Spatial Distribution Characteristics and Influencing Factors of Logistics Distribution Centers

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Abstract. Urban logistics transfer centers mainly provide the basic logistics space needs of people's livelihood such as express delivery, e-commerce delivery and fresh cold chain, which are important for promoting the high-quality development of logistics industry and improving the happiness index of residents. With the help of spatial analysis method and panel data model, the spatial distribution of logistics enterprises and their influencing factors in Beijing from 2006 to 2020 are analyzed. The article analyzes the spatial distribution characteristics of distribution centers and their influencing factors, and makes suggestions on the layout and location of various types of logistics distribution centers.

Keywords: distribution center · location · distribution characteristics · data model

1 Introduction

With the rapid development of globalization and e-commerce, the logistics industry has become an important part of economic growth. As an important link of the logistics system, the logistics transfer center undertakes the tasks of goods distribution, loading and unloading, and warehousing, and plays a vital role in the efficiency and cost of the whole logistics system. Therefore, it is of great significance to deeply study the logistics transfer center and its influencing factors to improve the logistics efficiency and reduce the cost. This study aims to explore the logistics distribution center and the influencing factors, and make corresponding optimization suggestions.

In terms of logistics and distribution site selection and influencing factors analysis, Qinglan et al. [1] analyzed the spatial agglomeration characteristics and influencing factors of warehousing logistics enterprises. To optimize the future location selection of warehousing logistics enterprises in Guangzhou, Tang Lingling et al. [2] considers the two main factors that directly affect the location of cargo flow and transportation distance. Shi Guoqiang [3] introduced logistics information technology into the logistics information system of the transfer center section of the logistics company. Zhao Yu'e [4]. The feasibility of building agricultural products distribution center in Dezhou city is analyzed from the perspective of non-economic factors. Sun et al. [5] in order

S. H. B. D. M. Zailani et al. (Eds.): ICMSEM 2023, 259, pp. 1492–1500, 2024.
https://doi.org/10.2991/978-94-6463-256-9_151

to balance the location cost and transportation cost of logistics distribution center, the location problem of electric vehicle parts logistics distribution center is decomposed by establishing the two-layer planning model. Vehicle path planning of distribution center is a widely used problem in supply chain at this stage [6]. He Yinnan et al. [7] analyzed the transportation cost and customers' satisfaction with time in the distribution process, and coal enterprises optimized the logistics distribution network to save transportation costs. Ma li et al. [8] discusses the paper to maximize the storage capacity without expanding the storage space in the distribution center, so as to ensure the distribution efficiency of logistics enterprises. Chen Hongli et al. [9] CLRIP integration optimization method is used to coordinate and optimize the distribution location, distribution path and inventory control of the distribution center of the logistics supply chain around the capital circulation circle, so as to provide the optimal spatial location layout, distribution path and inventory level point for the distribution center of the logistics supply chain around the capital circulation circle. Hu Jieqiong [10] positioning analysis of the distribution center of chain enterprises, combined with the actual situation of current enterprise operation and industry analysis, so as to give several factors affecting the location of the distribution center of chain enterprises for enterprises to reference. In conclusion, the logistics transport center and its influencing factors have become the hot issues in the current research. In the future, with the continuous development of information technology and the acceleration of the globalization process, the study of logistics transport centers and their influencing factors will become more important and urgent.

2 Study Design

2.1 Data Source

The data in this paper mainly comes from two ways, one is research data, research objects include S.F. Express, Jingdong Express and other key logistics enterprises, as well as the Beijing Municipal Bureau of Transportation, the Post Office Bureau of Commerce and other relevant government departments; second, 100 open API platform using crawler software to crawl logistics distribution center-related POI data, select "distribution center" express "distribution" "cold" and other key points, screening out duplicate and invalid data.

2.2 Research Methodology

Standard deviation ellipse.

Standard deviation ellipses can usually be used to determine the dispersion of point data sets and to measure the spatial distribution characteristics of point data sets. In this study, the directional trend of the spatial distribution of logistics centers was studied by standard deviation ellipse in Beijing. Standard deviation ellipses are calculated as follows:

$$SDE_x = \sqrt{\frac{\sum_{i=1}^{n}\left(x_i - \overline{X}\right)^2}{n}} \tag{1}$$

$$SDE_y = \sqrt{\frac{\sum_{i=1}^{n}\left(y_i - \overline{Y}\right)^2}{n}} \tag{2}$$

where x_i, y_i are the coordinates of element i, $\{\overline{X}, \overline{Y}\}$ denotes the mean center of the element, and n is the total number of elements.

kernel density analysis.

