Strategic Research on Talent Supply and Demand in the New Energy Vehicle Industry Chain: A Case Study of Nanning

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Abstract

The global automotive industry's accelerated transition toward electrification and intelligentization has positioned talent as a critical determinant of competitive advantage in the New Energy Vehicle (NEV) sector. While existing scholarship extensively examines mature coastal clusters, a significant gap remains in understanding talent dynamics within emerging inland hubs.

This study addresses this gap by presenting a granular analysis of Nanning's NEV talent ecosystem, integrating Human Capital and Cluster Theories to investigate the structural interdependencies between policy, industry, and education. Through quantitative analysis of regional data (2017-2024) and comparative benchmarking, the research identifies acute skill polarization—specifically, surpluses in low-skilled operational roles alongside critical shortages in high-value R&D and engineering functions within the core components segment. These imbalances are exacerbated by wage competitiveness gaps, nascent industrial clustering, and misaligned training pipelines. The study's primary contribution lies in its development of an integrated, closed-loop strategy framework for talent ecosystem development, which synergizes industry-education integration, high-end project attraction, and urban livability enhancement. The findings offer a replicable model for policy-makers in similar emerging industrial cities aiming to bridge the gap between national strategic ambitions and local implementation realities.

Keywords: New Energy Vehicles, Talent Supply-Demand, Industry-Education Integration, Workforce Retention, Industrial Clustering

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Introduction

Global Context of the NEV Industry

The twenty-first century has witnessed an unprecedented shift in the global automotive sector, driven by climate change mitigation, technological innovation, and industrial restructuring. Governments worldwide have enacted stringent emissions regulations and invested heavily in clean transportation technologies. The European Union's Fit for 55 package mandates a 55% reduction in greenhouse gas emissions by 2030, effectively phasing out new Internal Combustion Engine (ICE) sales by 2035 (European Commission, 2021). The United States offers substantial incentives for EV adoption. At the same time, Japan and South Korea have set ambitious electric mobility targets supported by strong R&D investments (Organization for Economic Co-operation and Development [OECD], 2023).

Against this global backdrop, NEVs-including Battery Electric Vehicles (BEVs), Plug-In Hybrid Electric Vehicles (PHEVs), and Fuel Cell Vehicles (FCVs)-are no longer a niche but a central competitive arena in the automotive industry. The rapid technological convergence of electrification, autonomous driving, and connected mobility has expanded the skill requirements for automotive professionals beyond traditional mechanical engineering into fields such as artificial intelligence, big data analytics, battery chemistry, and human-machine interface design (Frey & Osborne, 2017).

China's National Strategy and NEV Industry Development

China, as the world's largest NEV market, exemplifies this shift. National strategies, including the "Made in China 2025" initiative and the NEV Industry Development Plan (2021-2035), explicitly link technological leadership to the cultivation of a robust human capital base (Ministry of Industry and Information Technology [MIIT], 2020). However, the implementation of these national blueprints is characterized by significant regional disparities. While scholarly and policy attention has predominantly focused on established coastal hubs like Shanghai and Shenzhen, the role of inland cities—which are increasingly critical to China's industrial geography—remains underexplored.

Guangxi and Nanning's Strategic Position

Guangxi's integration into China's Belt and Road Initiative and its role as a bridge to ASEAN markets provide unique advantages for NEV industry expansion. Nanning benefits from proximity to emerging Southeast Asian EV markets, lower operating costs compared to coastal cities, and increasing infrastructure investment. Flagship projects such as BYD's 45GWh power battery plant have positioned the city as a potential western China hub for NEV production (Guangxi Talent Service Platform, 2022).

However, Nanning also faces significant constraints: wage competitiveness, incomplete industrial ecosystems, and a limited pipeline of high-end R&D professionals. Unlike Shanghai or Shenzhen, where dense supplier networks and established innovation ecosystems naturally attract talent, Nanning is still in the early stages of industrial clustering (OECD, 2023).

