

# ***Digital Empowerment for Supply Chain Optimization and Capacity Expansion in the NEV Industry: A Case Study of BYD***

**CAI, UEN SUM JAMES**

*Manila Xiamen International School, Xiamen, China  
shgylone@outlook.com*

**Abstract.** In contemporary society, a phenomenon has become increasingly overwhelming: more and more firms in the new energy vehicle (NEV) industry are undergoing digital transformation. The paper studies the case of BYD company Limited (BYD). It analyzes secondary data, such as industry reports and the enterprise's disclosures, to examine how digital transformation enables supply chain optimization and expansion of production capacity in the electric vehicle (EV) industry. By the analysis and the use of secondary data mentioned above, research has found that BYD's outcome of digitalization such as its digital system across procurement, manufacturing, logistics, and demand forecasting optimizes its supply chain and expand the production capacity which indicates the significant impact of digital transformation in optimizing supply chain and in reducing the coordination cost of production capacity expansion. These digital systems also provide critical support for scalable production expansion while mitigating the risk of overcapacity.

**Keywords:** Digital Transformation, Supply chain optimization, NEV, BYD, EV

## **1. Introduction**

The global transition from non-renewable to clean energy has accelerated the development of EVs, positioning the New Energy Vehicle (NEV) industry as a global focus. Governments worldwide have attached greater importance to eco-friendly industries and related products, introducing policy support that drives faster growth of the NEV sector and a continuous expansion of both supply and demand.

Against this backdrop, NEV enterprises are not only expanding manufacturing capacity but also adjusting operational strategies to maintain competitiveness. However, the high complexity of the NEV supply chain has highlighted the critical value of digitalization. Supported by big data and integrated information systems, digital supply chains can effectively improve cross-process coordination, as well as enhance overall visibility and responsiveness.

As a leading player in the industry, BYD stands out as a representative example. It has actively rolled out long-term development strategies centered on vertical integration, technological innovation, and large-scale production expansion. According to BYD's official annual reports, its annual NEV sales grew significantly from 3.02 million units in 2023 to 4.27 million in 2024, and

further reached 4.60 million in 2025, ranking first in global NEV sales [1]. This complexity makes digitalized supply chains essential for improving cross-process coordination, visibility, and responsiveness.

Existing studies on BYD primarily focus on the firm's technical strengths to explain the digital transformation and supply chain, such as its battery innovation. They are limited to the connection between digitalization, supply chain optimization and production capacity level. For instance, Zhan has examined BYD's digital transformation in the context of technological and strategic evolution, and further points out its contribution to advancing the EV industry, yet does not fully explore how the digital system mentioned interacts with production expansion within a coordinated, systematic framework [2].

This study uses BYD as a case to examine how digital transformation interacts with supply chain management and capacity expansion in the EV industry. It argues that these three elements are not separate strategies but mutually reinforcing: digital systems enable supply chain visibility and coordination, which, in turn, support more predictable capacity expansion. The study aims to provide practical insights for other EV firms and may also contribute to the digital operations and supply chain literature.

## 2. Literature review

### 2.1. Digital transformation in manufacturing

Digital transformation can be defined as a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies [3]. It is widely recognized in academic research that digital transformation is not simply the deployment of individual digital tools, but a holistic, organization-level strategic upgrade that reshapes operational processes and value creation logic [4]. Recent research on manufacturing firms in developing economies also indicates that digital tools, such as big data analytics capabilities, the Internet of Things, and cloud computing, offer the potential to streamline operations, reduce costs, and respond more effectively to market changes [5]. Digitalization serves as a foundational enabler in this study, supporting the analysis of supply chain optimization and capacity expansion.

### 2.2. Supply chain management in NEV industry

Within the NEV industry, digitalization offers significant benefits for the supply chain, including increased information availability, optimized logistics practices, real-time data collection, more efficient inventory management and greater transparency [6]. At the core of digital supply chain construction is big data analytics capability, which supports precise demand forecasting, dynamic inventory adjustment and multi-link collaborative scheduling, and is the key driver for supply chain efficiency improvement. Therefore, firms nowadays increasingly turn to digital systems to achieve this integration.

However, NEV supply chains still face multiple challenges, including high uncertainty and strong interdependence across links. This means that an effective supply chain requires strong coordination and visibility. Supply instability cannot be easily managed in isolation due to high coordination costs and systemic risks; if a problem occurs in one part of the supply chain and disrupts supply, the resulting costs may be difficult for firms to absorb. As a result, conventional reactive approaches to supply chain management are inadequate for supply networks with high uncertainty, as they respond

slowly and inefficiently after disruptions occur. In line with this view, Christopher and Peck point out that increasing supply chain complexity and interdependence have made firms more vulnerable to disruptions, thereby requiring greater visibility and resilience across the supply network [7]. Thus, firms must adopt proactive strategies such as digitalization to enhance visibility and coordination, and respond to disruptions efficiently and effectively.

