

Research on the Application of Green Supply Chain in New Energy Automobile Industry under the Background of "Double Carbon" Goal

-- BYD as an example

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Abstract: This paper adopts a case study approach to study the green supply chain of new energy vehicle enterprises represented by BYD. The SWOT method is used to analyze the advantages, disadvantages, opportunities and threats of BYD's green supply chain, and summarize the ways to implement the green supply chain in new energy vehicle enterprises, including: the construction of a reasonable vertical supply chain; increasing the research investment in new energy automobile environmental protection science and technology, as well as the digitization of supply chain management. Through the study of BYD's green supply chain management, it can be found that: the vertical supply chain enhances the stability of the green supply chain of new energy automobile enterprises; the green technology created by the continuous investment in scientific research promotes the supply chain of new energy vehicle enterprises to be more low-carbon and green; and the digitalization of the supply chain management is an effective tool for new energy automobile enterprises to carry out green supply chain management.

Keywords: Green supply chain management, New energy vehicles, Paths.

1. Introduction

The "dual-carbon" goal, i.e. "carbon peaking" and "carbon neutrality", is a goal proposed by China to address global climate change. For new energy vehicle manufacturers, the dual-carbon target has far-reaching significance. First of all, in order to adapt to the policies and regulations restricting compliance, new energy vehicle manufacturers should promptly adapt to the national policies related to the dual-carbon target to ensure the compliance of their own operations, and avoid being restricted or penalized for failing to comply with the policy requirements. With the introduction of the Sustainability Disclosure Standard, vehicle manufacturers need to establish a management and reporting mechanism for carbon emission information to meet the mandatory disclosure requirements. At the same time, by responding to the "dual carbon" new energy vehicle manufacturers can reduce operating costs and environmental risks. By optimizing the supply chain through carbon neutrality, new energy vehicle manufacturers can reduce production costs, and at the same time reduce the potential risks and losses caused by environmental issues. Finally, the implementation of the dual-carbon target brings huge market opportunities for new energy, energy saving and environmental protection industries .as there is a growing demand for green and environmentally friendly products, and consumers are more inclined to choose products from companies that focus on sustainable development. new energy vehicle manufacturers can obtain economic benefits by participating in these emerging markets. Therefore, new energy vehicle manufacturers should actively carry out green supply chain management to respond to the dual-carbon goal.

2. Overview of Current Status Worldwide

This paper illustrates the development status of domestic and international research from the concept and realization method of green supply chain, the significance of green supply chain to enterprises and the optimization of supply chain of new energy vehicle enterprises.

2.1. The Concept and Realization Method of Green Supply Chain

For the research on the concept and realization method of green supply chain, Zhu Qinhua. "Discussion on green logistics model based on green supply chain" (2016), proposed two aspects of green supply chain management, "green procurement" and "green logistics", focusing on the synergy in "green supply chain" and "green logistics", and the key industries in China were studied as the target [1]. Angappa Gunasekaran et al. (2012) studied the sustainable development of manufacturing and services [2]; Lan Zirui, Sun Zhenqing, and Cai Lin, "Evolutionary Game of Green-innovation Investment in Supply Chains under Low-carbon Development" (2019) studied the upstream and downstream firms in the supply chain to make green innovation investment decisions by utilizing methods such as evolutionary game [3]. Irina Harris et al. (2011) evaluated traditional cost optimization methods and analyzed the overall logistics and CO2 emissions using the European automotive industry as an example [4]. M.T. Melo et al. (2009) discussed firm location and supply chain network layout [5]. Atefeh Amindoust et al. (2012) studied the sustainable supplier selection problem and proposed a corresponding evaluation and ranking method [6].

2.2. Research on the Significance of Green Supply Chain to Enterprises

Most of the studies concluded that green supply chain management has a positive effect on the development of enterprises. Christina Maria Dües et al. (2013) explored the positive relationship between lean production and green supply chain [7]. Mingjun Jiang and Dongyan Chen, "Revenue sharing and green innovation investment of green supply chain under fairness preference" (2020) constructed an interest game model between manufacturers and manufacturers under information asymmetry based on fair preferences, and investigated the relationship between suppliers' optimal green innovation inputs and corporate revenue under information asymmetry [8]. Fang Chencheng and Zhang Jiantong, "Performance of green supply chain management: A systematic review and meta analysis" (2018) conducted a systematic empirical analysis of the positive relationship between green supply chain management strategies and enterprise performance, and obtained the positive effect of green supply chain management measures on enterprise performance [9]. Mao Tao, "Green Supply Chain Management Practice Progress, Difficulties and Solutions" (2021), in terms of environmental protection, argued that the introduction of green supply chain is a new management method for environmental protection [10].

