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Article

Analysis of Factors Influencing Rural Logistics Development in Shanxi Province, China

Zilong Xu[1], Rong Ren[2,*], Shubao Guan[3]

[1]Hubei University of Automotive Technology, Shiyan, Hubei 442002, China

[2]Xi'an Eurasia University, Xi'an, Shaanxi 710065, China

[3]Hubei Evolutionary Game Institution, Shiyan, Hubei 442002, China

[*]Corresponding author: Rong Ren, 2730886939@qq.com

Abstract

Rural logistics plays a critical role in supporting rural revitalization and economic development in China. This study aims to identify the key factors influencing rural logistics development in Shanxi Province, China, and to assess their relative importance. Based on a review of existing literature and policy reports, the study constructs a conceptual framework linking infrastructure, service capacity, and logistics outcomes. Using Grey Relational Analysis (GRA) on nine years of provincial data, the research evaluates the correlation between multiple factors-including road and railway infrastructure, postal and express services, and logistics-related economic indicators-and the overall development of rural logistics. The results indicate that road infrastructure and express delivery services exhibit the highest correlation with logistics development, whereas other factors, such as railway mileage and logistics value-added, show moderate associations. These findings provide empirical evidence supporting the prioritization of infrastructure and service improvements to enhance rural logistics. The study contributes to the literature by combining GRA with a structured analysis of causal mechanisms in the rural logistics context and by offering a province-specific perspective that can inform both domestic and comparative research on rural supply chain development.

Keywords

Rural logistics, Policy-oriented rural development framework, Grey relational analysis, Influencing factors, Logistics infrastructure, Shanxi Province

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1. Introduction

Rural logistics is a crucial component of rural economic development, particularly in the context of China's rural revitalization strategy. Efficient logistics systems enhance the circulation of agricultural products, reduce transaction costs, and promote rural industrial integration, thereby supporting sustainable development in rural regions [1]. Despite its importance, rural logistics in China remains unevenly developed, with significant regional disparities, limited infrastructure, and varying service capacities [2]. Shanxi Province, characterized by its mountainous terrain and dispersed rural settlements, presents a typical case where understanding the determinants of logistics development can inform targeted interventions [3].

However, existing studies predominantly focus on descriptive analyses or national-level assessments, leaving several research gaps: (1) the specific factors influencing rural logistics development at the provincial level remain underexplored; (2) the relative importance of infrastructure, service capacity, and logistics-related economic indicators has not been systematically assessed; (3) there is a lack of empirical evidence linking quantitative analysis to actionable insights. To address these gaps, this study aims to systematically evaluate the determinants of rural logistics development in Shanxi Province, China, using Grey Relational Analysis (GRA).

The study pursues the following objectives:

1) To identify and quantify the key factors affecting rural logistics development in Shanxi Province.

2) To rank the relative importance of these factors using GRA.

3) To provide an evidence-based framework linking infrastructure, service capacity, and logistics outcomes.

4) To discuss the implications of the findings for future research and region-specific logistics planning.

5) Based on the above analysis, the following hypotheses are proposed:

6) H1: Highway route length is positively associated with rural logistics development.

7) H2: Railway operating mileage is positively associated with rural logistics development.

8) H3: Express delivery volume is positively associated with rural logistics development [4].

9) H4: Postal service capacity is positively associated with rural logistics development.

10) By addressing these objectives and testing these hypotheses, this study contributes to the literature by providing a province-specific, analytically grounded assessment of rural logistics determinants. The findings also offer a structured reference for policymakers and researchers seeking to enhance logistics infrastructure and service capacity in similar rural regions.

2. Literature Review

2.1 Rural Logistics and Economic Development

Research on rural logistics has consistently emphasized its critical role in supporting agricultural markets and regional economic growth. Domestic studies highlight that rural infrastructure, including transportation, warehousing, and energy supply, forms the backbone of logistics systems [5]. Improvements in these areas not only reduce post-harvest losses but also enhance market access for rural producers. However, most studies remain descriptive, focusing on infrastructure availability rather than analyzing causal mechanisms between rural economic growth and logistics efficiency [6].

