and their upstream and downstream enterprises to establish effective communication, resource sharing, and risk and benefit mechanisms for common interests. However, the current theory on supply chain integration capabilities and supply chain risk is not in-depth enough, making it difficult to effectively solve this problem in practical applications.

The green procurement coefficient was 0.08 in 2018 and 0.22 in 2022. In 2022, the impact of adopting “green” supply chains for green procurement and green design is most significant. The

regression results of influencing factors of green supply chain are shown in Table 1.

“Green procurement” refers to an environmentally-oriented procurement activity, which aims to achieve the environmental protection goals set by enterprises by reducing waste sources, promoting reuse, reducing resource consumption, and achieving the substitutability of raw materials. In the upstream of the supply chain, low quality, low timeliness, and uncertainty about discarded products can all lead to enterprises not being able to “green purchase”. Considering environmental factors, the green suppliers of manufacturing enterprises play an important role in the stability of the supply chain. On the other hand, according to the concept of “recycling”, using rare earth elements in waste commodities as core raw materials for resource utilization not only helps to reduce the procurement risks of the electronics industry in the green supply chain, but also helps to achieve a circular economy. When facing procurement risks, the company should actively manage and control risks, and further integrate with external suppliers and various departments of the company.

Table 1: Regression results of influencing factors of green supply chain

Element	2018	2022
Green procurement	0.08	0.22
Green design	0.15	0.19
Green production	0.06	0.16
Green marketing	0.16	0.18
Green recycling	0.03	0.12

This paper proposes an innovative, sustainable, and strong vitality green supply chain management model. Based on the shift of the product industry from a traditional linear production model to a circular economy model, this article intends to establish a theoretical model based on green supply chain integration capabilities in the context of circular economy by studying how green supply chain risk management can promote supply chain integration capabilities, thereby affecting business performance. This model provides a theoretical basis for research in related fields. From a practical perspective, Chinese business operators have paid high attention to the integration capabilities of green supply chains. The research on green supply chain risk control and supply chain integration capabilities can provide a theoretical basis for enterprises to improve their integration capabilities and reduce the risks they face in production and operation. This can not only improve the company’s operating performance, but also improve the company’s environmental performance, allowing the rapid development of the manufacturing enterprise’s circular economy model, which is also a support and response to the national ecological civilization construction.

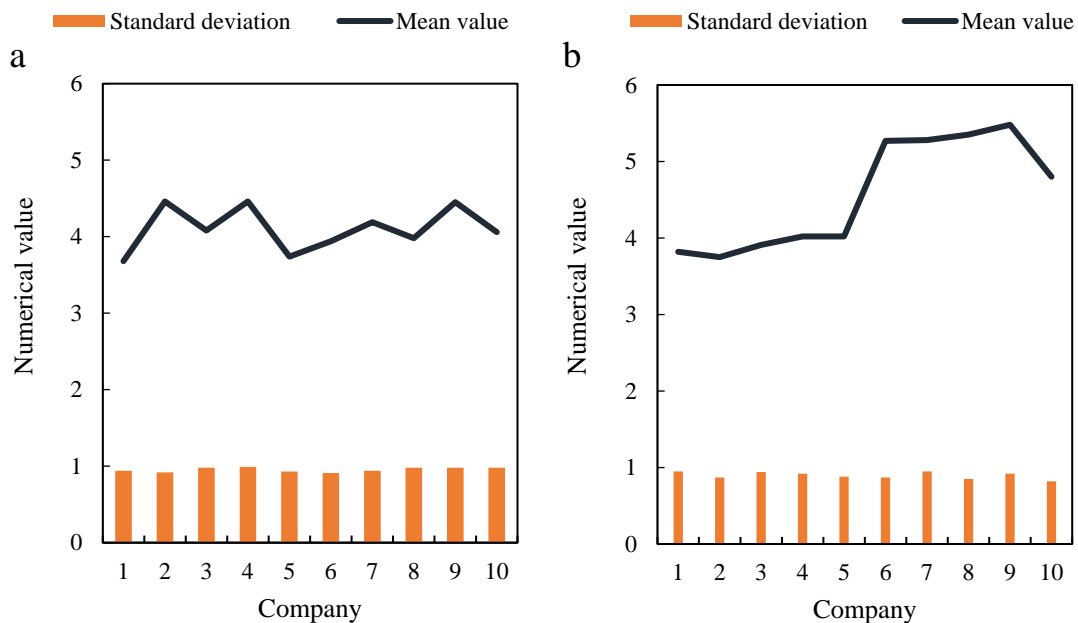


Figure 4: Distribution of green procurement practices by enterprises

The distribution of green procurement practices among enterprises is shown in Figure 4 (traditional

methods are shown in Figure 4 (a), and big data environments are shown in Figure 4 (b)). The variance in the big data environment is 0.898, while the variance in traditional green procurement practices is 0.955. Therefore, the manufacturing supply chain management scheme in the big data environment is more stable.

## 5. Conclusions

The research and development, design, production, marketing, and after-sales service of the manufacturing industry should be adjusted according to market changes. The in-depth application of “green supply chain” technology in the manufacturing industry in this article can effectively promote the development of the manufacturing industry. Through the application of big data and other technologies, it has promoted the innovation of production management and supply chain business processes in the manufacturing industry, the collaboration of research and development and design, the integration of business and finance, and the integration of production, supply, and sales. The cost management of the supply chain has been optimized to the maximum extent, thereby achieving the goal of reducing costs and improving efficiency. Manufacturing enterprises should seize the opportunity of transformation, make scientific and reasonable arrangements for the investment in industrialization and industrialization, and closely connect with the business processes of the green supply chain with the support of technologies such as big data, so as to achieve the optimal allocation of resources and improve the efficiency of resource utilization. In future work, it is necessary to innovate product and service mechanisms to improve the production and operation efficiency of the enterprise, optimize cost management, and achieve the goal of enhancing the comprehensive competitiveness of the enterprise, enhancing its economic and social benefits, and promoting the sustainable development of manufacturing enterprises.

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