### 2.3. Capacity expansion theories

In terms of production capacity expansion, existing research suggests that firms expand their production capacity to achieve economies of scale, which means increased production output reduces average costs and strengthens competitive advantage [8]. This mechanism is particularly important in the NEV industry, as substantial investments in manufacturing facilities require firms to spread fixed costs over larger production volumes.

However, although capacity expansion brings benefits to firms, it also creates an inherent trade-off between efficiency and risk [8]. On the one hand, expanding production enables firms to capture market share and improve cost efficiency. On the other hand, excessive expansion may increase fixed costs and reduce operational flexibility, making firms more vulnerable to demand fluctuations and market uncertainty. When market demand falls below expectations, capacity expansion will expose firms to significant financial risks [8].

## 3. Digital transformation of BYD

### 3.1. Digital infrastructure

Recent developments in BYD's digital transformation reflect a systemic rather than fragmented approach. Therefore, its investment in smart factories and automated production lines is not merely aimed at cost reduction but at creating a data-centric production environment. Thus, in this environment, the production process continuously generates data streams that feed back into operational decisions, creating a closed loop where inefficiencies can be identified and corrected in real time.

At the production level, BYD deploys automated equipment and digital monitoring systems to track production quality and equipment status in real time, a system already rolled out across its smart factories nationwide. This allows the firm to identify potential bottlenecks early and improve overall production efficiency. For battery manufacturing in particular, BYD has achieved a 100% numerical control and networking rate for key equipment, shortening the product development cycle by 25% and increasing production efficiency by 17.65% [9].

At the supply chain and capacity level, digital transformation improves both production consistency and scalability, directly supporting supply chain optimization and large-scale capacity expansion. On the supply side, the procurement cost of battery raw materials dropped by 8% in 2022, while inventory turnover increased by 20%. On the capacity side, BYD's Xi'an smart factory realizes a production takt of 60 seconds per vehicle, with an annual output of over one million units and per capita output value reaching 1.8 times the industry average [9].

### 3.2. Data-driven decision making

More importantly, BYD's annual reports note that the firm has adopted a data-driven approach to integrate sales, production, and logistics data, shifting from reactive responses to predictive

management [1]. By extending, the reports also mentioned that the company consolidates information from sales, production, and logistics systems into a unified platform, enabling real-time monitoring and adjustments. Then, predictive analytics are applied to forecast demand and optimize production schedules. The benefits of data-driven approaches extend beyond production scheduling.

This data-driven system delivers tangible improvements across multiple links. In production quality control, an AI-powered visual inspection system increases inspection efficiency fivefold compared with manual checks. In after-sales service, an intelligent diagnostic system trained on 2 billion kilometers of real-world driving data remotely resolves 90% of software faults, lifting after-sales efficiency by 40% and customer satisfaction to 98.2% in 2023. In battery operation management, BYD's battery health monitoring system predicts battery degradation risks 30 days in advance, reducing range-anxiety complaints by 60% [9].

Cross-system data integration optimizes production scheduling, cuts delivery lead times and shortens inventory cycles, effectively alleviating the supply-demand mismatch that incurs high costs in fast-growing industries. However, this system also relies heavily on data quality and model accuracy. Predictive models may fail to capture sudden market fluctuations in highly volatile environments, meaning digital systems must be complemented by operational flexibility [10].

### 3.3. Vertical integration strategy

Aside from these, a key feature of BYD's strategy is its vertical integration particularly in battery production. Before analyzing, vertical integration refers to a firm's ownership and control of multiple stages of its supply chain, from the sourcing of raw materials to manufacturing and distribution, which would otherwise be conducted by separate firms [11]. This decision can be understood as a response to structural vulnerabilities in the NEV supply chain. By internalizing the production of critical components, BYD reduces its exposure to external disruptions and price fluctuations. At the same time, vertical integration increases capital intensity and reduces flexibility in supplier selection. The success of this strategy therefore depends on the firm's ability to coordinate complex internal operations, an area where digital systems play a crucial role. Thus, digital transformation and vertical integration are not independent strategies but mutually reinforcing. The strategic value of this integrated approach is reflected in BYD's position in the power battery market: in 2023, the company held a 16.7% global market share, ranking second worldwide [9].

