# Synergistic Development of New Quality Productive Forces and Logistics Industry: A Case Study of Panzhihua City

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**Abstract**
New Quality Productive Forces (NQPF), driven by high technology and efficiency, are pivotal for high-quality development. As a foundational industry, the logistics sector plays a critical role in regional economies. Investigating the synergy between NQPF and logistics is essential for fostering their mutual advancement. This study examines Panzhihua City from 2018 to 2022, constructing an evaluation system to assess their synergistic development using entropy weighting and coupling coordination models. Results show that NQPF's comprehensive development index rose from 0.445 to 0.579, while logistics surged from 0.208 to 0.838. The systems maintained high-level coupling (C > 0.9), with coordination improving from barely coordinated (0.552) to well-coordinated (0.838), reflecting a robust interactive pattern. This research provides empirical evidence and policy insights for regional synergy.
**Keywords**: New Quality Productive Forces, Logistics Industry, Synergistic Development, Coupling Coordination Model

**Introduction**
Against the backdrop of the global new wave of technological revolution and industrial transformation, innovation-driven development has become a core strategic focus for major economies to reshape industrial competitiveness. From the U.S. "Advanced Manufacturing Leadership Strategy" to the EU's "Industry 5.0" initiative, technological breakthroughs and industrial synergy are universally regarded as pivotal to achieving high-quality economic growth. Within this international landscape, China's strategic emphasis on "accelerating the development of New Quality Productive Forces (NQPF)"—officially enshrined in the "14th Five-Year Plan Outline"—marks a critical shift from factor-driven to innovation-driven growth, positioning technological integration as the cornerstone of national economic upgrading.

As a foundational pillar of the national economy, the logistics industry's synergistic development with NQPF is indispensable to realizing this strategic goal. Theoretically, existing research has predominantly explored NQPF's independent application in high-end manufacturing and digital sectors (Yuan et al, 2025) or focused solely on the logistics industry's intelligent transformation (Yuan, Dai & Ma,2022). However, systematic analysis of

their reciprocal empowerment—how NQPF reshapes logistics systems and how advanced logistics in turn fuels NQPF—remains fragmented, especially at the city-level where industrial practices converge with strategic implementation.

Currently, China's logistics sector is transitioning toward quality- and efficiency-driven growth, with technological innovation as a key catalyst. Panzhihua, a resource-based city undergoing industrial restructuring, exemplifies this dynamic. Leveraging its unique advantages in vanadium-titanium and clean energy resources, the city has rapidly developed emerging industries, with output in new sectors reaching ¥5.54 billion in 2023—a 64% year-on-year increase. This transformation underscores the research significance of NQPF-logistics synergy: industrial upgrading generates demand for specialized transportation and smart logistics, while enhanced logistics infrastructure and services reciprocally fuel NQPF advancement.As China's "vanadium-titanium capital," Panzhihua employs digital technologies and intelligent equipment from NQPF to optimize logistics routes, improve warehouse management, and overcome traditional operational limitations, significantly reducing costs and enhancing delivery efficiency. Innovations like network freight platforms and smart supply chains bridge upstream-downstream resource industries, expanding logistics services and strengthening regional competitiveness. However, challenges persist, including inconsistent R&D investment and suboptimal logistics structures.

This study systematically examines the interaction between NQPF and logistics, providing empirical insights to support regional decision-making. Our analysis offers a policy framework for synergistic industrial development, addressing gaps in city-level research while advancing theoretical and practical understanding of this critical nexus.

*Research Status*
New - quality productive forces were first proposed by General Secretary Xi Jinping during his inspection in Heilongjiang in September 2023. It represents an innovative development of Marxist productive force theory, with innovation at its core and characterized by high - technology, high - efficiency, and high - quality. In current research, Cui & Du (2025), Du & Yang (2022), etc. explored its impacts from the dimensions of urban - rural integration and manufacturing industry related to new - quality productive forces, employing methods such as the difference - in - differences model and the entropy - weight TOPSIS method. In the past two years, CNKI has seen an abundance of relevant literatures. Scholars like Lei, Zhao, & Du (2025) discussed its connotation, value, and role in the high - quality development of agriculture and rural areas from multiple dimensions. Li X. (2024) and others studied its enabling effect on the development of the logistics industry. Hu, Wu, & Li (2024) evaluated the development level and spatio - temporal characteristics of the new - quality productive forces of regional logistics, echoing the theoretical discussions on its scientific connotation and the promoting role in high - quality development.

