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Research on Supply Chain Resilience Promotion Strategy of New Energy Vehicle Manufacturing Industry

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Abstract

Global supply chain volatility, critical material shortages and rising geopolitical risks pose severe challenges to the new energy vehicle manufacturing industry. Based on supply chain resilience theory, this paper analyzes the vulnerability nodes of the new energy vehicle industry supply chain and constructs a resilience enhancement framework covering supply network optimization, digital empowerment, diversified procurement and inventory management, green cycle system and policy coordination. The research shows that by enhancing the transparency of supply chain, strengthening the control of key links and establishing agile response mechanism, the risk resistance and sustainable competitiveness of NEV supply chain can be significantly improved.

Keywords

New Energy Vehicles; Supply Chain Resilience; Multi-Source Procurement; Digital Supply Chain;

1. Introduction

As the core carrier to achieve the goal of "double carbon", the new energy automobile industry is experiencing explosive growth. However, its supply chain is highly complex and global layout, facing multiple shocks such as tight supply of key raw materials such as lithium, cobalt and nickel, chip shortage, international logistics interruption and trade barriers. Therefore, systematic research and improvement of new energy vehicle supply chain resilience has become a key strategic proposition to ensure industrial security and achieve sustainable development, and is also the core research goal of this paper.

2. Vulnerability analysis of new energy vehicle supply chain

The vulnerability of new energy vehicle supply chain lies in the deep coupling between its global division of labor system and industrial technical characteristics. From upstream mineral resources to downstream vehicle manufacturing, the whole chain presents the triple risk superposition characteristics of "high concentration, high technical barriers and long link coordinatio n", which are specifically manifested as the following core problems:

1. Strategic imbalance of key mineral resources

The geographical distribution of lithium, cobalt, nickel and other power battery core materials is highly concentrated and mismatched with processing capacity. About 58% of the world's proven lithium resources are distributed in the South American "lithium triangle"(Chile, Argentina, Bolivia),75% of cobalt resources depend on Congo (DRC), while China is the world's largest battery material processing country (accounting for 65% of global refining capacity), and the mineral self-sufficiency rate is less than 30%. This structural contradiction makes the supply chain vulnerable to geopolitical impacts-for example, Chile promoted the nationalization of lithium mines in 2023, Indonesia banned nickel ore exports and other policy mutations, which directly triggered a 40% monthly surge in lithium carbonate prices, forcing Ningde Times, BYD and other enterprises to pay huge premiums to lock in mineral sources. More seriously, major mining countries are accelerating the construction of resource nationalist barriers, such as Australia requiring key mineral investments to pass "national security reviews" to further reduce supply flexibility.

2. Domestic substitution lag in core technology links of "EIC" system

Although China leads in battery cell manufacturing field (Ningde era global market share reached 37%), but there are still significant shortcomings in the field of high-end materials, core equipment and chips. For example: battery materials: lithium hydroxide for high-nickel cathode, silicon carbon cathode and other high-end materials rely on Hitachi Chemical, Umicore and other foreign companies; vehicle grade chips: IGBT modules 80% need to be imported (Led by Infineon and ON), the shortage of MCU chips led to the suspension of Xiaopeng Automobile for two weeks in 2023; manufacturing equipment: key equipment such as diaphragm coater and winder were monopolized by CKD of Japan and PNT of South Korea, and the yield gap of domestic equipment exceeded 15%. The technology generation difference makes the supply chain lack backup capability in the event of sudden power failure. A typical case is that the Inflation Reduction Act of the United States in 2022 regards "localization ratio of battery components" as the subsidy threshold, which makes China battery enterprises face the passive situation of being forced to reconstruct the North American supply chain.

3. Bullwhip effect amplification of multi-level global cooperation

A typical chain from spodumene mining in Australia → lithium salt processing in China → cathode material production in Korea → cell manufacturing in China → vehicle assembly in Germany, involving at least 5 countries and more than 8 links. This ultra-long link leads to distortion of supply and demand information and amplification step by step: For example, at the beginning of the global chip shortage in 2021, the error in demand forecast of automobile factories was only 5%, but by the time it was transmitted to wafer factories, the error had expanded to 40%, eventually causing capacity mismatch across the industry. At the same time, logistics bottlenecks aggravate the vulnerability of the system-power batteries belong to Class 9 dangerous goods, and special containers and special routes (whose cost can account for 25% of the total transportation cost) are required for sea transportation. The freight rate of Asia-Europe route soared by 250% due to the Red Sea crisis in 2023, which caused the delivery delay of BYD energy storage project for more than 3 months.