Kernel density estimation is a method to study the distribution characteristics of data from the data sample itself, by examining the spatial variation of point density in a regular region. In this paper, the test degree estimation method is used to study the spatial distribution characteristics of logistics transshipment centers in Beijing, and the specific formula is as follows:

$$f(x) = \frac{1}{nh_n}\sum_{i=1}^{n} k\left(\frac{x - x_i}{h_n}\right) \tag{3}$$

where n is the number of samples, and h_{n} is the search radius, k $\left(\frac{\mathrm{x}-\mathrm{x_i}}{h_{\mathrm{n}}}\right)$ is the kernel density function.

3 Spatial Layout Characteristics of Logistics Distribution Centers

3.1 Analysis of Spatial Layout Patterns

The spatial distribution patterns of express distribution centers, supermarket distribution centers and cold chain distribution centers were analyzed using standard deviation ellipses.

The distribution direction of the three types of logistics distribution centers is similar, all along the east-west direction, which is related to the narrow administrative jurisdiction of Beijing. Among them, the short axis of the express distribution center is the longest, and the long axis is relatively close to the short axis, indicating that the layout of the express distribution center in the city is more balanced, which is directly related to the pursuit of high timeliness distribution of express logistics.

3.2 Agglomeration Center Analysis

In order to gain an in-depth understanding of the agglomeration of logistics distribution centers, this study evaluates the kernel density of various types of logistics transfer centers. From the results of the kernel density evaluation, it can be seen that various types of urban logistics transfer centers form multiple agglomeration centers in space. Some agglomeration centers are close to each other and show a continuous distribution, while others have obvious distance differences.

4 Analysis of Influencing Factors

4.1 Variable Selection

With the number of logistics enterprises in each district and county as the explanatory variables, eight factors affecting the spatial layout of logistics industry in Beijing were selected and divided into three categories: economic environment, industrial association and micro factors.

Economic environment, including the level of economic development (GDP), the degree of openness (FDI) and government spending (GOV) (1) The level of economic development: logistics activities are flexibly penetrated in all aspects of production and sales, and are closely connected with social and economic activities. The level of economic development has a great impact on the logistics industry. The higher the level of regional economic development and the more mature the social division of labor, the more industrial and commercial enterprises tend to outsource the logistics business they are not good at to logistics agents. The increase of logistics demand promotes the agglomeration of logistics enterprises. (2) The higher the degree of opening to the outside world, on the one hand, the increased logistics demand through the increase of international trade will increase the business volume of logistics enterprises; (3) Government expenditure: considering the time cost and information timeliness, logistics enterprises tend to be laid out along the transportation corridor, and the infrastructure is often planned and built by the government, so it is related to government expenditure.

Micro factors, including residential demand (DEM), wage level (Sal) and income level (Inc) (1) Residential demand: In recent years, online shopping has become the choice of more and more consumers, and this way of purchasing goods has driven a surge in the delivery business. (2) Wage level: Wage level indicates the employment cost of enterprises. The logistics industry requires a large amount of labor, so the higher the average wage in a region, the greater the labor costs to be borne by logistics companies. (3) Income level: The increase of income level of residents will change the consumption structure, bringing about the increase of the quantity and quality of logistics business, causing the change of logistics demand structure, which will have an impact on logistics enterprises and their spatial distribution.

4.2 Analysis of Results

Overall regression analysis.

Appropriate tests were performed to select the appropriate model, as shown in Table 1. Since the lower test rejects the null hypothesis, this indicates that the fixed-effects model is superior to the mixed-effects model. Since the Breusch-Pagan test rejects the null hypothesis, this indicates that the random effects model is superior to the mixed effects model; since the Hausman test cannot reject the null hypothesis, it indicates that there is little difference in choosing the fixed effects model or the random effects model.

Regression analysis of different logistics companies

As can be seen from Table 2, among the influencing factors of transportation and warehousing logistics enterprises, government expenditure, residential demand, wage