Research Objectives

While substantial research exists on China's NEV industry, most studies focus on coastal megacities or national-level trends. There is limited literature addressing inland, emerging hubs

like Nanning, particularly in relation to talent ecosystem dynamics. This paper addresses this gap by:

   • Mapping the structural characteristics of Nanning's NEV talent supply and demand.
   • Identifying core deficits in skill categories across the value chain.
   • Comparing Nanning's situation with leading NEV hubs.
   • Proposing targeted strategies for talent attraction, training, and retention.

Literature Review

NEV Industry Development in the Global Context

Over the last two decades, the automotive industry has undergone a paradigm shift driven by decarbonization policies, advancements in battery technology, and consumer demand for sustainable mobility. According to the International Energy Agency (IEA) (2023), global electric car sales exceeded 14 million units in 2023, representing 18% of total car sales worldwide. Europe's aggressive regulatory measures, such as the EU's CO_2 emission standards and the Fit for 55 initiative, have accelerated market penetration (European Commission, 2021). Japan and South Korea focus on hybrid technology leadership and hydrogen fuel cell vehicles (OECD, 2023).

China's National NEV Strategy and Regional Implementation

China has rapidly ascended to become the largest NEV market globally, backed by targeted subsidies, infrastructure investment, and industrial policy (MIIT, 2020). This aligns with the strategic goals outlined in the New Energy Vehicle Industry Development Plan (2021-2035) issued by MIIT, which emphasizes technological advancement, supply chain integration, and talent cultivation. The NEV Industry Development Plan (2021-2035) emphasizes core technological breakthroughs, industrial cluster formation, and talent ecosystem enhancement. Empirical studies show that policy-induced market expansion is closely tied to regional talent attraction and retention China Automotive Technology and Research Center (CATARC, 2021).

In inland provinces, however, challenges such as limited R&D platforms, weaker salary competitiveness, and slower industrial clustering hinder alignment with national strategic goals (OECD, 2023).

Talent Supply-Demand Dynamics in Emerging Industries

Human Capital Theory (Becker, 1993) provides a foundation for understanding the role of education, training, and skill accumulation in economic productivity. In the NEV sector, talent requirements have shifted from traditional mechanical engineering to a hybrid skill set incorporating electrical engineering, software development, and data analytics (Frey & Osborne, 2017).

Chinese studies indicate that supply-demand imbalances in NEV talent are particularly acute in the midstream (vehicle manufacturing) and upstream (core components) due to long training cycles and rapid technological change (Guangxi Talent Service Platform, 2022). Aftermarket services, in contrast, often show relative equilibrium thanks to shorter skill acquisition timelines and higher market flexibility.

International Models of Industry-Education Integration

Germany's "dual system" vocational education model has been widely cited for its ability to align industrial needs with educational output, especially in the automotive sector (Euler, 2013). Students split their time between classroom instruction and paid apprenticeships within companies, ensuring that skills remain relevant to evolving technologies.

China-ASEAN collaborations, such as the Luban Workshops in Laos and the China-Indonesia Automotive Academies, have demonstrated that cross-border industry-education partnerships can accelerate skill development in strategic emerging industries (Liuzhou City Vocational College, 2023).

Theoretical Foundations: Human Capital and Cluster Theory

This study is anchored in two complementary theoretical frameworks. Human Capital Theory (Becker, 1993) provides a microeconomic rationale for investing in education and training, positing that skills are a form of capital that enhances productivity and innovation. In the context of the NEV sector, the theory explains why rapid technological change creates persistent skill mismatches—the high cost and long lead time of developing specialized human capital often lag behind industry expansion.