4. Continuous squeeze of hidden costs and green barriers

In order to cope with volatility, enterprises are forced to increase safety inventory, but the inventory cost of power batteries is as high as about 20%/year due to high technical iteration risk (due to technical iteration risk). Ningde Times financial report shows that its inventory impairment loss in 2023 reached 1.87 billion yuan, an increase of 67% year-on-year. In addition, the EU's "New Battery Regulations" require the disclosure of product life cycle carbon footprint from 2027. Due to the insufficient average green electricity utilization rate of China battery enterprises (about 35% vs 70% in Europe), they face potential carbon tariff costs of more than 12 euros per kWh, resulting in systematic weakening of supply chain cost advantages.

5. Closed loop fracture of resources caused by the lack of recycling system

The current power battery recovery rate is less than 30%, and a large amount of nickel and cobalt resources are lost. At the technical level, the battery pack structure is not standardized (more than 200 models), making the dismantling cost as high as 80 yuan/kWh; on the business model, regular recycling enterprises need to pay a premium for used batteries.(about 120% of the market price) Competing with small workshops, Tianneng Group lost 430 million yuan in recycling business in 2023. The bottleneck of resource regeneration further aggravated the upstream mineral constraints, forming a one-way consumption chain of "mining and abandonment".

3. The Core Strategy Of Supply Chain Resilience Enhancement

The essence of the construction of new energy vehicle supply chain resilience is the systematic reconstruction of resource control, technology autonomy and network agility.

1. Reconstruction of resource control power: breaking geographical monopoly and constructing multidimensional guarantee

The first breakthrough lies in breaking the rigid constraint of geographical monopoly of resources. China enterprises are reshaping mineral safety through "three-dimensional breakthrough": Accelerate the commercialization of lithium extraction technology in Qinghai Salt Lake in China (The cost is reduced to 30,000 yuan/ton), and the equity mine source is locked overseas with capital ties.(For example, Ningde era acquired Bolivia lithium mine for US $865 million), and promoted the industrialization of sodium-ion batteries to replace lithium resources (The mass production cost of Zhongke HaiNa is 30% lower than that of lithium iron phosphate). This multi-track parallel resource strategy needs to be coordinated with regional manufacturing networks. Ningde era German factory is adjacent to BMW Leipzig base, reducing the time limit of transnational logistics from 45 days to 4 hours; BYD Mexico factory relies on the US-Mexico Agreement to circumvent the IRA Act barriers, forming a short-chain paradigm of "500 km capacity radiation circle". The deeper transformation lies in the reconstruction of supplier relationship. The pyramid partner system includes 40% strategic suppliers into joint R & D and cross-shareholding (such as GAC's 1 billion investment in Ganfeng Lithium Industry),50% core suppliers implement inventory sharing (Xiaopeng and China Innovation Airlines jointly build production line), and the remaining 10% standby suppliers realize rapid switching through standardization certification, forming a supply ecosystem of combining rigidity and softness.

2. Digital empowerment: Building transparent and intelligent "nerve center"

Digital empowerment implants "nerve center" for supply chain, its core value lies in cracking information black box. Blockchain enabled "battery passport" has been applied to 300,000 BMW electric vehicles, tracing material carbon footprint and ethical compliance throughout life cycle; Artificial intelligence drives risk prediction and dynamic optimization_Tencent Cloud AI model reduces the prediction error of battery material procurement to 7%, and the response speed of Ningde era digital twin platform simulating six-level power outage shock increases by 72%. In the physical world, intelligent logistics system is reconstructing efficiency boundary: Jingdong Logistics deployed unmanned warehouses for Weilai to increase battery turnover by 40%, Tucson driverless trucks reduced transportation costs by 35% in California-Texas battery lines, and technology enabled "end-to-end visual control" to be transformed from concept to substantial improvement in pressure resistance.

3. Innovation of dynamic operation mechanism: building buffer and agile response system

Innovation of dynamic operation mechanism focuses on buffer and agile dual objectives. National strategic reserve (Qinghai lithium library meets 3 months 'demand), industry mutual aid pool (China Automobile Association chip sharing relieves 20% shortage), enterprise safety inventory (BYD "Nickel Cobalt Bank" locks 12 months of consumption) constitutes a three-level buffer system. Flexible manufacturing technology gives the production system elastic resilience: Geely SEA architecture supports switching of battery pack capacity configuration within 2 hours, and Tesla Shanghai factory AGV system achieves ±30% capacity fluctuation tolerance. When the crisis broke out, Great Wall Motor opened up high-voltage harness capacity to Celis, Anji Logistics integrated idle capacity and other collaborative mechanisms, so that the capacity guarantee rate under the Red Sea crisis increased by 90%, confirming the actual combat value of "shared resilience".