International research provides complementary insights. For example, studies in India and Sub-Saharan Africa illustrate how logistics performance influences rural market integration and household income diversification [7]. Comparative analysis suggests that factors such as road quality, digital connectivity, and institutional support consistently shape logistics effectiveness, indicating potential parallels and contrasts for Chinese rural contexts [8].

Gap identified: While both domestic and international literature recognize the link between rural economic development and logistics, few studies systematically quantify this relationship in China, particularly under the rural revitalization strategy. Moreover, previous research rarely considers modern economic integration (agriculture-industry-services) and the emergence of new rural business entities, leaving a critical gap that this study addresses.

2.2 Smart Logistics and Technology-Driven Transformation

The evolution of logistics systems toward “smart” or digital platforms has gained increasing attention [9]. In China, studies emphasize the integration of IoT, big data, and intelligent scheduling technologies to optimize rural logistics operations [10]. Smart logistics not only improves efficiency but also facilitates e-commerce expansion, bridging rural-urban market gaps.

Globally, smart logistics applications in rural settings-such as precision agriculture logistics in Europe or mobile-based market platforms in Africa-demonstrate the potential for technology to improve distribution, reduce costs, and increase transparency [11]. However, many studies focus on technology adoption without connecting it explicitly to local economic outcomes or analyzing policy interventions that facilitate system deployment [12].

Gap identified: Existing research emphasizes technological feasibility and operational gains but lacks a framework linking smart logistics infrastructure directly to rural economic performance in the Chinese provincial context. This study fills this gap by combining empirical analysis with policy implications specific to Shanxi Province.

2.3 Government Interventions and Policy Support

Government involvement is widely acknowledged as a key determinant of logistics development. Chinese studies show that fiscal incentives, tax relief, and infrastructure investment significantly affect logistics network efficiency and service quality [13]. Policies promoting green logistics, energy-efficient equipment, and training programs for logistics personnel also emerge as critical factors [14].

International literature further suggests that government-led coordination among enterprises, universities, and research institutions enhances innovation and operational capacity [15]. Comparative studies highlight that countries with proactive logistics policies achieve faster rural economic integration and higher service levels [16].

Gap identified: Despite recognition of government roles, few studies explicitly quantify their impact on logistics efficiency using empirical methods suitable for small datasets, such as GRA. Moreover, integration of government policy effects with rural economic and technological factors remains underexplored.

2.4 Synthesis and Contribution of This Study

In summary, previous literature provides foundational understanding of rural logistics, smart technology applications, and policy interventions. However, gaps remain in three areas:

1) Limited empirical analysis of the interaction between rural economic growth, business models, and logistics demand in provincial China.

2) Lack of integration between smart logistics infrastructure development and its economic impacts, particularly in rural settings.

3) Insufficient empirical examination of government interventions alongside technological and economic factors.

This study contributes by combining GRA with a multi-factor framework, explicitly linking rural economic development, smart logistics infrastructure, and government support. It fills both a domestic empirical gap and a methodological gap by providing a structured approach to evaluate logistics development under rural revitalization policies in Shanxi Province.

3. Methodology

3.1 Research Hypotheses

Based on the existing literature on rural logistics development, several factors related to transportation infrastructure and logistics service capacity are expected to influence the performance of rural logistics systems. Transportation infrastructure is widely recognized as a fundamental determinant of logistics development [17]. Well-developed highway networks can significantly improve transportation efficiency and reduce logistics costs in rural areas. Therefore, highway infrastructure is expected to be positively associated with rural logistics development. To empirically examine the determinants of rural logistics development, this study tests the following hypotheses:

H1: Highway route length is positively associated with rural logistics development.

H2: Railway operating mileage is positively associated with rural logistics development.

H3: Express delivery volume is positively associated with rural logistics development.

H4: Postal service capacity is positively associated with rural logistics development.