Table 1 Estimation results of the overall regression model

Explanatory variables	Meaning	Ors	Gers	Fixed effect	Random effects
Economic environment	Economic Development Level	−1.111*** (0.232)	−1.111*** (0.238)	0.753***	0.412*
	Openness	0.032*** (0.005)	0.035*** (0.005)	0.015*** (0.003)	0.025*** (0.003)
	Government Spending	3.532*** (1.312)	3.585*** (1.287)	2.585*** (0.741)	2.705*** (0.773)
Industrial association	Industry Development Level	0.432*** (0.098)	0.432*** (0.098)	0.332*** (0.115)	0.358*** (0.115)
	Business Development Level	0.002 (0.004)	0.002 (0.004)	−0.03 (0.001)	−0.002 (0.003)
Micro factors	Residents' needs	5.332*** (0.635)	5.582*** (0.662)	4.045*** (1.125)	3.845*** (1.002)
	Wage level	0.536 (0.658)	0.589 (0.625)	−2.187*** (0.425)	−1.787*** (0.478)
	Income level	55.258 (68.258)	55.230 (66.878)	125.031*** (38.365)	125.131*** (39.323)
C	Intercept term	−178.897 (165.341)	−177.74 (168.87)	−487.031*** (38.258)	128.131*** (39.874)
	Number of companies			26.389	
	F-test			43.26***	
	Brusch Pagan			335.86***	
	Hausmann test			0.1038	

Note: The values in parentheses are the standard deviations of the coefficients. ***, **, * denote significant at 1%, 5%, 10% confidence level, respectively

level and income level have significant effects, except for the wage level which is negative. Among the factors affecting freight forwarders, the level of economic development, openness to the outside world, and income level are positive, while the level of business development and wage level are negative, and other effects are not significant. Transportation infrastructure is provided by the government, so transportation and warehousing are influenced by government spending.

Table 2 Estimation results of regression models for types

Explanatory variables	Meaning	Type of transport and storage		Type of freight forwarding		Comprehensive	
		Fixed effect	Random effects	Fixed effect	Random effects	Fixed effect	Random effects
Economic environment	Economic Development Level	0.032 (0.065)	0.045 (0.063)	0.235*** (0.026)	0.287*** (0.043)	0.858*** (0.187)	0.000 (0.147)
	Openness	0.001 (0.001)	0.001 (0.001)	0.007*** (0.002)	0.007*** (0.005)	0.157*** (0.004)	0.017*** (0.003)
	Government Spending	0.617*** (0.234)	0.827*** (0.204)	0.132 (0.145)	0.165 (0.125)	1.727*** (0.563)	2.027*** (0.385)
Industrial association	Industry Development Level	0.19 (0.032)	0.025 (0.023)	0.031 (0.25)	0.035 (0.145)	0.727*** (0.. 363)	0.337*** (0.087)
	Business Development Level	0.000 (0.000)	−0.001 (0.000)	−0.002***	−0.102*** (0.245)	−0.001 (0.002)	0.001 (0.01)
Micro factors	Residents' needs	1.302*** (0.325)	1.842*** (0.256)	−0.032 (0.225)	2.342*** (0.854)	2.762*** (0.874)	1.352*** (0.745)
	Wage level	−0.312*** (0.125)	−0.412*** (0.135)	−0.432*** (0.097)	−0.546*** (0.098)	1.312*** (0.325)	−0.584***

(*continued*)

Table 2 (*continued*)

Explanatory variables	Meaning	Type of transport and storage		Type of freight forwarding		Comprehensive	
		Fixed effect	Random effects	Fixed effect	Random effects	Fixed effect	Random effects
	Income level	25.102*** (10.325)	17.258 (10.325)	15.502*** (7.89)	16.202*** (7.258)	88.302*** (28.98)	91.302*** (29.365)
C	Intercept term	25.102*** (31.25)	50.28 (40.25)	−75.102*** (22.58)	−69.12*** (33.58)	−587.12*** (87.25)	−337.12*** (105.25)
	Number of companies	10247		4255		11258	
	F-test	69.38***		55.38***		27.38***	
	Brusch Pagan	358.98***		325.38***		227.18***	
	Hausmann test	9.25		187.38***		−98.02	

5 Conclusions and Recommendations

Based on the registration information of logistics distribution centers and panel data of 16 districts and counties, using analysis method and panel data model, it is found that among the factors affecting the spatial layout of logistics distribution centers, the level of economic development, the degree of openness to the outside world, government expenditure, the level of industrial development, the level of residents' demand and income have significant promotion effects on residents' consumption, the effect of wage level is negative, and the effect of enterprise development level is not significant.

In order to promote the healthy development and rational layout of the logistics industry in Beijing, the following views are proposed:

Support the optimization of the layout of various types of logistics enterprises and the realization of logistics functional zoning. Different types of logistics enterprises are distributed with different influencing factors and have different requirements for regional development environment and infrastructure, and should be reasonably planned according to the characteristics of different types of logistics enterprises. Transportation and warehousing type has strong dependence on transportation facilities and covers a large area, and should be guided to be laid out in suburban areas with convenient transportation and low land prices. To achieve a reasonable logistics layout including transportation, warehousing and freight forwarding, to form a perfect logistics function partition and promote the healthy and orderly development of logistics industry.

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