Industrial Clustering and Talent Ecosystem Theory

Porter's Cluster Theory (Porter, 1998) posits that geographic concentration of interconnected companies, suppliers, and associated institutions enhances competitiveness by facilitating knowledge spillovers and specialized labor markets. Applied to NEV development, successful clusters such as Shanghai and Shenzhen have leveraged dense supplier networks, high research intensity, and favorable lifestyle conditions to attract high-caliber talent (OECD, 2023). However, Nanning's NEV cluster is still in its formative stage, with limited supplier diversity, fragmented industrial linkages, and underdeveloped professional service ecosystems. This constrains the city's ability to generate the self-reinforcing talent attraction and retention effects observed in mature clusters.

Identified Research Gaps

While the literature extensively covers coastal megacities and mature industrial bases, fewer empirical studies address inland, early-stage NEV hubs such as Nanning. Three specific gaps emerge:

Regional Talent Ecosystem Development-Most existing research focuses on national-level policy impacts or case studies from established clusters like Shanghai, Shenzhen, and Beijing (OECD, 2023). There is a lack of granular, city-level analysis for inland regions where industrial ecosystems are still forming.

Interdisciplinary Skill Integration-The NEV sector increasingly demands hybrid competencies that span automotive engineering, ICT, and renewable energy systems (Frey & Osborne, 2017). Few studies examine how education and training systems can effectively integrate these domains, particularly in regions without a strong pre-existing industrial base.

Talent Retention in Emerging Industrial Cities-While talent attraction has been studied in the context of high-income, globally connected cities, there is limited research on retention strategies for inland cities with less developed urban amenities and lower wage competitiveness (OECD, 2023).

Methodology

Research Design
This study employs a quantitative research design to systematically evaluate the talent supply-demand dynamics within Nanning's NEV industry chain. The research focuses on measurable indicators-such as employment figures, vacancy rates, and wage levels-collected from authoritative statistical sources and enterprise records.

Data Sources
Official Statistical Data
Guangxi Talent Service Platform: Annual datasets (2017-2024) on workforce demand and supply, broken down by industry segment, occupation, and skill category.

National Bureau of Statistics: Sectoral employment, wage levels, and output statistics for the automotive manufacturing and NEV sectors.

China Association of Automobile Manufacturers (CAAM): National NEV production, sales, and industry workforce reports.

Enterprise-Level Recruitment Data
Recruitment announcements of major NEV enterprises in Nanning.

Internal HR bulletins detailing unfilled positions, required qualifications, and recruitment timelines.

Variable Definition and Segmentation
The NEV industry was segmented into:

• Upstream - Core component manufacturing (e.g., batteries, motors, electronic control systems)

• Midstream - Complete vehicle manufacturing and assembly

• Downstream-Aftermarket services, including maintenance, sales, charging infrastructure, and recycling

Key variables:

• Talent Demand (TD) - Number of positions posted during the survey period

• Talent Supply (TS) - Number of qualified candidates available

• Talent Gap (TG) - TD-TS; positive values indicate shortages

• Shortage Rate (SR) - TG ÷ TD × 100%

Results

National and Regional NEV Talent Trends (2017-2024)
Between 2017 and 2024:

• NEV manufacturing demand increased from 68.62% to 72.82% of total industry demand (+4.2 percentage points).

• Core components demand fell by 9 percentage points.

Aftermarket services grew by 4.6 percentage points (Guangxi Talent Service Platform, 2024).

Interpretation: Midstream manufacturing absorbed most new demand due to expansion projects, while upstream components faced volatile investment cycles. Aftermarket growth reflects the market's transition toward service infrastructure.

Table 1 Segment-Wise Talent Supply–Demand Gap

Segment	Demand Share 2023	Supply Share 2023	Gap (pp)	Shortage Severity
Vehicle Manufacturing	72.82%	78.50%	+5.68	Moderate
Core Components	19.28%	14.19%	-5.09	Severe
Aftermarket Services	7.90%	7.31%	-0.59	Balanced

Source: Guangxi Talent Service Platform (2022)

Interpretation: Core components suffer the most acute shortage, with supply lagging demand by over 5 percentage points. Manufacturing shows a surplus in aggregate, but this is concentrated in low-skill roles.