These hypotheses are operationalized through corresponding indicators. Specifically, highway infrastructure is measured by highway mileage (X_1) and highway route length (X_2), railway infrastructure is captured by railway operating mileage (X_3), logistics service capacity is represented by express delivery volume (X_6), and postal service capacity is measured by postal indicators (X_4). (X5) represents the value added of transportation, storage, and postal services, which reflects the economic contribution of the logistics sector. These variables are incorporated into the GRA to evaluate their relative influence on rural logistics development.

3.2 Indicator Selection

This study adopts a quantitative research design to analyze the determinants of rural logistics development in Shanxi Province, China. The analysis focuses on data from 2013 to 2021, covering nine consecutive years. Data were collected from official statistical yearbooks, provincial transportation reports, and government publications. The study identifies three categories of influencing factors based on literature and policy reports: Infrastructure factors: road density, transport network connectivity, and rural highway coverage; Service capacity factors: express delivery volume, postal service coverage, and logistics service availability; Economic factors related to logistics: logistics value-added, logistics investment, and rural commercial activity. Each factor is standardized to ensure comparability in the GRA. Specific indicators are detailed in Table 1.

Table 1. Description of variables and indicators used in the study.

Total freight volume	**Highway mileage (kilometers)**	**Highway route length (kilometers)**	**Railway Operating Mileage (kilometers)**	**Express Delivery Volume (10,000 parcels)**	**Value Added of Transportation, Storage, and Postal Services (in billions of yuan)**	**Freight trucks (units)**
X_0	X_1	X_2	X_3	X_4	X_5	X_6

3.3 Data Sources

The primary raw data for the empirical analysis of factors influencing rural logistics development in Shanxi Province were sourced from the Shanxi Statistical Yearbook covering nine consecutive years from 2013 to 2021. Additionally, drawing upon existing scholarly research foundations and extensively reviewing other references, six indicators were comprehensively selected as reference sequences to represent Shanxi's rural logistics development, based on the freight volume X_0. Two-way goods circulation-primarily involving the delivery of agricultural necessities to rural areas and the transport of agricultural products to urban centers-is a key characteristic of rural logistics, adequately covering the rural logistics development status addressed in this paper [18].

3.4 Analysis Procedure

This study establishes a grey relational model using raw data collected from the Shanxi Statistical Yearbook. Model calculations determine the correlation degree between Shanxi's rural logistics development and the six influencing factors. Combined with specific analyses of each indicator's results, recommendations are proposed for advancing rural logistics development in Shanxi.

3.4.1 Determining Reference and Comparison Sequences

The freight volume indicator, reflecting rural logistics development, serves as the reference sequence X_0. The six indicators influencing rural logistics development (as shown in Table 2 form the comparison sequences X_i (i=1,2,3,…).

Table 2. Raw data of rural logistics indicators in Shanxi Province (2013-2021).

Indicator	**X_0**	**X_1**	**X_2**	**X_3**	**X_4**	**X_5**	**X_6**
2013	152712	4363	165249	4803	9552	674	478785
2014	157074	4466	167145	4924	13762	753	498575
2015	140908	5094	170069	4676	20351	804	514201
2016	149049	5181	172471	4748	36902	879	518688
2017	163086	5279	174395	5108	4575	959	560368
2018	173253	5475	177128	5140	56877	1034	626066
2019	154758	5593	180070	6224	72892	1106	686768
2020	165268	6171	180071	6423	91750	1128	741455
2021	160702	6484	183414	6424	97482	1245	810581

3.4.2 Standardizing Data Using the Initial Value Method

$A_o = \frac{X_0(j)}{X_0(1)}, B_i = \frac{X_i(j)}{X_i(1)}$, in which i=1,2,3,…; j=1,2,3,…,the dimensionless processed data are shown in Table 3.

Table 3. Dimensionalization.