## 4. Supply chain analysis

### 4.1. Supply side management

Focusing on the supply side of supply chain management within the NEV industry, BYD's strategy presents a transition from dependency to control by securing access to raw materials and integrating key production stages, which reduces uncertainty in input availability. In practice, the company spun off its key component divisions, including batteries, electric motors, and electronic controls, into independent subsidiaries (collectively known as "Fudi" companies) between 2019 and 2021. These subsidiaries supply not only BYD but also external automakers, creating internal competition while maintaining supply stability. This structure enables BYD to better control costs and ensure production continuity when facing raw material price fluctuations or external disruptions [12]. Besides, the digital systems mentioned above further strengthen this control by improving coordination with remaining external suppliers, which creates a more resilient supply chain. In

addition, from an analytical perspective, this represents a shift from a reactive model, responding to disruptions after they occur, toward a predictive model that forecasts risks and enables preemptive responses. This shift can be seen as another outcome of digitalization.

## 4.2. Demand side analysis

Moving to the demand side of supply chain management in the NEV industry, it can be observed that the rise in quantity demanded, while supporting expansion, has been uneven across markets. Demand is influenced by different policies and regional differences, which create both opportunities and challenges for NEV industry growth. In response to this situation, BYD has expanded into multiple international markets. By the end of 2023, the company had entered Japan, Germany, Australia, Brazil, and the UAE, becoming a leading NEV seller in several countries [13]. In Thailand, BYD established its first overseas passenger vehicle production base and achieved a registration volume of 30,650 units in 2023, capturing over 40% market share and becoming the top-selling pure electric vehicle brand in the country. The ATTO 3 alone accounted for 19,214 units, exceeding 25% market share in the pure electric segment [13]. This geographic diversification helps spread demand risk, but it also increases operational complexity, especially in logistics and inventory management. Digital tools help manage this complexity by providing real-time data and improving forecasting accuracy, although they cannot fully eliminate demand uncertainty.

## 4.3. Supply-demand matching

Moreover, BYD balances supply and demand through the same integration mentioned above, combining sales, production, and inventory data into a unified digital platform. One key outcome is the availability of real-time sales data. Data from dealerships and overseas markets are continuously monitored and used to forecast demand, which allows production schedules to be adjusted accordingly. For example, BYD uses digital forecasting systems to identify changes in customer demand and allocate production capacity to higher-demand vehicle models. This reduces both shortages and excess inventory, which are common sources of inefficiency. In addition, BYD implemented Vendor-Managed Inventory (VMI) strategies and established VMI warehouses, significantly improving supply chain information visibility and enabling real-time communication. These measures help prevent both liquidity problems caused by excess inventory and production stoppages due to parts shortages, thereby enhancing overall supply chain stability. However, effective supply-demand matching requires not only accurate data but also responsive production systems. Without such systems, even the most accurate data will have limited value.

## 5. Capacity expansion and production strategy

### 5.1. Production capacity growth

BYD's aggressive capacity expansion is a strategic response to booming new energy vehicle (NEV) market demand. Its vehicle deliveries surged from 0.6 million units in 2021 to 4.27 million in 2024, requiring massive capacity upgrades to match market growth. Larger output helps BYD leverage economies of scale to dilute fixed costs, lower unit production expenses and consolidate market competitiveness. Nevertheless, expanded capacity raises fixed cost burdens, leaving the firm more exposed to demand volatility and amplifying both profit upside and operational risks.

## 5.2. Drivers of expansion

The drivers of this expansion are both external and internal. Externally, government policies such as China's NEV purchase subsidies, purchase tax exemptions, and the NEV credit system have stimulated consumer demand and encouraged manufacturers to increase production capacity. Strong market demand has in turn incentivized firms to invest in large-scale operations. Internally, BYD's digital transformation supports expansion by improving operational efficiency, enhancing demand forecasting, and reducing uncertainty, thereby making large-scale investments more manageable.

## 5.3. Challenges

Despite these advantages, the risks associated with rapid expansion remain significant. Overcapacity is a key concern: rapid expansion increases production volume, and when supply significantly exceeds demand, excess capacity and inventory pressures arise. To mitigate this risk, BYD relies on its digital forecasting systems, which integrate sales, production, and inventory data. This enables the company to adjust production schedules more effectively in response to changing demand conditions, thereby reducing the likelihood of excess inventory and underutilized capacity. At the same time, increasingly intense global competition leads to price pressure and reduced profitability, further slowing market growth. Firms' expansion strategies must therefore be carefully managed, with close attention to both market conditions and operational capabilities.

## 6. Discussion

### 6.1. Impact of digital transformation

The BYD case study demonstrates the benefits of digital transformation, which improves operational efficiency and responsiveness by integrating data across production and supply chain systems. Through digitalization, BYD reduces information delays and enhances coordination across different stages of operation. These changes allow the firm to respond more efficiently to fluctuations in market demand, thereby minimizing inefficiencies such as overproduction and inventory shortages. Moreover, the digital systems provide BYD with competitive advantages in areas such as faster production scheduling, shorter delivery lead times, and more accurate demand forecasting. In contrast, many conventional NEV firms still rely on fragmented systems that limit their ability to respond to rapid market changes, giving digitally integrated firms like BYD a structural advantage. In essence, this data-driven integration reduces the coordination costs that typically escalate when firms scale up production capacity, reinforcing the link between digitalization and scalable expansion.