2.3. New Energy Vehicle Supply Chain Optimization

Yi Yuyin et al. (2021) conduct an in-depth study of the automotive supply chain based on optimal pricing of trade-in [11]; Qiu Zeguo et al. (2020) study the recycling and subsidy of closed-loop new energy vehicle power battery in-depth on the basis of game theory [11]; Lu Huifang et al. (2016) explore the financing methods in the new energy vehicle supply chain [13]; Xie Jiaping et al. (2020) studied the new energy vehicle supply chain based on multi-stage contract decision optimization [14].

3. Research Methodology and Data Collection

This paper aims to analyze how BYD, as a new energy vehicle company, implements green concepts in its supply chain, and collects data and information through various ways, including searching for news about green supply chain on BYD's official website, promotional videos, media reports, and videos of expert interviews. Meanwhile, a large number of journal articles in related fields were searched and read through academic resource platforms such as China Knowledge Network. Subsequently, BYD's internal and external environments were analyzed using the SWOT analysis tool, and BYD's strengths, weaknesses, opportunities and threats in green supply chain management were identified, summarizing four possible strategies, namely, SO, ST, WO and WT. It summarizes the four possible strategies, namely SO strategy, ST strategy, WO strategy and WT strategy, to extract BYD's successful approach in green supply chain construction for the reference of other new vehicle enterprises committing to the implementation of green supply chain management, so as to promote the development of the entire new energy vehicle industry in the direction of greener, more efficient, and more sustainable development. The reason why this paper chooses BYD as the case study of green supply chain management for new energy vehicle enterprises is that

BYD's total sales of new energy vehicles have reached 1,868,500 units, which makes it the champion of sales in both the local market and the global market. In addition to its success in new energy vehicle manufacturing, BYD has also made significant contributions in the field of green development. BYD has been committed to reducing carbon emissions and promoting sustainable development. According to statistics, BYD's total cumulative reduction of carbon dioxide emissions has exceeded 8.92 million tons. In addition, as the number of BYD's new energy vehicles increases, its greenhouse gas emission density shows a decreasing trend year by year, which reflects the actual effectiveness of BYD's environmental protection endeavors.

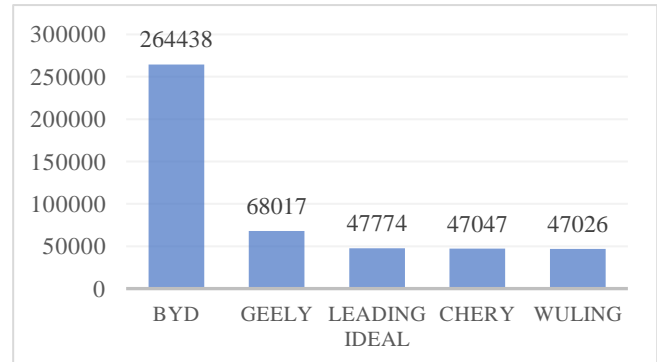


Figure 1. The top 5 Chinese car brands in terms of sales in June 2024

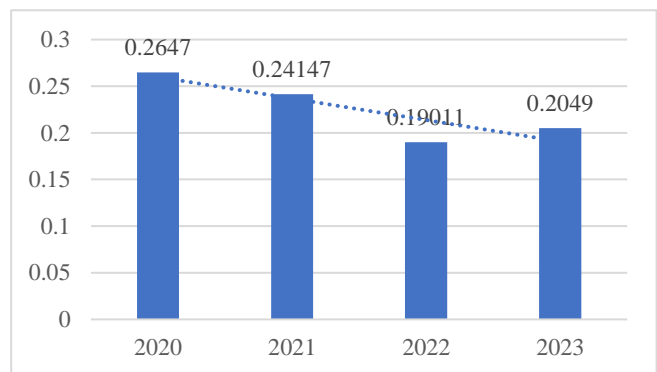


Figure 2. GHG emission intensity (tons/million revenue)

4. Case Study: SWOT Analysis of BYD's Green Supply Chain Management

4.1. Strength

4.1.1. Vertically integrated supply chains

(1) Supply chain stability: BYD is known for its strong vertical supply chain management capabilities, especially in the key three electric systems (battery, motor and electronic control), BYD has become the only company in the world that can realize independent R&D and production. The upstream involves the procurement of raw materials and supplier management; the midstream focuses on all aspects of vehicle production, including parts manufacturing, assembly and quality control; and the downstream extends to battery recycling, maintenance services and other areas, forming a complete ecosystem from production to consumption and recycling. This all-round industrial chain layout ensures the strong stability of BYD's supply chain, enabling it to give priority to environmentally friendly materials when

purchasing raw materials to reduce the pressure on the ecosystem, adopting energy-saving technologies and clean energy in the production process to reduce carbon emissions, realizing the efficient use of resources by optimizing routes, adopting environmentally friendly packaging during transportation, and establishing a complete industrial chain for the recycling of waste products, such as battery recycling. Through such comprehensive whole-process management, enterprises can not only maintain the stability of their supply chains, but also demonstrate their commitment to social responsibility and the greening of their supply chains.