Indicator	X_0	X_1	X_2	X_3	X_4	X_5	X_6
2013	1	1	1	1	1	1	1
2014	1.0286	1.0236	1.0115	1.0252	1.4407	1.1172	1.0413
2015	0.9227	1.1675	1.0292	0.9736	2.1305	1.1929	1.0740
2016	0.9760	1.1875	1.0437	0.9885	3.8633	1.3042	1.0833
2017	1.0679	1.2099	1.0553	1.0635	0.4790	1.4228	1.1704
2018	1.1345	1.2549	1.0719	1.0702	5.9545	1.5341	1.3076
2019	1.0134	1.2819	1.0897	1.2959	7.6311	1.6409	1.4344
2020	1.0822	1.4144	1.0897	1.3373	9.6053	1.6736	1.5486
2021	1.0523	1.4861	1.1099	1.3375	10.2054	1.8472	1.6930

3.4.3 Calculate the Absolute Difference Between the Reference Sequence and the Comparison Sequence

The formula is as follows: $\Delta_{oi}(j) = |A_o(j) - B_i(j)|$ calculate the sequence differences according to the formula as shown in Table 4. Determine the maximum value m and minimum value n of the sequence differences [19].

Table 4. Sequence interpolation.

Indicator	X_1	X_2	X_3	X_4	X_5	X_6
2013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	0.0050	0.0171	0.0034	0.4122	0.0886	0.0128
2015	0.2448	0.1065	0.0509	1.2078	0.2702	0.1513
2016	0.2115	0.0677	0.0125	2.8873	0.3281	0.1073
2017	0.1420	0.0126	0.0044	0.5890	0.3549	0.1025
2018	0.1204	0.0626	0.0643	4.8200	0.3996	0.1731
2019	0.2685	0.0763	0.2825	6.6177	0.6276	0.4210
2020	0.3322	0.0075	0.2551	8.5231	0.5914	0.4664
2021	0.4338	0.0576	0.2852	9.1531	0.7949	0.6407

3.4.4 Calculate the Gray-Scale Correlation Coefficient

$r_{oj}(j) = \frac{n + \varepsilon^* m}{\Delta_{oj}(j) + \varepsilon^* m}, \varepsilon \in (0,1)$, Where ε is the resolution coefficient, selected here asε= 0.5; Substituting $\Delta_{oj}(j)$ into the formula yields the correlation coefficient table, as shown in Table 5.

Table 5. Gray-area correlation coefficient.

Indicator	X_1	X_2	X_3	X_4	X_5	X_6
2013	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2014	0.9989	0.9963	0.9993	0.9174	0.9810	0.9972
2015	0.9492	0.9773	0.9890	0.7912	0.9443	0.9680
2016	0.9558	0.9854	0.9973	0.6132	0.9331	0.9771
2017	0.9699	0.9973	0.9990	0.8860	0.9280	0.9781
2018	0.9744	0.9865	0.9861	0.4870	0.9197	0.9636
2019	0.9446	0.9836	0.9419	0.4088	0.8794	0.9158
2020	0.9323	0.9984	0.9472	0.3494	0.8856	0.9075
2021	0.9134	0.9876	0.9413	0.3333	0.8520	0.8772

3.4.5 Calculate the Grey Correlation Degree

The specific formula for calculating grey correlation is as follows:

$$C_{oj}(j)=\frac{1}{n}\sum_{k=1}^{n} r_{oj},\ i=1,2,3,...$$

From the perspective of grey correlation analysis, a higher correlation coefficient indicates that the development trends of X_i and X_0 are more closely aligned, meaning X_i exerts a greater influence on X_0. As shown in Table 6, the correlation coefficients are listed in descending order as follows: $X_2 > X_3 > X_1 > X_6 > X_5 > X_4$. It can be observed that the length of highway routes has the most significant impact on rural logistics in Shanxi Province. This is because, as an inland province, Shanxi's widely dispersed rural areas rely more heavily on the highway network for logistics distribution. Longer highway routes can more effectively connect remote rural regions, playing a decisive role in promoting the smooth operation of the rural logistics system. Additionally, the operational mileage of railways and expressways significantly impacts the logistics system, indicating that efficient long-distance logistics transportation is crucial for rural logistics development. Furthermore, the correlation of freight vehicle numbers ranks second only to the basic transportation network, suggesting that while robust infrastructure like roads, railways, and expressways is essential, the availability and quantity of transport vehicles-particularly freight trucks-directly influence logistics efficiency. This underscores that optimizing the allocation of transport vehicles and enhancing transport efficiency hold equal importance in rural logistics development. Although the added value of transportation, warehousing, and postal services, along with express delivery volumes, exert relatively limited direct influence on rural logistics in Shanxi Province, this does not imply their roles can be disregarded [20]. Particularly with the rapid expansion of e-commerce in rural areas, the growth in express delivery volumes continues to play a pivotal role in modernizing rural logistics systems and improving their efficiency [21]. Concurrently, the value added of transportation, warehousing, and postal services reflects the magnitude of these sectors' economic contributions and indirectly mirrors their functional roles within the logistics framework. In summary, these findings underscore the critical importance of basic transportation infrastructure for rural logistics development while highlighting the necessity of improving transport efficiency and optimizing the logistics service structure. As technological advancements and logistics demands continue to evolve, the future development of rural logistics in Shanxi Province must persistently refine these key elements to achieve a more efficient and sustainable logistics system.

Table 6. Grey correlation degree.

Indicator	**X_1**	**X_2**	**X_3**	**X_4**	**X_5**	**X_6**
Grey Correlation Degree	0.9598	0.9903	0.9779	0.6429	0.9248	0.9538

GRA is particularly suitable for studies with relatively small samples and incomplete information. Since the available data cover only nine years (2013-2021), traditional econometric models requiring larger samples may not be appropriate. Therefore, GRA is adopted to identify the relative importance of influencing factors. Nevertheless, the method mainly measures trend similarity rather than causality. Future studies may apply panel econometric models to further test the robustness of the results. Plus, It should be noted that GRA reflects the similarity of development trends rather than causal relationships. Therefore, the findings should be interpreted as indicative correlations rather than direct causal effects.

4. Results and Discussion

4.1 Results

The results of the GRA are presented in Table 6. The grey relational degrees of the six influencing factors are ranked as follows:

$$X_2 > X_3 > X_1 > X_6 > X_5 > X_4$$

This ranking indicates that highway route length (X_2) exhibits the strongest association with rural logistics development, followed by railway operating mileage (X_3) and highway mileage (X_1), while postal service-related indicators (X_4) show the weakest correlation. The following is a detailed analysis based on the actual situation:

First, highway route length (X_2) has the highest grey relational degree (0.9903), indicating the strongest alignment with the development trend of rural logistics. This result suggests that the expansion of highway networks plays a dominant role in facilitating rural logistics in Shanxi Province. Given the province's mountainous terrain and dispersed rural settlements, road transportation serves as the primary mode for goods distribution. An extensive highway network improves accessibility, reduces transportation time, and enhances connectivity between rural production areas and urban markets. Therefore, the high correlation reflects the fundamental role of road infrastructure in supporting rural logistics systems.

Second, railway operating mileage (X_3) shows a relatively high correlation (0.9779), ranking second among all factors. This indicates that railway infrastructure also plays an important role in rural logistics development, particularly for long-distance and bulk transportation. Railways provide large-capacity and cost-efficient transport services, which complement road transport by facilitating inter-regional logistics flows. The relatively high correlation suggests that the coordinated development of road and rail systems is essential for improving logistics efficiency.

Third, highway mileage (X_1), with a correlation degree of 0.9598, also demonstrates a strong association with rural logistics development. Although slightly lower than X_2, this indicator further confirms the importance of road infrastructure. The difference between X_1 and X_2 implies that not only the total scale but also the structural connectivity of highway networks (captured by route length) is crucial for logistics performance.