This table highlights the segmental imbalance in Nanning's NEV industry, where upstream technical roles are underfilled despite overall growth in manufacturing. It also underscores the need to differentiate between aggregate surplus and skill-specific shortages.

Occupational-Level Shortages
Top shortage categories by number of positions:
Entry-Level Technical Operators-1,400 (BYD Nanning Yongning Project)
• Electrical Welding Maintenance Workers-828
• Software Development Engineers-44
• Surface Engineers-43
• Vehicle Engineers-43
Trend: While entry-level operators dominate numerically, strategic shortages occur in software and design engineering, which are critical for long-term competitiveness.

Wage-Shortage Correlation
Pearson correlation between average annual wages and shortage rates across 25 occupational categories in Nanning's NEV industry (2021): $r = -0.68$, $p < 0.01$. Interpretation: Higher wages are associated with lower shortage rates, supporting the hypothesis that compensation is a key determinant of talent availability (CATARC, 2021).

Table 2 Comparative Benchmarking: Nanning vs. Shanghai & Chongqing

Indicator	Nanning	Shanghai	Chongqing
Avg. Annual Wage (RMB '000)	90	145	105
Shortage Rate (%)	38.2	21.5	33.7
Share of R&D Roles (%)	7	18	9

Interpretation: Nanning's lower wage levels and smaller proportion of R&D roles partly explain its higher shortage rate. Shanghai's mature cluster attracts more high-end talent; Chongqing's structure is closer to Nanning but benefits from a longer automotive history.

This comparative table illustrates how regional disparities in wages and R&D intensity contribute to talent shortages. It suggests that Nanning must enhance both compensation and innovation capacity to remain competitive.

Time-Series Analysis: Policy Impact Windows
Two inflection points in demand growth:
2019: Local subsidies for NEV purchases triggered a spike in aftermarket service demand.
2021: Vehicle manufacturers' large-scale battery production plan expanded manufacturing demand significantly.

Structural Insights
Three key characteristics emerge:
• Skill Polarization - Surplus in low-skill roles, shortage in high-skill technical positions.
• Segmental Imbalance - Severe gaps in core components despite manufacturing expansion.
• Wage Elasticity - Strong statistical link between pay and talent scarcity.

Discussion

Skill Polarization and Structural Talent Gaps
Quantitatively, the results reveal a clear pattern of skill polarization: An oversupply of low-skilled operational positions alongside chronic shortages in high-skilled technical and R&D roles. This aligns with Human Capital Theory (Becker, 1993), which posits that in knowledge-intensive industries, the long lead time and high cost of skill formation create persistent mismatches when industrial expansion outpaces the cultivation of talent.

Such mismatches are particularly acute in the core components segment. Data show that the share of available talent in this segment trails demand by over five percentage points. These roles-such as battery systems engineers-form the technological heart of NEV competitiveness, requiring expertise in electrochemistry, materials science, and thermal management.

Wage Competitiveness and Regional Disparities
In comparison to Shanghai and Chongqing, Nanning's average annual salary is approximately 62% of Shanghai's, with R&D roles accounting for a significantly lower share of total positions (7% vs. 18% in Shanghai). Correlation analysis confirms that higher wages are strongly associated with lower shortage rates.

Industrial Clustering and Agglomeration Effects
Porter's Cluster Theory (Porter, 1998) suggests that mature industrial clusters enhance competitiveness through dense supplier networks, knowledge spillovers, and specialized labor markets. While Nanning's NEV chain spans upstream, midstream, and downstream activities, supplier density is low, and enterprises remain geographically dispersed.

Talent Mobility Patterns
Supply–demand trends suggest a three-phase talent mobility pattern in Nanning's NEV sector:
• Graduation Phase - Output of local NEV-related graduates is roughly aligned with overall enterprise demand, but skills matching is suboptimal.
• Outflow Phase - High-achieving graduates gravitate toward the Pearl River Delta for better pay and career opportunities.