Currently, research on new - quality productive forces and the logistics industry mainly focuses on the national level or large - scale regions such as the Yangtze River Economic Belt (Kong, Zhang, Zhang, & Lu, 2025) and the three northeastern provinces. However, there is relatively little research on a single city. Moreover, most literatures only explore the one - way impact of new - quality productive forces on the logistics industry, with limited research on the coordinated development of the two. Therefore, based on the theory of coordinated

development, this paper uses the entropy method to determine the weights and analyzes the coordinated development level of new - quality productive forces and the logistics industry in Panzhihua from 2018 to 2022 through the coupling degree model. By revealing the interaction mechanism and impact path between them, it provides a scientific basis for Panzhihua to formulate coordinated development policies, promotes the sustainable and high - quality development of the logistics industry with new - quality productive forces, and simultaneously accelerates the formation of new - quality productive forces, achieving a benign interaction and coordinated progress between the two.

## Research Design
### *Construction of the Indicator System*
*Construction of the New Productive Forces Indicator System*

Based on the connotation and characteristics of new productive forces, drawing on the methodological approaches of scholars such as Xu, Zhang, & Yuan (2025) and Zhang, Chen, Yang, & Wang (2025), and considering the accessibility of data, this study constructs a comprehensive evaluation indicator system for new productive forces from three dimensions: new laborers, new objects of labor, and new means of labor, as presented in Table 1.

In terms of new laborers, the indicators selected for measurement include: fiscal expenditure on science and technology; education expenditure as a proportion of total fiscal expenditure; number of students enrolled in institutions of higher education; per capita GDP; average wage of employed workers; number of employees in the tertiary industry as a proportion of total employment; and number of R&D personnel. For new objects of labor, the measuring indicators are: number of enterprises with research and development institutions; number of enterprises engaging in R&D activities; environmental protection expenditure as a proportion of total government public fiscal expenditure; industrial wastewater discharge relative to GDP; and industrial waste gas emissions relative to GDP. Regarding new means of labor, the indicators used for measurement comprise: number of mobile phone users; number of patent applications; full-time equivalent of R&D personnel in industrial enterprises above designated size; investment in scientific and technological research and development (R&D) funds; expenditure on technological transformation; and ratio of internal R&D expenditure to main business income.

Table 1

*Comprehensive Evaluation Index System of New Productive Forces*

| Criterion Layer | Indicator Layer | Unit | Attribute | Code |
|---|---|---|---|---|
| New Laborers | Fiscal expenditure on science and technology | 10,000 yuan | + | A1 |
| | Education expenditure / total fiscal expenditure | % | + | A2 |
| | Number of students enrolled in institutions of higher education | person | + | A3 |
| | | yuan | + | A4 |
| | Per capita GDP | yuan | + | A5 |
| | Average wage of employed workers | % | + | A6 |
| | | person | + | A7 |
| | Number of employees in the tertiary industry / total employment | | | A8 |
| | Number of R&D personnel | | | |
| New Objects of Labor | Number of enterprises with research and development institutions | Unit | + | A9 |
| | Number of enterprises engaging in R&D activities | unit | + | A10 |
| | Environmental protection expenditure / total government public fiscal expenditure | % | + | A11 |
| | | % | — | A12 |
| | Industrial wastewater discharge / GDP | % | — | A13 |
| | Industrial waste gas emissions / GDP | | | |
| New Means of Labor | Number of mobile phone users | 10,000 users | + | A14 |
| | Number of patent applications | item | + | A15 |
| | Full-time equivalent of R&D personnel in industrial enterprises above designated size | person-year | + | A16 |
| | | 10,000 yuan | + | A17 |
| | Investment in scientific and technological research and development (R&D) funds | 10,000 yuan | + | A18 |
| | Expenditure on technological transformation | % | + | A19 |
| | Ratio of internal R&D expenditure to main business income | | | |

*Construction of the Logistics Industry Indicator System*

Through a review of relevant literature and based on the research findings of scholars such as Liu & Ning (2021) and Mi & Kai (2014), this study constructs a comprehensive evaluation indicator system for the logistics industry from three aspects: economic development level, logistics infrastructure, and logistics development scale, as detailed in Table 2.For the dimension of economic development level, the selected indicators include regional gross domestic product, total retail sales of social consumer goods, total import and export volume, and operating income of industrial enterprises above designated size. In terms of logistics infrastructure, the indicators used for measurement are mileage of graded highways, total mileage of expressways, number of post offices, land for logistics and warehousing, number of civil motor vehicles, and growth rate of fixed-asset investment in transportation, storage, and postal services. Regarding logistics development scale, the indicators comprise freight turnover volume, highway freight volume, railway freight volume, express delivery business volume, gross output value of transportation, storage, and postal services, and postal business income.