(2) Green suppliers: For raw material suppliers, due to the vertical supply chain, BYD has more choices for suppliers, which enables it to continuously improve and strengthen the green procurement system of “green suppliers and green raw materials”. At the same time, BYD enhances the recycling of resources in the procurement process, reduces the number of packaging materials used, and adopts more environmentally friendly materials to reduce the use of harmful substances. For example, the materials used for car mats have been gradually changed to TPE, which is formaldehyde-free, environmentally friendly, odorless, and has better abrasion and high-temperature resistance.

(3) Green Logistics: The vertical supply chain allows BYD to manage its own logistics methods more efficiently and improve them towards greening. BYD has taken several innovative measures in the field of low-carbon marine transportation to reduce the environmental impact of the marine transportation industry. The use of carbon-neutral fuels (such as methanol to replace fossil fuels) is a low-carbon transportation method that significantly reduces CO₂ emissions during transportation. In addition, road transportation by new energy vehicles is one of the key environmental strategies pursued by BYD. BYD strongly promotes the use of electric vehicles and other clean energy vehicles for cargo transportation. These new modes of transportation not only effectively reduce air pollution, but also help reduce CO₂ emissions. These comprehensive environmental protection measures enable BYD to build a greener, more efficient and sustainable transportation network.

4.1.2. Focus on green technology innovation

By the end of 2023, BYD's cumulative R&D investment has approached RMB 150 billion. In terms of talent reserves, BYD has a large and professional R&D team, numbering more than 100,000. This scale enables BYD to have sufficient human resources in technological innovation and product development, which brings BYD a huge technological leadership advantage and also lays a strong foundation for the company's long-term green development. In addition, as the core force of BYD in the field of vehicle R&D, the wholly-owned subsidiary of BYD, FinDreams Battery, is committed to the technology development of the three major electrics (motor, electronic control and battery), chips, and core components such as the vehicle frame. Its green technology achievements cover a wide range of cutting-edge fields, such as the blade battery, DM-I/DM-P hybrid technology and Cell to Body technology. Through the continuous innovation and iterative upgrading of these technologies, BYD has demonstrated its strong technical reserves and powerful technical strength in the field of green technologies for new energy vehicles.

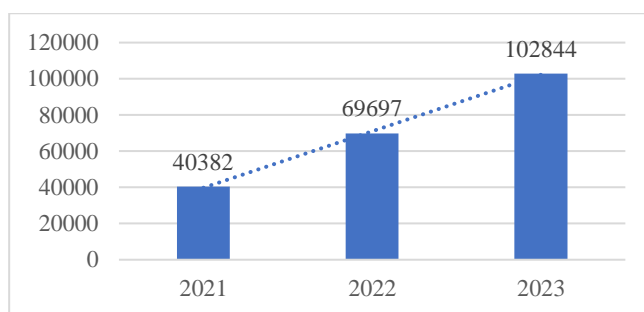


Figure 3. Number of BYD R&D staff

4.1.3. Supply chain digitalization to promote greening

BYD has launched a SRM (Supplier Relationship Management) system, which can release key information such as suppliers' production dynamics and inventory status to the management in real time, so as to enable the production plan to be adjusted quickly according to the changes in market demand, effectively reducing the waste of resources due to overproduction and avoiding the excessive consumption of resources and inventory backlog. In addition to the supplier relationship management system, BYD is also pushing forward the construction of an energy and carbon management platform. The platform has in-depth data collection capabilities at the shop floor, production line, and equipment levels, enabling the company to manage energy usage finely. In addition, the platform is able to accurately calculate the carbon emissions of each segment through real-time monitoring of energy consumption data, thus ensuring that the source of carbon emission data is authoritative and traceable, and safeguarding the accuracy and reliability of the measurements.

4.1.4. Reverse Logistics: Battery Recycling

In terms of recycling channels, BYD combines with logistics parks in provinces and cities all over the country to form a recycling network for used batteries; in terms of evaluation and screening, BYD's used battery recycling factory disassembles and evaluates used batteries, and through the control of the closed-loop industrial chain, dismantles and recycles them in an effective and delicate way. In the field of dismantling and recycling, BYD already owns the recycling process of positive electrode materials and has made in-depth cooperation with recycling whitelisted enterprises.