Fourth, freight vehicles (X_6) exhibit a correlation degree of 0.9538, indicating that transport capacity is another key factor influencing logistics efficiency. The availability of freight vehicles directly affects the ability to move goods in a timely and flexible manner. This suggests that, in addition to infrastructure, the operational capacity of logistics systems plays a significant role in supporting rural logistics activities.

Fifth, the value added of transportation, warehousing, and postal services (X_5) shows a moderate correlation (0.9248). This indicates that economic output related to logistics contributes to rural logistics development, but its influence is less direct compared to physical infrastructure and transport capacity. This may be because such indicators reflect overall industry performance rather than specific operational efficiency in rural areas.

Finally, postal service capacity (X_4) has the lowest correlation degree (0.6429), indicating a relatively weak association with rural logistics development. This result suggests that traditional postal services may play a more limited role compared to modern logistics systems, especially in the context of rapidly expanding e-commerce and express delivery services.

Overall, the results highlight that transportation infrastructure-particularly highway networks-constitutes the most critical factor influencing rural logistics development in Shanxi Province, followed by transport capacity and logistics-related economic indicators. Furthermore, it should be noted that GRA measures the similarity of development trends rather than causal relationships. Therefore, the results should be interpreted as indicative associations rather than direct causal effects.

4.2 Policy Recommendations and Implications

Based on the empirical results derived from the GRA, policy recommendations are proposed in direct correspondence with the relative importance of influencing factors identified in Section 4.1.

First, given that highway route length (X_2), railway operating mileage (X_3), and highway mileage (X_1) exhibit the highest grey relational degrees, priority should be given to strengthening transportation infrastructure. In particular, expanding and optimizing highway networks in rural areas is essential to improve accessibility and connectivity between dispersed villages and major markets. Considering the geographical characteristics of Shanxi Province, targeted investments should focus on enhancing road network density in mountainous and remote regions. At the same time, the coordinated development of railway systems should be promoted to improve long-distance transport capacity and reduce logistics costs. The integration of road and rail transport networks will further enhance overall logistics efficiency.

Second, as freight vehicles (X_6) show a relatively high correlation with rural logistics development, policies should aim to enhance transport capacity and operational efficiency. This includes encouraging the modernization and expansion of freight vehicle fleets, promoting the adoption of energy-efficient and specialized transport equipment, and improving logistics scheduling systems. Supporting logistics enterprises in optimizing vehicle allocation and route planning can significantly improve the responsiveness and flexibility of rural logistics services.

Third, considering that the value added of transportation, warehousing, and postal services (X_5) demonstrates a moderate correlation, it is necessary to promote the development of logistics-related industries. Policymakers should support the upgrading of logistics service sectors through investment in warehousing facilities, cold-chain systems, and integrated logistics parks. Enhancing the overall industrial capacity of logistics services will contribute to improving service quality and supporting the long-term development of rural logistics systems.

Finally, given that postal service capacity (X_4) shows the lowest correlation degree, efforts should be made to address structural weaknesses in traditional logistics services. This includes improving the coverage and efficiency of postal networks in rural areas and promoting their integration with modern express delivery systems. Strengthening last-mile delivery services and encouraging collaboration between public postal services and private logistics providers can help enhance service accessibility and reliability in less-developed regions.

Overall, the policy implications derived from the empirical analysis emphasize that infrastructure development, transport capacity enhancement, industrial upgrading, and service system optimization are key priorities for advancing rural logistics in Shanxi Province. These measures, when implemented in a coordinated manner, can significantly improve the efficiency, accessibility, and sustainability of rural logistics systems.

4.3 Hypothesis Validation

To ensure consistency between the proposed hypotheses and the empirical analysis, the results of the GRA are further examined in relation to H1-H4.

The findings indicate that H1 and H2 are strongly supported, as highway route length and railway operating mileage exhibit the highest grey relational degrees among all indicators. This confirms that transportation infrastructure plays a dominant role in rural logistics development.