Table 2

*Comprehensive Evaluation Index System of the Logistics Industry*

| Criterion Layer | Indicator Layer | Unit | Attribute | Code |
|---|---|---|---|---|
| Economic Development Level | Regional gross domestic product (GDP) | 100 million yuan | + | B1 |
| | | 100 million yuan | + | B2 |
| | Total retail sales of social consumer goods | 100 million yuan | + | B3 |
| | | 100 million yuan | + | B4 |
| | Total import and export volume | | | |
| | Operating income of industrial enterprises above designated size | | | |
| Logistics Infrastructure | Mileage of graded highways | km | + | B5 |
| | Total mileage of expressways | km | + | B6 |
| | Number of post offices | location | + | B7 |
| | Land for logistics and warehousing | square | + | B8 |
| | Number of civil motor vehicles | kilometer | + | B9 |
| | Growth rate of fixed-asset investment in transportation, storage, and postal services | unit % | + | B10 |
| Logistics Development Scale | Freight turnover volume | 10,000 ton-km | + | B11 |
| | Highway freight volume | 10,000 tons | + | B12 |
| | Railway freight volume | 10,000 tons | + | B13 |
| | Express delivery business volume | 10,000 items | + | B14 |
| | Gross output value of transportation, storage, and postal services | 10,000 yuan | + | B15 |
| | Postal business income | 100 million yuan | + | B16 |

*Data Sources*

Data were obtained from the Panzhihua Statistical Yearbook and the Statistical Communique of Panzhihua on National Economic and Social Development for the period 2018–2022. All data underwent standardization to ensure reliability, as shown in Tables 3 and 4.

Table 3

*Original Data of Each Indicator in the New Productive Forces Index System (2018–2022)*

| Criterion Layer | Indicator Layer | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| New Laborers | Fiscal expenditure on science and technology | 12494 | 14904 | 13104 | 6589 | 5878 |
| | Education expenditure / total fiscal expenditure | 0.184 | 0.198 | 0.172 | 0.299 | 0.176 |
| | Number of students enrolled in institutions of higher education | 26617 | 28918 | 25785 | 32640 | 34865 |
| | Per capita GDP | 76163 | 82460 | 85806 | 93406 | 100454 |
| | Average wage of employed workers | 84288 | 90077 | 94070 | 102919 | 108898 |
| | Number of employees in the tertiary industry / total employment | 0.42 | 0.425 | 0.477 | 0.482 | 0.45 |
| | Number of R&D personnel | 3125 | 1910 | 2660 | 2223 | 3725 |
| New Objects of Labor | Number of enterprises with research and development institutions | 18 | 17 | 20 | 19 | 23 |
| | Number of enterprises engaging in R&D activities | 44 | 39 | 46 | 45 | 58 |
| | Environmental protection expenditure / total government public fiscal expenditure | 0.408 | 0.226 | 0.229 | 0.2 | 0.112 |
| | Industrial wastewater discharge / GDP | 3.978 | 4.863 | 4.588 | 3.458 | 3.255 |
| | Industrial waste gas emissions / GDP | 1.824 | 2.883 | 2.986 | 2.733 | 2.778 |
| New Means of Labor | Number of mobile phone users | 157.38 | 149.2 | 145.4 | 147.02 | 150.36 |
| | Number of patent applications | 673 | 736 | 653 | 544 | 630 |
| | Full-time equivalent of R&D personnel in industrial enterprises above designated size | 1964 | 1058 | 1584 | 1575 | 2028 |
| | Investment in scientific and technological research and development (R&D) funds | 14438 | 138351 | 156045 | 183294 | 147323 |
| | Expenditure on technological transformation | 31497 | 18379.8 | 23670.3 | 65325.6 | 71553.4 |
| | Ratio of internal R&D expenditure to main business income | 0.69 | 0.59 | 0.64 | 0.57 | 0.47 |

Table 4

*Original Data of Each Indicator in the Logistics Industry Index System (2018–2022)*

| Criterion Layer | Indicator Layer | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Economic Development Level | Regional gross domestic product (GDP) | 941.45 | 1010.13 | 1040.82 | 1133.95 | 1220.52 |
| | Total retail sales of social consumer goods | 218.22 | 240.55 | 235.15 | 278.29 | 285.73 |
| | Total import and export volume | 30.61 | 31.72 | 30.43 | 41.47 | 53.1 |
| | Operating income of industrial enterprises above designated size | 1691.83 | 1845.6 | 1922.27 | 2233.61 | 2296.62 |
| Logistics Infrastructure | Mileage of graded highways | 3733.91 | 4083 | 4321.93 | 4439.3 | 4487.57 |
| | Total mileage of expressways | 195 | 195 | 233 | 233 | 233 |
| | Number of post offices | 68 | 69 | 69 | 69 | 69 |
| | Land for logistics and warehousing | 3.58 | 3.58 | 3.58 | 3.51 | 3.51 |
| | Number of civil motor vehicles | 181613 | 198239 | 214371 | 230389 | 241998 |
| | Growth rate of fixed-asset investment in transportation, storage, and postal services | 2.5 | 18.7 | -0.3 | -7.5 | 16.8 |
| Logistics Development Scale | Freight turnover volume | 622082 | 667373 | 537835 | 593274 | 614954 |
| | Highway freight volume | 10740 | 11966 | 8133 | 10491 | 10704 |
| | Railway freight volume | 2049.16 | 2235.18 | 2316.87 | 2127.13 | 2369.68 |
| | Express delivery business volume | 2195.86 | 3159.49 | 4454.31 | 5843.5 | 6042.01 |
| | Gross output value of transportation, storage, and postal services | 385194 | 400897 | 314621 | 343229 | 349064 |
| | Postal business income | 4.84 | 5.15 | 7.53 | 7.4 | 7.91 |

**Calculation of the Coupling Coordination Degree Model**

*Entropy Method*

The entropy weighting method, as an objective weighting approach, effectively captures the implicit information within indicator data. By calculating weights for each indicator through this method, it provides a reliable foundation for comprehensive evaluations.