4.2. Weakness

4.2.1. Unclear technology strategy

New energy vehicle technology is more inclined to theoretical research and technical reserves. At the same time new energy vehicle enterprises seek opportunities for development by launching a new energy vehicle every 3-5 years for market validation. The formulation and implementation of technology strategy has become the key to an enterprise's competitive advantage. However, formulating and implementing a technology strategy often requires huge capital investment, which not only includes the original R&D costs, but also involves the salary expenses required to attract and cultivate top technological talents as well as the time costs to support long-term research. When competitive market pressures lead to compromises, there is an uneven allocation of resources, resulting in firms being unable to focus sufficient resources on those strategically important technological challenges, thus slowing down the process of technological innovation.

4.2.2. Vertical supply chain brings about quality problems

Due to the high degree of vertical integration in the supply chain, BYD's auto parts business lacks the constraints of the market mechanism, resulting in serious perfunctory submissions of parts from various departments, quality and corruption problems, and waste of resources.

4.3. Opportunity

4.3.1. New Energy Market Prospects

With the growing global demand for new energy vehicles and green technology, BYD has the opportunity to rely on its green supply chain, green technology and green development corporate image to further expand its market share and increase its corporate profitability.

4.3.2. Relevant policy support

The Chinese government has introduced a series of favorable policies to support the development of the new energy vehicle industry, such as reducing the vehicle purchase tax for new energy vehicles and improving the charging

infrastructure. These policies have effectively expanded market consumption, stimulated the vitality of the new energy vehicle market, and increased the development opportunities for new energy vehicle companies.

4.4. Threat

On the background of the instability of global supply chains, enterprises need to reassess and adjust their resource allocation in an unstable supply chain environment, which can affect the continued operation and efficiency of green supply chains. In addition, with the global emphasis on environmental protection, governments and international organizations are enacting increasingly stringent environmental regulations, such as the European Union's new battery bill, which sets out clear requirements for the use of hazardous substances in batteries. BYD needs to ensure that the raw materials and products in its supply chain comply with these regulations, or it may face market access restrictions or additional costs for compliance

4.5. Strategies

Table 1. Lists 4 possible strategies of BYD's green supply chain management based on SWOT

	Strength	Weakness
Opportunity	SO strategy: keep the original business model unchanged, give full play to the advantages of enterprise technology and vertical integration, while fully seizing the external opportunities to strive for more market share, and increase investment in R&D of energy-saving technologies.	WO Strategy: Strengthen openness to change in technology, seek technology cooperation, and further expand market share so as to better focus on new energy technology investments.
Threat	ST strategy: enhance the vertical integration of the supply chain, improve stability to cope with external environmental risks, while maintaining investment in scientific research to ensure that the quality of core components, such as motor, electronic control and battery, is qualified and leading the industry.	WT strategy: Outsourcing of uncompetitive and highly polluting businesses such as rubber and paint, and streamlining of vertical integration to strengthen quality control of core components.

5. Summary

By taking BYD as a case study to analyze the advantages, disadvantages, opportunities, threats and possible strategies for new energy vehicle enterprises to carry out green supply chain management, the following conclusions can be obtained.

Qualified vertical supply chain management adds stability to the greening of supply chain management of new energy vehicle enterprises: through moderate vertical integration of supply chain, new energy vehicle enterprises are conducive to ensuring the stability of their own supply chain from upstream suppliers to downstream logistics and transportation under the unstable environment of the global supply chain, so as to realize the greening of the whole supply chain management, such as green suppliers, green procurement, green logistics, Battery recycling, etc.

Green technology created by continuous investment in scientific research promotes the supply chain of new energy vehicle enterprises to be more low-carbon and green: more advanced new energy vehicle technologies, such as batteries with longer endurance and environmentally friendly materials, hybrid systems with higher efficiency and lower carbon emissions, as well as photovoltaic technologies with a longer lifespan and a lower damage rate, etc., can help the supply chain of new energy vehicle enterprises to be low-carbon and green and move towards the goal of carbon neutrality.

Digital supply chain management is an effective tool for green supply chain management of new energy vehicle enterprises: Digital supply chain management can effectively help new energy vehicle enterprises to balance orders and production, and manage energy and carbon emissions, so as

to improve the greenness of the supply chain. For example, the SRM system can effectively reduce the waste of resources due to overproduction, and the energy and carbon management platform ensures that the source of carbon emissions data is authoritative and traceable, and the measurement is accurate and reliable.

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