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A Review of the Spatial Pattern of the Logistics Industry

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Abstract

By analyzing the research of domestic and foreign scholars on the spatial pattern of logistics industry, from the perspective of the concept of logistics and the research area, we use the literature research method to systematically sort out the relevant research progress about the spatial distribution of logistics. The progress of research on logistics industry is reviewed. The results show that: the research on the spatial pattern of logistics industry in foreign countries has started earlier and is relatively mature, and has basically formed a perfect theory, and can clearly understand that logistics industry has a great impact on economy and society; the reasonable optimization of the spatial pattern of logistics industry can realize the optimal allocation of resource factors, and different regions have shown their own uniqueness in the process of evolution. The research method has changed from qualitative description and simple quantitative evaluation to the use of qualitative and quantitative combination, cluster analysis, GIS spatial analysis, factor analysis and other technical methods; with the advent of the era of scientific and technological information, big data or new data began to be applied to the study of logistics industry space. Compared with the developed regions in the east, the research results on the spatial pattern of logistics industry in Xinjiang are not very rich. With the development and evolution of the spatial pattern of logistics industry, most of the previous researches are based on gravity model and vector autoregressive Granger causality test; and the study of the distribution of the spatial pattern of logistics industry in terms of time or geographical space is relatively single.

Keywords

Logistics, Spatial Pattern, Research Review, POI

1. Introduction

With more and more international regional collaboration and trade and invest-

ment activities, China's logistics industry has ushered in an important strategic opportunity period. As a fundamental, strategic and forward-looking industry, the logistics industry's activities involve industry, agriculture, business services and other areas of economic activity. With globalization and the continuous transformation of production methods, more and more logistics enterprises are appearing in cities, and their business scope and organizational network are becoming more and more complex. Foreign research on logistics industry is also becoming more and more abundant.

Foreign scholars' research on the spatial pattern of logistics industry has continued from the 1990s to the present. (Alberto, 2000) used hierarchical analysis to explore the factors influencing the layout of logistics enterprises. (van den Heuvel, De Langen, van Donselaar, & Fransoo, 2013) analyzed the changes in the spatial pattern of logistics clusters in the Dutch province of Brabant based on the industrial concentration index and employment density. (Rivera, Sheffi, & Welsch, 2014) explored the degree of concentration, development trend and spatial pattern of logistics enterprises in the United States based on two logistics concentration indexes established by the number of employment and the number of enterprises. (Hesse & Rodrigue, 2004) pointed out that the development of the logistics industry has obvious geographical significance, and the evolution of flows, nodes/locations, and networks has become the core of transportation geography studies; (Cidell, 2010; O'Connor, 2010) explored the spatial expansion patterns of the logistics industry in terms of transportation infrastructure and warehousing and transportation activities, respectively; (Dablanc & Ross, 2012) pointed out the geographical characteristics of the logistics industry: first, the "spatial expansion of logistics", such as the spatial dispersion pattern of logistics facilities in Atlanta; second, the concentration of logistics activities in metropolitan areas. Based on the accessibility perspective, (Verhetsel et al., 2015) argued that the main factors influencing the location of logistics companies are, in order, land rent, proximity to ports, proximity to highways, and location in business parks and inland navigation terminals.

In his monograph, (Fisher, 2002) studied the planning of logistics system: firstly, he divided the urban logistics system into two parts: firstly, the planning of logistics network and routes, then the planning of logistics nodes, according to the functions of logistics nodes; they were divided into three categories, namely, transportation, production and integrated, and finally, he applied the characteristics of these three types of logistics nodes to study their location methods. (Rodrigue & Hesse, 2006) by studying the geographical distribution of traffic in logistics and freight operations, proposed that freight transportation in logistics systems is a comprehensive demand under logistics agglomeration, and the study showed that logistics agglomeration is gradually growing around the world. (Olsson & Woxenius, 2012) analyzed the accessibility of logistics centers from the perspective of their radius. (Li, Kwan, Wang, & Wang, 2018) used points of interest to estimate employment locations and estimated inter-regional com-

muting patterns in the center of Shanghai, China by applying a gravity model. (Wu, Ye, Ren, & Du, 2018) observed the behavioral changes of Twitter users in the city of London by mining data from social media. (Gottapu & Monangi, 2017) proposed a group recommendation system based on POI, which can provide restaurant recommendations for social groups, among others.