(1) Standardization. Given that the original data of each indicator have different measurement units and dimensions, the improved range method was employed for standardization and normalization to ensure the processed values fall within the range of [0.001, 0.991]. The standardization formula is as follows:

$$
Y_{ij} = \begin{cases} \frac{X_{ij}-min(X_{ij})}{max(X_{ij})-min(X_{ij})} \times 0.99 + 0.0001, & for\ positive\ indicators \\ \frac{max(X_{ij})-X_{ij}}{max(X_{ij})-min(X_{ij})} \times 0.99 + 0.0001, & for\ negvtive\ indicators \end{cases} \qquad （1）
$$

i=1，2，3，…，m；j=1，2，3，…，n。

In Equation (1), $X_{ij}$ represents the original value of the j-th indicator in the i-th year; $\min X_j$ and $\max X_i$ denote the minimum and maximum values of the j-th indicator, respectively; $Y_{ij}$ denotes the standardized data.

(2) Calculate the proportion of indicator j in year i.

$$T_{ij} = Y_{ij} \div \sum_{i=1}^{m} Y_{ij} \qquad (2)$$

(3) Compute the information entropy for indicator j.

$$e_j = -k \sum_{i=1}^{m} \left( T_{ij} \times ln T_{ij} \right) \qquad (3)$$

In Equation (3), $k = \frac{1}{\ln m}$, ensuring $e_j \in [0,1]$, When $T_{ij}=0$, we define $T_{ij} \times \ln T_{ij} = 0$。

(4) Compute the information entropy redundancy measure.

$$d_j = 1 - e_j \qquad (4)$$

(5) Calculate the indicator weights.

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \qquad (5)$$

Throughout Eqs. (1) to (5), m corresponds to the observation period length (in years), while n indicates the complete indicator set cardinality.

(6) Compute the integrated development index for each subsystem through comprehensive evaluation.

$$M = \sum_{i=1}^{n} \left( Y_{ij} \times w_j \right) \qquad (6)$$

In Equation (6), M represents the composite development index for either New Quality Productive Forces or the logistics industry; $Y_{ij}$ denotes the standardized values of each indicator, and $W_j$ corresponds to the respective indicator weights within each system.

3.3.2 Coupling Degree Model

The coupling degree model, originally derived from physics, quantifies the coordination between two or more interacting systems. This method provides a concise numerical representation of interaction intensity and has been widely adopted in interdisciplinary research.

To analyze the interaction between Panzhihua's New Quality Productive Forces (NQPF) and logistics industry, we establish the coupling degree model as follows:

$$C = 2 \sqrt{\frac{M_1 \times M_2}{(M_1 + M_2)^2}} \qquad (7)$$

In Equation (7): $M_1$: Composite development index of New Quality Productive Forces (NQPF);

$M_2$: Composite development index of the logistics industry;

C: Coupling degree (range: 0–1), where values approaching 1 indicate stronger NQPF-logistics synergy

The coupling degree C follows the classification in Table 5, with C→1 denoting optimal interaction and lower values indicating progressively weaker coupling.

Table 5

*Classification of Coupling Degree Grade Intervals*

| Coupling Degree | Type of Coupling State |
|---|---|
| 0＜C≤0.3 | Low-level coupling |
| 0.3＜C≤0.6 | Antagonistic coupling |
| 0.6＜C≤0.8 | Running-in coupling |
| 0.8＜C≤0.9 | Initial coupling |
| 0.9＜C≤1.0 | High-level coupling |

*Coupling Coordination Model*

While coupling degree quantifies interaction intensity between subsystems, it cannot assess coordination quality or reveal synergistic relationships. To evaluate system harmony and co-development, we introduce the coupling coordination degree (CCD) model (Wang et al., 2025):

Key Equations:

$$G = \propto M_1 + \beta M_2 \qquad （8）$$
$$D = \sqrt{C \times T} \qquad （9）$$

**Parameter Definitions**

G: Comprehensive coordination index

α, β: Weight coefficients (set as α=β=0.5, assuming equal system importance)

D: CCD metric, where higher values indicate stronger synergistic interaction (Wang & Zhao, 2024; Fan & Li, 2025)

**Classification**

CCD levels follow Table 6's categorical thresholds.