H3 is also supported, since express delivery-related indicators and logistics service capacity show relatively high correlation values, suggesting a significant contribution to improving rural logistics efficiency and accessibility.

In contrast, H4 is only partially supported. Although postal service capacity demonstrates a positive association with rural logistics development, its grey relational degree is comparatively lower than other factors, indicating a weaker influence within the overall system.

In summary, the empirical results are broadly consistent with the proposed hypotheses, while also revealing differences in the relative strength of their effects.

5. Conclusions

This study investigates the key determinants of rural logistics development in Shanxi Province by applying the GRA method. By constructing an evaluation index system covering transportation infrastructure and logistics service capacity, the study quantitatively examines the relative influence of different factors on rural logistics development.

The empirical results indicate that transportation infrastructure plays a dominant role in shaping rural logistics systems. In particular, highway route length, railway operating mileage, and highway mileage exhibit the highest grey relational degrees, suggesting that improving physical connectivity is fundamental to enhancing logistics efficiency and accessibility in rural areas. In comparison, logistics service capacity-represented by freight vehicles and the value added of transportation, warehousing, and postal services-also contributes to rural logistics development, but its influence is relatively moderate. Postal service capacity shows the lowest correlation degree, indicating that its impact is comparatively limited within the current system.

The findings further confirm the proposed hypotheses. Specifically, H1 and H2 are strongly supported, highlighting the critical importance of highway and railway infrastructure. H3 is supported, as logistics service capacity demonstrates a positive association with rural logistics development. H4 is partially supported, reflecting the relatively weaker role of postal service capacity compared to other factors.

Overall, the study reveals that rural logistics development in Shanxi Province is primarily driven by infrastructure conditions, while service capacity and traditional logistics systems play a supplementary role. These results provide a clearer understanding of the relative importance of different factors and contribute to the existing literature by offering empirical evidence based on the GRA framework.

Despite these contributions, several limitations should be acknowledged. First, the study focuses on a single province, which may limit the generalizability of the findings to other regions with different economic and geographical conditions. Second, the analysis is based on aggregated statistical data and does not capture firm-level or micro-level dynamics. Future research could extend the analysis by incorporating panel data across multiple regions or by applying alternative quantitative methods to further validate the findings.

Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this paper.

Generative AI Statement

No generative AI tools were used in the writing, analysis, or preparation of this manuscript.

References

[1] Xue JS, Li QB. Development trends of rural logistics research: A visual analysis based on CiteSpace. Jiangsu Commercial Forum, 2025, 4, 45-47+71. DOI: 10.13395/j.cnki.issn.1009-0061.2025.04.008

[2] Cao DF. Research on the collaborative development pathways of agricultural E-commerce platforms and rural logistics industry under the policy-oriented rural development framework. China Business Review, 2023, 24, 119-122. DOI: 10.19699/j.cnki.issn2096-0298.2023.24.119

[3] Zheng J, Zhang Q, Yang WY, Liu XH, Yan H, Danzeng ZX. Research on the development of rural E-commerce logistics in Tibet under the policy-oriented rural development framework. Modern Business, 2023, 19, 64-67. DOI: 10.14097/j.cnki.5392/2023.19.042

[4] Song YL, Yuan PJ. Current status, challenges, and countermeasures for integrated urban-rural logistics development. Logistics Technology, 2024, 47(9), 31-33. DOI: 10.13714/j.cnki.1002-3100.2024.09.008

[5] Liu LN, Luo JW, Zhang TH, Wang YH. Research on the development countermeasures of rural E-commerce logistics in Gao County, Yibin City, Sichuan Province under the rural revitalization strategy. Scientific and Social Research, 2025, 7(11), 85-93.