4. Green cycle system construction: turning waste into treasure and low-carbon transformation

Green cycle system is rewriting resource logic. The key to transforming retired batteries from "pollution burden" to "urban mine" lies in building a dual value chain of hierarchical utilization and regeneration purification. Ningde Times cooperates with China Southern Power Grid to increase the utilization rate of retired battery energy storage to 75%. Greenmei hydrometallurgy technology makes the purity of recycled lithium reach 99.9% and the cost is lower than that of mining. Business model innovation is also important: Nilai BaaS battery leasing achieves 95% recycling rate through property rights unification, which is 3 times more efficient than traditional decentralized recycling mode. Low-carbon transformation forces supply chain restructuring-LONGi Green Energy provides 10 billion kWh of green electricity annually for Ningde era, reducing carbon emission per kWh battery to 45kg; BYD sets an access red line of 50% green electricity utilization rate for suppliers, transforming environmental constraints into competitive advantages.

5. Policy and ecological synergy: Building the cornerstone of institutional resilience

Policy and ecological synergy form the cornerstone of institutional resilience. At the national level, lithium resources will be included in the strategic mineral catalogue, a 50 billion overseas M & A fund will be set up, and 150% of the research and development expenses will be deducted to stimulate technical challenges.(Refer to Huawei HiSilicon model). Mandatory standardization at the industry level through power battery size (Ministry of Industry and Information Technology reduces more than 200 models), CAIR data sharing platform (risk warning 14 days in advance) reduces system friction. Facing the international rules game, China enterprises '"compliance innovation" is more forward-looking: Brussels carbon accounting center in Ningde era directly connects with EU new regulations, while "lithium battery ASEAN" regional chain avoids IRA bill containment through Malaysian nickel processing and Vietnam assembly mode.

4. Implementation Path Suggestion

The construction of new energy vehicle supply chain resilience should follow the gradual logic of "short-term hemostasis, medium-term fitness and long-term soul casting", and advance synchronously in the three battlefields of resource security, technological autonomy and circular ecology. The implementation path should be guided by national strategy, enterprise practice as the main body and industry collaboration as the link, and break through structural bottlenecks in stages.

1. Short-term (1-2 years): Establish risk firewall and alternative capability incubation

At the resource end, the government should accelerate the promotion of national lithium cobalt strategic reserve.(Refer to crude oil reserve mode), 500,000 tons of lithium carbonate equivalent storage facilities will be arranged in Qinghai and Sichuan to meet the emergency demand of head battery enterprises for 3 months; at the enterprise level, it is necessary to accelerate the acquisition of mineral rights and interests, for example, the Bolivia Salt Lake Project in Ningde Times needs to achieve an annual production capacity of 50,000 tons of LCE by 2026. Accelerate the domestic replacement of chips at the technical end, promote the National Integrated Circuit Industry Fund to increase support for vehicle-grade chips, focus on supporting SMIC and other expansion of vehicle-grade MCU production lines, and aim to increase the localization rate from the current level to more than 25% by 2027. At the same time, digital infrastructure construction has become a top priority. The Ministry of Industry and Information Technology takes the lead in formulating and implementing the Data Sharing Standard for New Energy Vehicle Supply Chain, compulsorily requiring automobile enterprises and battery manufacturers to access the blockchain traceability platform, with the goal of realizing full coverage of TOP10 enterprise battery passports by 2027. The flexible manufacturing reform takes modular platform as the incision. BYD, Geely and other enterprises need to complete the standardized design of cells (size reduced to 5 specifications), so as to reduce the production line switching time to less than 4 hours. The success sign of this stage is to shorten the power supply recovery time from 56 days to 35 days, and increase the inventory turnover efficiency by more than 20%.

2. Medium-term (3-5 years): regional network formation and circular economy scale

In terms of manufacturing layout, China enterprises need to basically build "Asia-Europe-America Iron Triangle" capacity reconstruction: Hungarian base radiates European automobile enterprises in Ningde era (Target capacity up to 100GWh) BYD Brazil plant covers South American market (Increase raw material localization rate by 70%), Southeast Asia takes Indonesia nickel processing + Vietnam Pack assembly as the hub (Avoiding the localization requirements of the IRA Act in the United States). Technical attack into the deep water area, sodium ion battery cost needs to be reduced to 0.5 yuan/Wh (15% lower than LFP), the yield of solid-state battery pilot line exceeded 80%, gradually replacing imported high-end materials. The policy side studied and implemented the mandatory mechanism of "producer responsibility extension"(exploring the deposit system, etc.), and the commercial side expanded the coverage of Weilai BaaS mode.(Target covers 50% of newly sold vehicles), and the technology side promotes intelligent disassembly production lines (disassembly cost is reduced to 40 yuan/kWh). The core indicators at this stage are lithium resource self-sufficiency rate exceeding 40%, retired battery recovery rate jumping from 30% to 65%, and carbon footprint intensity decreasing by 30%(to 60 kgCO2/kWh).