Table 6

*Classification of Coupling Coordination Degree Grade Intervals*

| Coupling Coordination Degree | Development Type | Coupling Coordination Degree | Development Type |
|---|---|---|---|
| 0≤D＜0.1 | Extreme imbalance | 0.5≤D＜0.6 | Barely coordinated |
| 0.1≤D＜0.2 | Severe imbalance | 0.6≤D＜0.7 | Primary coordination |
| 0.2≤D＜0.3 | Moderate imbalance | 0.7≤D＜0.8 | Intermediate coordination |
| 0.3≤D＜0.4 | Mild imbalance | 0.8≤D＜0.9 | Good coordination |
| 0.4≤D＜0.5 | Imbalance on the verge | 0.9≤D≤1.0 | High-quality coordination |

*Obstacle Degree Model*

To identify key constraints affecting the NQPF-logistics synergy in Panzhihua, we employ an obstacle degree model (Peng & Wu, 2025) that quantifies impediment factors:

Core Equations:

$$F_j = w_j \qquad （10）$$
$$I_j = 1 - Y_{ij} \qquad （11）$$

$$Q_{ij} = \frac{F_j \times I_j}{\sum_{j=1}^{n}(F_j \times I_j)} \times 100\% \qquad （12）$$

In Equations (10), (11), and (12), $W_j$ denotes the weight of the j-th indicator, $Y_{ij}$ represents its standardized value, $F_j$ is the factor contribution degree, $I_j$ is the indicator deviation degree, and $Q_{ij}$ is the obstacle degree. A higher value of $Q_{ij}$ indicates a greater obstacle of indicator j to the coordinated development of the two systems, whereas a lower value suggests less obstruction (Peng & Wu, 2025).

*Empirical Analysis*

To clearly reveal the collaborative development trends between the new productive forces and the logistics industry in Panzhihua City from 2018 to 2022, this section conducts an empirical analysis from three dimensions: comprehensive development level, coupling coordination relationship, and obstacle factors, based on the indicator system and measurement models established earlier. By calculating the comprehensive development level indices of the two systems, their dynamic change trends are tracked; using the coupling degree and coupling coordination degree models, the intensity and quality of their interactive collaboration are quantified; and through the obstacle degree model, the key factors constraining collaborative development are identified. Through multi-dimensional analysis, this study systematically presents the real-world characteristics and internal mechanisms of the collaborative development of the two systems, providing an empirical basis for the subsequent policy recommendations.

*Comprehensive Development Level*

The comprehensive development level indices of the new productive forces and the logistics industry were calculated according to Equation (6), and the trend chart of their comprehensive development levels was plotted, as shown in Figure 1.
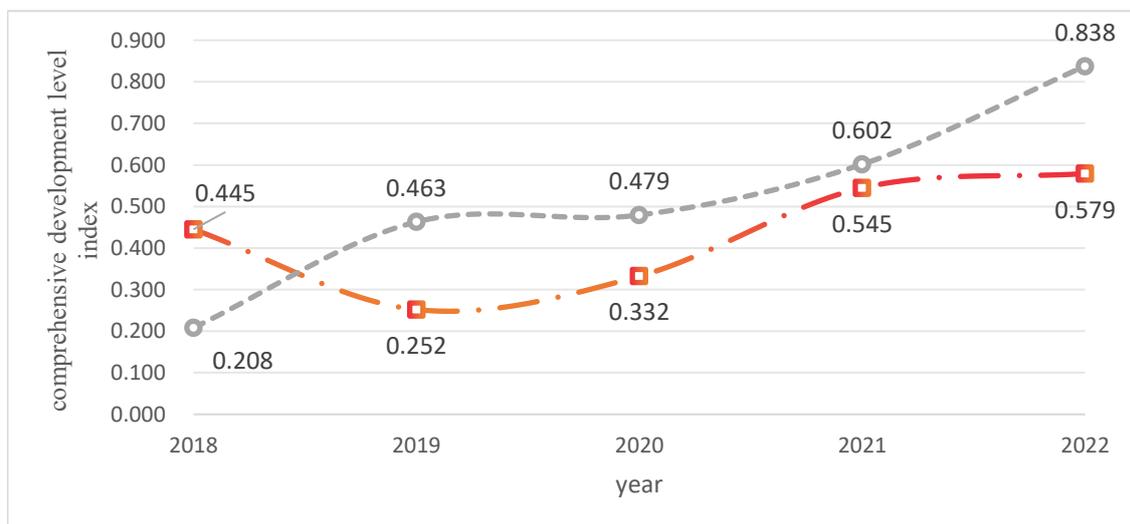


Figure 1 Trend of Comprehensive Development Levels of New Productive Forces and Logistics Industry in Panzhihua (2018–2022)

As shown in Figure 1, the comprehensive development level indices of both new productive forces and the logistics industry in Panzhihua City exhibited an overall upward trend from 2018 to 2022, indicating favorable development of both systems during the study period.