Domestic scholars inherited and developed the research of foreign scholars on the network and spatial structure of logistics industry, which contains the comprehensive elaboration of theory and in-depth exploration of empirical evidence, and has achieved fruitful results. (Zong et al., 2009) studied the spatial network structure of logistics companies. (Yan & Wang, 2013) researched and analyzed the spatial structure of logistics in Beibu Gulf of Guangxi from logistics node cities and their constituted logistics networks, and put forward suggestions for optimizing the spatial structure of logistics in Beibu Gulf economic region. (Zhu & Zhou, 2017) explored the spatial distribution characteristics, formation and evolution rules and driving mechanisms of urban logistics industry from the perspective of spatial territory by dividing the urban logistics industry into logistics nodes and logistics enterprises for research. In recent years, with the technological progress of location-based service (LBS) providers such as Baidu and Tencent, some of these studies on the spatial distribution of enterprises collected point-of-information (POI) data as the basic data for the study. (Wang et al., 2021) selected nine high-speed railway stations with different locations and levels nationwide as the research object, and used the POI information of 10 types of industries within the periphery of the high-speed railway stations as the research data to explore the industrial structure characteristics of high-speed railway station areas under different locations by Ripley's K function, kernel density estimation and industry index. (Xue et al., 2020) used 36 cities in three northeastern provinces as the study area, and analyzed the urban spatial structure and its industry composition mechanism by using more than 4 million point-of-interest industry classification big data, using kernel density estimation, standard deviation ellipse, and locational entropy.

2. Progress of Research Methods in Logistics Industry

The current foreign research on network pattern is mainly divided into two blocks: one is how to construct the network, and the other is how to analyze the constructed network. The methods of constructing networks generally use mathematical models, as well as various improved models based on mathematical models; for example, fuzzy hierarchical analysis, spatial clustering, exponential models and other analysis methods.

(Woudsma, 2001) created a spatio-temporal model for warehousing centers and studied their spatio-temporal characteristics. (Kayikci, 2010) used fuzzy hierarchical analysis and artificial neural network methods to study logistics centers from social, economic and environmental aspects and revealed the agglomeration effect of logistics industry. (Kumar, Zhalnin, Kim, & Beaulieu,

2017) applied spatial clustering and econometrics to analyze the competitive advantages of transportation and logistics agglomerations in various regions of the continental U.S. The study showed that logistics agglomerations are mainly concentrated in large cities and transportation infrastructure has a very positive impact on logistics agglomeration. (Malik, Kumari, & Agrawal, 2015) studied the siting options of urban reverse logistics and obtained the optimal by establishing graph theory and matrix method for site selection.

Domestic scholars generally focus on spatial variation measurement and spatial layout morphology description, and the research methods mostly use a combination of qualitative and quantitative methods. Some of the literature uses indicators such as employment, value added, freight volume, logistics infrastructure scale, and the number of logistics nodes, and uses methods such as Gini coefficient, coefficient of variation, locational entropy, and Thayer index to carry out analysis. (Liang, 2019) used principal component analysis to measure the development level of urban logistics industry in five major urban clusters in China from 2005 to 2016, determined the spatial correlations of logistics industry development among cities with the help of gravity model, analyzed the characteristics of spatial network structure of logistics industry development and explored its operational effects with the help of social network analysis. (Wang et al., 2011) analyzed the current situation and trend development in the context of industrial transformation, and studied the development trend, spatial layout and spatio-temporal evolution characteristics of logistics in the Yangtze River Delta region using a combination of theoretical and empirical research methods. (Liang et al., 2013) studied the spatial pattern and evolution pattern of Shanghai port logistics enterprises and analyzed their key influencing factors by using Arc GIS spatial analysis and mathematical statistical methods. Based on the review of domestic and foreign research progress, (Wang & Zhang, 2014) selected a sample of 1855 A-grade logistics enterprises in China to portray and analyze the layout characteristics of logistics enterprises in China, including the overall pattern, spatial agglomeration, and coverage level, from the multi-layer scales of macro-regions, provincial political regions and cities, and examined the formation mechanism of logistics enterprise layout from various perspectives.