### 6.2. Practice implications

Although BYD has strengthened its competitive position through vertical integration, digital transformation, and capacity expansion as discussed above, the firm still faces several strategic challenges. First, the company's rapid expansion increases the risk of overcapacity; if future market demand growth slows, capacity utilization may decline and fixed-cost pressure will increase. Second, intensifying competition in the global NEV market may lead to further price competition and lower profit margins, limiting the benefits gained from economies of scale. Last, despite these efforts, BYD remains exposed to external uncertainties. Sustaining growth will therefore depend on the company's ability to balance expansion with effective risk management and strategic flexibility.

## 7. Conclusion

This paper examined the roles of digital transformation, supply chain optimization, and capacity expansion in the NEV industry, using BYD as a case study. The analysis shows that digital technologies enhance efficiency and improve supply-demand coordination, thereby supporting large-scale production growth. Moreover, the findings highlight the importance of integrating digital transformation with broader strategic choices. BYD's success is not attributable to digitalization alone, but rather to its ability to combine digitalization with vertical integration and proactive supply chain management. The study further notes the risks associated with rapid expansion, including overcapacity and market uncertainty. While digitalization cannot eliminate these risks, it can help mitigate them through improved demand forecasting and cross-functional coordination. Firms are therefore advised to balance growth ambitions with operational and market realities.

The single case study of BYD limits the generalizability of its findings, as it is highly focused on one specific firm. Future research could address these limitations by conducting comparative studies with other EV firms that contribute to NEV industry in order to improve the robustness of conclusions.

## References

- [1] BYD. (2024). *Periodic reports BYD*. <https://www.bydglobal.com/en/InvestorAnnals.html>
- [2] Zhan, Y. (2025b). Digital transformation in China: BYD as a case study for technological and strategic evolution. In *Advances in Economics, Business and Management Research* pp. 628–638. [https://doi.org/10.2991/978-94-6463-748-9\\_70](https://doi.org/10.2991/978-94-6463-748-9_70)
- [3] Hinterhuber, A., Vescovi, T., & Checchinato, F. (Eds.). (2021). *Managing digital transformation: Understanding the strategic process* (1st ed.). Routledge. <https://doi.org/10.4324/9781003008637>
- [4] Bilal, M. (2025). *Research on influencing factors of digital transformation in manufacturing sector and its impact on firm performance: The mediating role of big data analytics capability and the moderating effect of digital literacy* [Doctoral dissertation, Jiangsu University].
- [5] Choi, T. M., Wallace, S. W., & Wang, Y. (2018). Big data analytics in operations management. *International Journal of Production Economics*, 200, 1–5. <https://doi.org/10.1016/j.ijpe.2018.02.016>
- [6] Bigliardi, B., Bottani, E., & Casella, G. (2022). The digitalization of supply chain: A review. *Procedia Computer Science*, 200, 1806–1815. <https://doi.org/10.1016/j.procs.2022.01.381>
- [7] Christopher, M., & Peck, H. (2004). Building the resilient supply chain. *The International Journal of Logistics Management*, 15(2), 1–14. <https://doi.org/10.1108/09574090410700275>
- [8] Besanko, D., Shanley, M., & Schaefer, M. (2017a). *Economics of strategy*. Wiley.
- [9] Kaiser, F., & Obermaier, R. (2020). Vertical (dis-)integration and firm performance: A management paradigm revisited. *Schmalenbach Business Review*, 72(1), 1–37. <https://doi.org/10.1007/s41464-020-00083-1>
- [10] Gao, X., & Wang, Y. (2026). Digital empowerment of the entire industry chain for new quality productive forces: A study on BYD's financial performance leap. *Market Modernization*, (3), 1-3.
- [11] Lieberman, M. B. (1987). The learning curve, diffusion, and competitive strategy. *Strategic Management Journal*, 8(5), 441–452. <https://doi.org/10.1002/smj.4250080504>
- [12] Mao, Z. (2025). *Research on the enhancement effect of supply chain resilience on corporate value creation: A case study of BYD* [Master's thesis, Shaoxing University].
- [13] Liu, J., Liu, H., & Yu, H. (2025). From product globalization to capacity globalization: BYD's comprehensive overseas expansion strategy. *Global Sustainability Research*, 4(2), 1–18. <https://doi.org/10.56556/gssr.v4i2.1232>