The comprehensive development level index of new productive forces rose from 0.445 in 2018 to 0.579 in 2022. From 2018 to 2019, the index declined from 0.445 to 0.252, likely attributed to a significant reduction in R&D investment, shrinking innovation entities, and the loss of high-end talent. In 2019, the number of R&D personnel dropped to 1,910, and expenditure on technological transformation decreased to 183.798 million yuan, representing a 38.88% and 41.65% decline respectively compared to 2018 (3,125 personnel and 314.97 million yuan). Concurrently, the number of enterprises with R&D institutions decreased to 17, and those engaging in R&D activities fell to 39, weakening corporate innovation vitality and constraining technological innovation capacity, thereby causing a decline in the development level of new productive forces. The index rebounded steadily after 2019, reflecting improved innovation environments. However, the growth slowed between 2021 and 2022, constrained by multiple factors: persistent impacts of the COVID-19 pandemic on R&D activities, cautious corporate innovation investment amid global economic downturn, increased difficulty in technological innovation due to industrial transformation and upgrading, and insufficient supply of high-end talent.

The comprehensive development level index of the logistics industry climbed continuously from 0.208 in 2018 to 0.838 in 2022, indicating a strong momentum of high-quality development during the study period. In terms of infrastructure construction, the total mileage of expressways in the city increased from 195 km to 233 km in 2020, optimizing regional road network layout, shortening spatial-temporal distances to hub cities such as Chengdu and Kunming, improving transportation efficiency, and reducing logistics costs. From 2019 to 2020, the index only slightly increased from 0.463 to 0.479, with slowed growth likely impacted by the COVID-19 pandemic and associated lockdown measures. From 2020 to 2022, guided by post-pandemic economic recovery policies and the "14th Five-Year Plan" for modern logistics development, the comprehensive development level of the logistics industry accelerated, reflecting its return to an upward trajectory alongside normalized economic and social operations and sustained national economic growth. Postal business revenue reached 791 million yuan in 2022, a 63.34% increase from 2018, highlighting its robust development momentum.

*Coupling Coordination Analysis*
Based on Equations (1) to (3), the coupling degree and coupling coordination degree of the two systems in Panzhihua City were calculated. The results, classified according to the established grade intervals, are presented in Table 7.

Table 7

*Coupling Degree and Coupling Coordination Degree between New Productive Forces and Logistics Industry in Panzhihua City from 2018 to 2022*

| year | Coupling Degree | Grade | Coupling Coordination Degree | Grade |
|------|------|------|------|------|
| 2018 | 0.932 | High-level coupling | 0.552 | Barely coordinated |
| 2019 | 0.955 | High-level coupling | 0.584 | Barely coordinated |
| 2020 | 0.983 | High-level coupling | 0.632 | Primary coordination |
| 2021 | 0.999 | High-level coupling | 0.757 | Intermediate coordination |
| 2022 | 0.983 | High-level coupling | 0.835 | Good coordination |

As shown in Table 7, the coupling degree between new productive forces and the logistics industry in Panzhihua City remained at a high level above 0.9 from 2018 to 2022, indicating significant effectiveness in their collaborative development. Specifically, the coupling degree fluctuated slightly overall, rising from 0.932 in 2018 to 0.983 in 2022, reflecting increasingly close and mature interactions between new productive forces and the logistics industry.

Also evident in Table 7, the coupling coordination degree between the two systems in Panzhihua showed a steady upward trend from 2018 to 2022, indicating continuous improvement in their collaborative development level. In 2018 and 2019, the coupling coordination degrees were 0.552 and 0.584, respectively, both in the barely coordinated stage, suggesting that the two systems had initially established a collaborative relationship but with insufficient interaction. In 2020, it reached 0.632, entering the primary coordination stage, marking substantial progress in their collaborative development. It stood at 0.757 (intermediate coordination) in 2021 and 0.835 (good coordination) in 2022. This continuously optimizing evolutionary trajectory indicates that over time, the synergistic effects between new productive forces and the logistics industry in Panzhihua have been strengthening, with an accelerating formation of a positive interaction pattern between the systems.

As shown in Figure 2, both the coupling degree and coupling coordination degree of the two systems exhibited a steady upward trend and gradually converged over the years, reflecting the continuous enhancement of their collaborative development level. This change is driven by both the national innovation-driven development strategy and policies for logistics industry transformation and upgrading, as well as Panzhihua's context-specific policy system. The Panzhihua Action Plan for Technological Support to the Strategy of Strengthening the City through Industry issued in 2019 took technological innovation as the core driving force, focused on the development of high-tech industries, supported the transformation and upgrading of leading industries and the rapid growth of emerging industries, and promoted high-quality economic development. The Key Points for Panzhihua's Science and Technology Innovation Work issued in the same year aimed to build a regional innovation hub, implemented dual drives of mass entrepreneurship and innovation (MEI) and technology finance, and coordinated technological research and development with achievement transformation. The Three-Year Action Plan for Smart Logistics Development implemented in 2020 focused on "digitalization, intellectualization, and networking", promoted three major projects (upgrading of logistics infrastructure, application of information technology, and