3. Current Status of the Logistics Industry Research Region

Overseas, with the continuous development of the logistics industry, more and more scholars have begun to turn their perspectives to its spatial pattern development and regional influence; under the regional and urban scale, the research on logistics space mainly focuses on the classification, location and role of logistics parks and distribution centers, etc. (Bowen Jr, 2008) studied the spatial layout of warehouse logistics centers in the U.S. and analyzed their location distribution on this basis. (Hesse, 2004) conducted an empirical study on the land development of logistics parks in Germany and concluded that the intensification of regional competition is conducive to accelerating land consumption and

further expansion. (Pekkarinen, 2005) conducted a study on the study by (Hansen, 2004) shows that the phenomenon of industrial clusters and the industrial chains and supply chains included in industrial clusters are influenced to some extent by the degree of development of regional logistics capacity. (Malecki, 2002) conducted an empirical analysis of the world city network using international airline data for several years and showed that the world city network is hierarchical and factional, while (Cook, Emerson, Gillmore, & Yamagishi, 1983) added cargo flow data to airline passenger flows and evaluated the hierarchy of hub cities in Asia, Europe and the Americas.

Domestic scholars have also carefully studied the logistics industry in most provinces and cities. (Jing & Cai, 2010) studied the logistics data of four municipalities directly under the central government and fifteen sub-provincial cities in China, and the results showed that the logistics industry agglomeration has the strongest impact on the eastern cities in China. With the help of Arc GIS spatial analysis module, (Lu, 2012) studied the spatial evolution of urban logistics zones in Beijing, and analyzed and studied the characteristics of urban logistics spatial structure and evolution theory mainly including the spatial evolution characteristics and evolution mechanism of urban external space. (Zhong, 2011) measured the level of logistics industry agglomeration in China's provinces and cities by using location entropy and described its significant spatial correlation by using spatial statistics. (Zhao & Geng, 2015) integrated various methods to study the agglomeration of logistics industry in various regions of Beijing, and found through the study that Chaoyang, Shunyi and Fengtai are the regions where logistics enterprises are mainly concentrated. (Fu et al., 2017) studied the hotspots and agglomeration characteristics of retail commercial centers in Guangzhou using POI data, and the study showed that there is a correlation between enterprises and the spatial distribution of regional economy in Guangzhou, as a way to provide relevant departments with suggestions and countermeasures for the planning and development of retail industry. Using POI data of Beijing logistics industry and classifying them, (Li, 2017) studied the spatial distribution characteristics of Beijing's logistics industry and the influence mechanism of distribution differences, and by portraying the spatial pattern of logistics in Beijing, he elucidated the microscopic mechanism of the role of type differences, supply and demand side factors and location selection behavior, and revealed the inner mechanism of traffic, ground rent and assets on the formation of spatial differentiation.

(Qian et al., 2011) investigated the spatial clustering characteristics of logistics enterprises in Guangzhou based on 3771 logistics enterprises in the city, and revealed the main factors influencing their spatial patterns by using GIS spatial analysis. (Xie et al., 2015) evaluated the development level of logistics industry in 16 cities of Yangtze River Delta in 2002 and 2010 by constructing indexes based on yearbook data, using entropy TOPSIS method, relative development rate index, coefficient of variation and spatial autocorrelation. (Jiang, 2017) based on