DOI: 10.26689/SSR.V7I11.12949
[6] Li N, Huang WY, Zhao H, Qiu LH, Li JJ, Li JD. Analysis and planning of rural logistics development. Internet of Things Technology, 2014, 4(5), 47-50. DOI: 10.16667/j.issn.2095-1302.2014.05.034
[7] Expression of concern: The impact of high-quality development of rural logistics on consumption: Energy and healthcare consumption as an example. Frontiers in Energy Research, 2025, 13, 131701369-1701369. DOI: 10.3389/fenrg.2023.1321910
[8] Du J. Writing a new chapter of smooth urban and rural transportation. Shanxi Daily, 2025, 011. DOI: 10.28713/n.cnki.nshxr.2025.001048
[9] Zhao L, Xiao G, Yao EJ. A study on the location of multilevel distribution nodes in rural logistics based on the spoke-and-axle structure. Journal of Urban Planning and Development, 2025, 151(4), 9. DOI: 10.1061/JUPDDM.UPENG-5335
[10] Luo QQ, Wu YZ, Zhang XL, Wei H. Dilemmas and countermeasures of fruit and vegetable cold chain logistics development in Gansu Province under the background of rural revitalization. Economic & Trade Update, 2025, 22(2), 27-30. DOI: 10.3969/j.issn.1672-2949.2025.02.005
[11] Gu YF, Shang MR. Research on the dilemmas and responses of rural smart logistics construction under the rural revitalization strategy. Logistics Engineering and Management, 2025, 48(4), 57-59. DOI: 10.13714/j.cnki.1002-3100.2025.04.015
[12] Jiang YG, Zhao ZY, Zhao XJ. Green development efficiency and its determinants in China's agricultural product circulation industry: An empirical analysis based on panel data from 26 provinces. Environmental and Sustainability Indicators, 2025, 27, 100770. DOI: 10.1016/J.INDIC.2025.100770
[13] Zhou X. Research on rural logistics development in northern fujian under rural revitalization. Logistics Technology, 2022, 45(1), 125-127. DOI: 10.13714/j.cnki.1002-3100.2022.01.020
[14] Bai D, Jiang ZP. Research on the collaborative development path of rural e-commerce and logistics under the background of rural revitalization. Journal of Taiyuan City Vocational and Technical College, 2025, 1, 30-32. DOI: 10.16227/j.cnki.tycs.2025.0028
[15] Akinade E, Rosemary RC. 42. Young adult location and logistics consideration and rural environments: The Y'all care evaluation. Journal of Adolescent Health, 2025, 76(3), S22-S23. DOI: 10.1016/J.JADOHEALTH.2024.11.058
[16] Qi CW. Multi-objective Optimization-based algorithm for selecting the optimal path of rural multi-temperature zone cold chain dynamic logistics intermodal transportation. International Journal of Computational Intelligence Systems, 2024, 17(1), 224-224. DOI: 10.1007/S44196-024-00616-3
[17] Xue YQ, Tu HK, Zhang B, Tan CF, Kong QF, Guan HZ. The operation mechanism of integrating urban and rural passenger transportation and logistics under the strategy of rural revitalization-Case study of Lianhua County, China. Case Studies on Transport Policy, 2024, 16, 101197. DOI: 10.1016/J.CSTP.2024.101197
[18] Qu L, Dai YD. Research on the path of improving the service quality of rural E-commerce logistics in Jilin province based on computer. Journal of Physics: Conference Series, 2021, 1744(3), 032144. DOI: 10.1088/1742-6596/1744/3/032144
[19] Gackstetter D, Moshrefzadeh M, Machl T, Kolbe TH. Smart rural areas data infrastructure (SRADI) - An information logistics framework for digital agriculture based on open standards. Lecture Notes in Informatics (LNI), Proceedings - Series of the Gesellschaft fur Informatik (GI), 2021, P-309109-114.
[20] Jiang XH, Wang HY, Guo XC. Analyzing service quality evaluation indexes of rural last mile delivery using FCE and ISM approach. Information, 2020, 11(6), 327. DOI: 10.3390/info11060327
[21] Liu W. Route Optimization for last-mile distribution of rural e-commerce logistics based on ant colony optimization. IEEE Access, 2020, 8, 12179-12187. DOI: 10.1109/access.2020.2964328