optimization of industrial ecology), and built an efficient and intelligent modern logistics service system. The Panzhihua 14th Five-Year Plan for Modern Logistics Industry Development in 2021 identified "logistics + technology" as the development direction, promoted in-depth integration of new-generation information technologies such as the Internet of Things, big data, and artificial intelligence with the logistics industry, and constructed a smart and digital modern logistics service system. The introduction and implementation of these policies have formed a dual-drive mechanism of technological innovation and logistics upgrading, which not only promoted the development of the two industries themselves but also enhanced their collaborative development through policy synergy, achieving continuous optimization of coupling coordination degree and high-quality development of the regional economy.



Figure 2 Trend Chart of Synergistic Development between New Productive Forces and Logistics Industry in Panzhihua City from 2018 to 2022

*Analysis of Obstacle Factors*

As shown in Figure 3, the obstacle degrees of logistics infrastructure, new objects of labor, new means of labor, and logistics development scale exhibited a steady upward trend, while those of economic development level and new laborers showed a fluctuating downward trend. By examining the obstacle degrees of the six criterion layers in 2022, it is evident that to promote the positive collaborative development between new productive forces and the logistics industry in Panzhihua, future efforts should focus on the construction of logistics infrastructure and the optimization of new laborers.
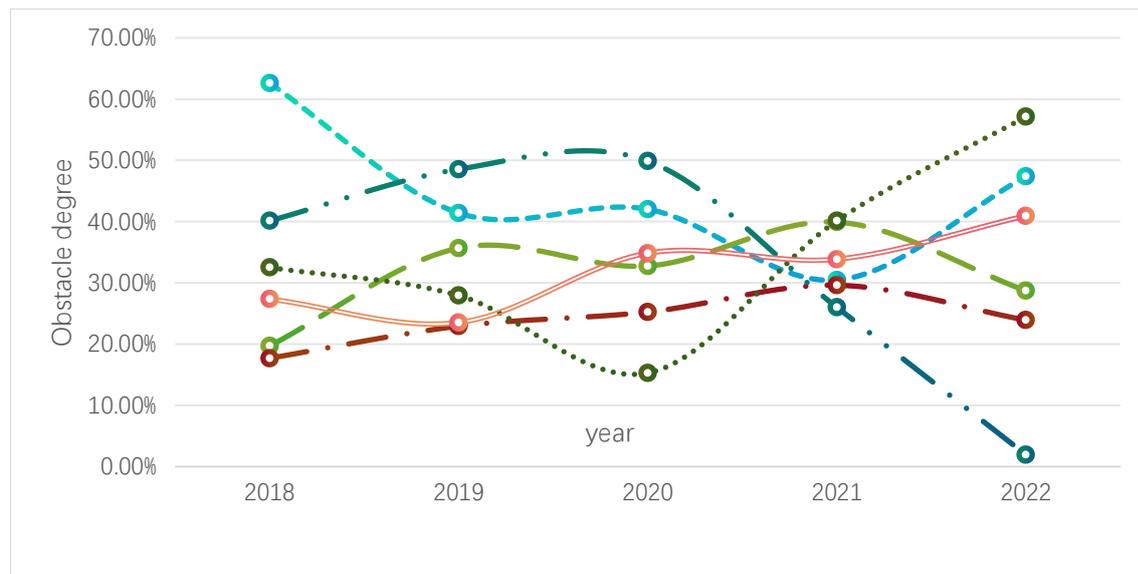
Figure 3 Obstacle Degree of First-level Indicators for the Synergistic Development between New Productive Forces and Logistics Industry in Panzhihua City from 2018 to 2022

Following the analysis of obstacle degrees at the criterion layer, the obstacle degrees of each indicator within the indicator layer for the collaborative development of new productive forces and the logistics industry in Panzhihua were further calculated, with the top 10 obstacle factors identified and presented in Table 8.

Table 8
*Ranking of Obstacle Factors for the Synergistic Development between New Productive Forces and Logistics Industry in Panzhihua City from 2018 to 2022*