• Return Phase - A small cohort of mid-career technical and managerial staff return after gaining experience elsewhere.

This pattern mirrors those in OECD countries, but successful regions often turn return migration into a stable talent stock through simultaneous industrial upgrading and urban environment improvement (OECD, 2023).

Policy Implementation Gaps

Despite Nanning's talent initiatives - such as the "Talent Green Card" program-execution challenges remain:

• Low awareness among firms and professionals.
• Slow processing of subsidies and residency incentives.
• Poor alignment with enterprise needs.

International Experiences and Applicability

Germany's automotive transition leveraged the dual system of vocational education (Euler, 2013). Japan has relied on in-house long-term training, pairing lifetime employment with cross-department rotations. ASEAN countries such as Thailand and Malaysia have co-located training centers with foreign-invested vehicle plants.

For Nanning, three practices are readily adaptable:

• Rapid establishment of industry - education alliances.
• Leveraging anchor projects to create training-to-placement pipelines.
• Regional internationalization to attract multinational automakers and global talent.

Synthesis of Key Findings

The structural causes of Nanning's NEV talent imbalances can be summarized as:

• Economic Factors - Wage competitiveness lags.
• Industrial Factors - Incomplete supply chain, weak clustering effects.
• Educational Factors - NEV-specialized education started late.
• Urban Livability Factors - Industrial parks are distant from city centers.

Strategic Recommendations

• Deepening Industry–Education Integration

Establish joint NEV colleges, embed dual-qualification faculty models, and create modular training pipelines aligned with industry certification schemes.

• Attracting High-End Projects and Global Talent

Target strategic investors, implement "one enterprise, one policy" talent packages, and leverage ASEAN market access.

• Strengthening Skilled Workforce Training

Host regional NEV skills competitions, create continuing education pathways, and formalize enterprise-based apprenticeships.

• Optimizing Talent Support and Urban Livability

Develop NEV-focused HR service sub-parks, improve on-site amenities in industrial zones, and enhance transport infrastructure.

• Establishing Interdisciplinary NEV Academic Majors

Integrate automotive engineering with computer science, data analytics, and electrochemistry; adopt modern apprenticeship structures; and promote international faculty exchange.

• Monitoring and Evaluation

Implement KPI frameworks, conduct annual talent audits, and establish feedback loops between industry and academia.

Conclusion

The rapid expansion of China's New Energy Vehicle (NEV) industry has elevated talent as a strategic resource, particularly in emerging inland hubs like Nanning. This study provides a comprehensive analysis of Nanning's NEV talent ecosystem, revealing structural mismatches between supply and demand, pronounced skill polarization, and regional disparities in wage competitiveness and industrial clustering. Through empirical data and comparative benchmarking, the research identifies critical shortages in high-skilled roles—especially within core components and R&D functions—and highlights the influence of wage elasticity and urban livability on talent retention.

Drawing on Human Capital Theory and Cluster Theory, the findings underscore the need for integrated strategies that align education, industry, and urban development. International experiences from Germany, Japan, and ASEAN countries offer valuable lessons, while Nanning's unique position within the China-ASEAN corridor presents opportunities for regional internationalization and strategic investment.

To address these challenges, the paper proposes a six-pronged strategy encompassing industry–education integration, high-end project attraction, workforce training, urban optimization, interdisciplinary academic development, and continuous monitoring. These recommendations aim to transform Nanning's NEV talent landscape from reactive recruitment to proactive ecosystem building.

Ultimately, this study contributes to the literature by bridging national policy frameworks with city-level implementation insights, offering a replicable model for other inland NEV hubs seeking to accelerate industrial upgrading through talent-driven development. Future research may extend this framework to longitudinal studies and cross-regional comparisons, further enriching the discourse on sustainable talent strategies in strategic emerging industries.

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