the spatio-temporal data of A-grade logistics enterprises in Zhejiang Province from 2005 to 2015, the nearest neighbor index, Ripey's K-function analysis method, and spatial hotspot clustering to explore the pattern only. (Zhu & Zhou 2017) used standard deviation ellipse analysis, sample square analysis, Ripley's K function, and negative binomial regression model to measure the spatial clustering level of logistics enterprises in Yiwu city in 2002, 2008, and 2015, and the influencing factors were divided into three main categories: location factors, market factors, and government factors. Based on POI data, (Li, Liang, Yan, & Wang, 2018) used DBSCAN clustering algorithm and POI clustering density calculation method to study the overall and sub-industry spatial layout clustering of service industries in Zhengzhou East New (Yang et al., 2018) based on the POI data of logistics enterprises in Hebei province in 2016, using 168 districts and counties in Hebei province as the basic research unit, using ArcGIS nuclear density, buffer zone, overlay and other spatial analysis; and using SPSS software to quantify indicators for variable correlation analysis, the results obtained: topographic conditions are the basic factors, the development level of industry and trade is the correlation factor, traffic conditions are the necessary The results showed that topographic conditions are the basic factor, the level of industrial and trade development is the correlation factor, the transportation condition is the necessary factor, and the radiation of Beijing and Tianjin is the external factor. (Cheng et al., 2018) used Baidu online map and statistical panel data to construct logistics heat data and logistics heat correlation index, selected the logistics industry value added data of 18 prefecture-level cities in Henan Province from 2005 to 2015, and used the research methods of center of gravity model and spatial autocorrelation, so as to explore the spatial pattern of the logistics industry in Henan Province at different scales. It is concluded that multiple factors such as natural endowment, economic, social, historical, institutional and cultural development affect the spatial pattern. (Xie & Wei, 2019) took Beijing logistics enterprises as the research object, and the data in this paper were obtained from the registration information of the commercial registration of logistics enterprises in Beijing, and analyzed the spatial distribution of logistics enterprises in Beijing from 1996 to 2006 and its influencing factors. With the help of GIS spatial distribution evolution analysis method, kernel density analysis, hotspot analysis, influence factor analysis method and the use of panel data regression model, it is concluded that economic environment, government expenditure and micro factors are the influencing factors of spatial distribution. (Li, 2021) based on the data of A-class logistics enterprises from 2006-2018. Using 2006, 2010, 2014 and 2018 as the research time points", using kernel density estimation method, center of gravity shift model, spatial autocorrelation analysis, and geographic detector model, it concludes that economic factors, social factors, market factors, and openness are the influencing factors of spatial distribution. (Zhang & Chai, 2021) firstly converted the enterprise network registration data into GIS data, and the study scope was Xi'an city from 1995 to 2019,

using standard deviation ellipse, mean nearest neighbor analysis, kernel density analysis, correlation analysis and OLS regression method to explore the influencing factors from five aspects: production, consumption, transportation, industry and society. (Chen & Zhou, 2022) conducted the spatial agglomeration characteristics analysis of logistics industry based on POI data, and the study covers 11 prefecture-level cities in Zhejiang Province, extracted data in 2011, 2016 and 2020, and explored the influencing factors of spatial distribution using location quotient, kernel density estimation, buffer zone analysis, and spatial autocorrelation model.

4. Conclusion

1) Scholars at home and abroad have done a lot of research on the analysis of the spatial pattern of logistics industry, and have discussed the theory and methods of the spatial pattern of logistics industry from many levels and perspectives, and have achieved many results. It is found that foreign research on the spatial pattern of logistics industry has started earlier and is relatively mature, which has basically formed a perfect theory and can clearly understand that logistics industry has a great impact on economy and society; the reasonable optimization of the spatial pattern of logistics industry can realize the optimal allocation of resource factors, and different regions have shown their own uniqueness in the evolution process. The research method has changed from qualitative description and simple quantitative evaluation to the use of qualitative and quantitative combination, cluster analysis, GIS spatial analysis, factor analysis and other technical methods.

2) Compared with the developed eastern regions, the research results on the spatial pattern of logistics industry in western China are not very abundant. With the development and evolution of the spatial pattern of logistics industry, most of the previous studies are based on gravity model and vector autoregressive Granger causality test; the distribution of the spatial pattern of logistics industry is studied from time or geographic space alone.

3) In the existing literature, some scholars have studied the logistics industry from the perspective of logistics system, and studied the positioning and optimization of logistics nodes and logistics elements. Some scholars study the current state of clustering and influencing factors of the logistics industry from the macro level based on panel data, and a few geographers study the spatial distribution and clustering of the logistics industry from the micro level. However, the application of big data such as POI to the spatial empirical analysis of the logistics industry has yielded few results.

4) The modeling methods used at this stage are mainly statistical models, and future research may focus more on the application of simulation prediction models and more on the development of empirical studies. The current literature research mainly focuses on the theoretical discussion of modeling methods, with relatively little empirical research. The rapid development of logistics practice

will promote the new theory. With the rapid development of logistics in China, a large number of problems will emerge in logistics practice that need to be explored in depth, and the research aiming at Chinese logistics practice and focusing on local problems will become the mainstream direction of future research. The mainstream direction of future research will be to focus on Chinese logistics practice and local issues.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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