| Year | Item | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------|------|---|---|---|---|---|---|---|---|---|----|
| 2018 | Obstacle factor | A2 | A6 | B3 | A3 | A17 | A5 | A8 | A4 | A9 | B6 |
| | Obstacle degree (%) | 18.5 | 10.82 | 10.69 | 10.33 | 9.27 | 8.66 | 8.43 | 8.3 | 6.93 | 6.81 |
| 2019 | Obstacle factor | A2 | A12 | A17 | A8 | A6 | A7/A9 | B3 | A11 | A13 | A3 |
| | Obstacle degree (%) | 11.98 | 10.6 | 9.08 | 7.48 | 7.37 | 6.95 | 6.9 | 6.68 | 5.59 | 5.54 |
| 2020 | Obstacle factor | A2 | A12 | A3 | A17 | A13 | B3 | A11 | A9 | A7 | A10 |
| | Obstacle degree (%) | 16.9 | 13.01 | 9.42 | 9.17 | 9.12 | 7.08 | 6.21 | 4.94 | 4.59 | 4.37 |
| 2021 | Obstacle factor | A12 | A13 | A1 | A7 | A8 | A14 | A9 | A10 | A18 | A15 |
| | Obstacle degree (%) | 14.96 | 11.58 | 11.52 | 9.45 | 8.22 | 7.89 | 7.84 | 7.43 | 4.46 | 3.73 |
| 2022 | Obstacle factor | A2 | A12 | A1 | A10 | A18 | A13 | A6 | A14 | A16 | B8 |
| | Obstacle degree (%) | 25.97 | 16.96 | 13.51 | 11.38 | 8.77 | 8.53 | 7.41 | 4.75 | 1.62 | 1.4 |

Based on the obstacle degrees of each indicator in Table 8, A2 (education expenditure/total fiscal expenditure) ranked as the primary obstacle factor in 2018, 2020, and

2022, with its obstacle degree surging to 25.97% in 2022. A12 (new objects of labor) remained a significant obstacle factor from 2019 to 2022, showing an overall upward trend in obstacle degree. Indicators related to logistics infrastructure (e.g., A13) saw a marked increase in obstacle degree in the later period, entering the list of key obstacle factors. Overall, the key obstacle factors exhibited dynamic changes. Education expenditure/total fiscal expenditure, fiscal expenditure on science and technology, industrial waste gas emissions/GDP, and total mileage of expressways were the critical factors hindering the collaborative development between new productive forces and the logistics industry in Panzhihua from 2018 to 2022. This indicates that the three criterion layers—new laborers, new objects of labor, and logistics infrastructure—exerted the strongest constraints. Accordingly, future efforts can focus on these three aspects to formulate practical strategies, thereby promoting positive collaborative development between new productive forces and the logistics industry in Panzhihua.

## Conclusions and Recommendations
### Research Conclusions

Based on panel data of Panzhihua City from 2018 to 2022, this study examines the collaborative development of new productive forces and the logistics industry, analyzing the comprehensive development level index, coupling degree, coupling coordination degree, and obstacle factors of the two systems. Four key conclusions are drawn as follows:

First, in terms of the comprehensive development level index, both the new productive forces and the logistics industry in Panzhihua showed an annual upward trend from 2018 to 2022. However, the comprehensive development level of new productive forces remained relatively low and lagged behind that of the logistics industry. Its index rose steadily from 0.445 in 2018 to 0.579 in 2022, with an average annual growth rate of 6.81%. In contrast, the logistics industry developed more rapidly, with its index surging from 0.208 to 0.838, at an average annual growth rate of 41.60%. This reflects that the logistics industry, as a foundational supporting sector, took the lead in development, laying the groundwork for the cultivation of new productive forces.

Second, regarding the coupling degree, the two systems maintained a high coupling degree above 0.9 from 2018 to 2022, belonging to the high-level coupling type. The coupling degree fluctuated slightly overall, increasing from 0.932 in 2018 to 0.983 in 2022, with an average annual growth rate of 1.34%. This indicates that the interactive relationship between them has become increasingly close and mature.

Third, in terms of the coupling coordination degree, the coordination between the two systems improved year by year from 2018 to 2022, rising from barely coordinated (0.552) in 2018 to well-coordinated (0.835) in 2022, with an average annual growth rate of 10.90%. Particularly after 2020, the coupling coordination degree accelerated, reflecting continuous improvement in the quality of collaborative development and strengthened positive interaction between the two systems.

Fourth, in terms of obstacle degrees, the main factors hindering the collaborative development of the two systems from 2018 to 2022 included education expenditure/total

fiscal expenditure, fiscal expenditure on science and technology, industrial waste gas emissions/GDP, and total mileage of expressways.

*Policy Recommendations*

To promote the high-quality collaborative development of new productive forces and the logistics industry in Panzhihua, efforts can be focused on three aspects:

First, strengthen the construction of logistics infrastructure. Promote the construction of railways and high-speed railways, increase the density of expressways, enhance freight connections with surrounding hub cities, build smart logistics hubs, and realize intelligent scheduling and visual management of goods.

Second, strengthen the cultivation of high-tech talents. Deepen industry-university-research-application cooperation, cultivate talents tailored to needs, improve enterprise talent training systems, and attract high-level talents through preferential policies, forming a positive cycle between talent development and industrial growth.

Third, practice the concept of green development. Promote new energy logistics vehicles and green warehousing facilities relying on clean energy. Governments should encourage enterprises to achieve green transformation through policy incentives, and join forces with scientific research institutions to overcome technical bottlenecks, thereby promoting the sustainable development of the logistics industry (Adams & Brown, 2023).

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