3. Long-term (6-10 years): forging AI-driven intelligent supply chain ecology

Resource security is fundamentally broken through advanced recycling technologies (such as direct recycling), large-scale commercialization or breakthroughs in biological extraction technologies. In terms of intelligent networks, the production network has evolved into a "distributed manufacturing cloud". Relying on the industrial meta-universe platform, the Nanjing "black lamp factory" in Ningde era can schedule the production capacity of the German base in real time, and the global order satisfaction time limit is compressed to 72 hours. Artificial intelligence becomes the resilience hub: AI risk early warning model prediction accuracy rate exceeds 90%, digital twin system independently generates outage response plan (such as Red Sea crisis automatic switching Central European train route). Circular economy completes closed-loop revolution: recycled materials meet 50% battery production demand, green electricity covers the whole industry chain. Finally, supply chain outage recovery time limit is ≤7 days, and carbon emission reduction of the whole chain is 80%.

5. Conclusion

As a key engine of global green transformation, the new energy automobile industry is facing unprecedented complex challenges to the security and resilience of its supply chain. Resource constraints, technological bottlenecks, geopolitical conflicts and green rule reshaping are intertwined, exposing the deep hidden dangers of systemic risks under the highly globalized division of labor system-strategic imbalance of key minerals, control of core technologies, fluctuation amplification of long-chain collaboration, continuous erosion of hidden costs and fracture of resource closed loop. These vulnerabilities not only threaten the stable operation of the industry, but also concern the overall strategic situation of national energy security and low-carbon transformation.In the face of difficulties, the resilience construction path proposed in this study breaks geographical monopoly with multi-dimensional resource guarantee system, breaks through supply constraints with core technology, improves transparency and response speed with digital intelligent network, enhances system elasticity with dynamic buffering and sharing mechanism, and builds sustainable foundation by relying on green cycle transformation and policy ecological coordination.

Looking forward to the future, the resilience of NEV supply chain has broken through the boundary of single enterprise risk management and become the core guarantee of national industrial security and the key lever of global climate governance. Facing the triple pressure of intensified geo-conflict, frequent climate disasters and iteration of key technologies, and systemic risks in all links of the industrial chain, it is urgent to build a collaborative governance network covering the whole life cycle. Joint research through deepening technology (such as solid-state battery recycling technology), establish a dynamic resource sharing mechanism This will not only effectively resist the "broken chain" crisis and safeguard industrial sovereignty, but also accelerate the decarbonization of global transportation by building a green and low-carbon global supply chain system, and ultimately promote the new energy automobile industry to move towards a more sustainable and inclusive high-quality development paradigm.

References

[1] Zhou Tiancheng, Cheng Jianning, Li Bingjie, et al. Study on the supply chain resilience and safety of new energy automobile industry chain in China [J]. Supply Chain Management, 2025, 6 (03):35-45.DOI:10.19868/j.cnki.gylgl.2025.03.003.

[2] Zhou Wenyi, Wu Xianqin, Lian Chunying. Study on battery supply chain toughness of new energy automobile industry--Evidence based on Ningde era [J]. SME Management and Technology, 2024,(22):124-127.

[3] Lv Yue. How to improve the resilience and safety level of industrial chain supply chain in the new era [J]. Journal of Beijing Technology and Business University (Social Science Edition), 2023, 38 (01):98-108.

[4] Song Ying. Multi-measures to ensure the safety of nonferrous metal industry chain supply chain [J]. China Nonferrous Metals, 2024,(21):42.

[5] LI Tianjian, ZHAO Xuejun. New China's exploration of ensuring the safety of industrial chain supply chain [J]. Management World, 2022, 38 (09):31-41.DOI:10.19744/j.cnki.11-1235/f.2022.0128.

[6] Zheng Yun, Shi Shuai. China's new energy vehicle supply chain welcomes change [J]. Automobile and Parts, 2020,(18):32-35.

[7] Wang Qian. Policy Suggestions on Maintaining the Security and Stability of China's Manufacturing Industry Chain under the Trend of Counter-globalization [J]. Wisdom China, 2022,(05):24-27.

[8] Hu Yangbo.A Study on Supply Chain Resilience Improvement Strategy of Automobile Manufacturing Company [D]. Henan University of Technology, 2023.DOI:10.27791/d.cnki.ghegy.2023.000735.

[9] Lin Chao. Development achievements, risks and challenges faced by China's new energy automobile industry and countermeasures [J]. China Economic and Trade Guide, 2024,(03):38-40.

[10] China Industrial Competitiveness Report (2023·No.12): Improving the Resilience and Safety Level of Industrial Chain Supply Chain [J]. China Industrial Economy, 2024,(04):2.