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Portrait analysis of gravity sphere of influence and spatial interaction intensity of urban logistics center—A case study of Zhengzhou City

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Abstract: By using space syntax and word vector theory respectively, this paper optimizes the measurement method of comprehensive strength parameter and distance parameter in the gravity model, combines the subjective feeling and preference law of logistics elements on spatial structure when they travel with the spatial distribution form of material supply and demand, and realizes the identification of urban logistics center and the division of gravitational sphere of influence. Then, a complex network is constructed on this basis, and the spatial interaction strength between logistics centers is presented by using edge weights. Finally, the dynamic and static form portrait analysis of urban logistics center is completed.

1. Summary

1.1 Issues/problems

With the rapid development of emerging industries such as e-commerce and takeout delivery, the main body of urban logistics activities is gradually expanding from traditional logistics enterprises to individual delivery workers. Their spatial location rules and travel and mobility rules are affected by industrial policies, internal competition and new technological means. At the same time, as the place where the material demand is generated, big cities have always been the key layout of logistics enterprises and logistics nodes. When the government plans the logistics land and the enterprises select the location of the distribution center, they all expect to achieve the optimal material flow efficiency. Therefore, it is necessary to accurately analyze the spatial location status of urban logistics industry based on big data such as interest points and movement trajectories, and use new technologies to provide reference for optimizing the spatial layout of urban logistics. Identifying and analyzing the influence scope and interaction strength of urban logistics center is conducive to optimizing the spatial layout of logistics elements, which is of great significance to realize the cost reduction and efficiency increase of logistics industry.

1.2 Procedures

Using multi-source big data, space syntax and word vector theory, this paper improves and modifies the parameters of the gravity model to analyze the gravity influence scope and spatial interaction characteristics of the urban logistics center, and shows the development trend of the urban logistics industry through quantitative analysis and qualitative evaluation, so as to provide reference for optimizing the coordinated development of the urban logistics industry.

1.3 Conclusions

(1) Due to differences in spatial accessibility, the overall distribution of gravity spheres of influence has created disparities in the comprehensive strength of logistics across different regions. However, upon analysis, it is still evident that the gravity sphere of influence for logistics centers primarily covers areas with high levels of social activity. From the perspective of individual logistics centers, the first and second level logistics centers in municipal districts have a large supply and demand of materials, and the spatial distance is close, so the spatial characteristics of their strength scope squeezing each other appear. The third level logistics centers in peripheral counties and cities are attracted by the main urban areas, and their influence scope shows the characteristics of large area, extending along the road network and tilting to the municipal district. In general, the sphere of influence of logistics centers conforms to the principle of proximity correlation in geography, and the spatial distribution of the identified logistics centers is highly consistent with the key logistics construction projects supported in the planning documents, and the spatial matching degree between the material demand end and the supply end is high.

(2) From the perspective of the overall situation of spatial interaction, the municipal district as the core, the three directions of east, west and south are the main directions of logistics spatial interaction, and the interaction strength between the logistics centers with high level and short spatial distance is relatively large. Combined with the design of urban cluster and core plate in the Master Plan of Zhengzhou Land Space (2020-2035), Combined with the planning of logistics industry service system in the "Implementation Opinions of Zhengzhou Municipal People's Government on Accelerating the Transformation and Development of Modern Logistics Industry", it can also be seen that the three directions of east, west and south are the priority development direction of urban industrial upgrading. The analysis results of this paper are basically consistent with the expectations of the planning document. However, due to the support of key policies, the key projects of e-commerce, express delivery and cold chain logistics have been planned and constructed, which not only enhances the intensity of spatial interaction with the municipal district, but also promotes the intensity of social activities in the whole Xinzheng city. Therefore, based on the existing construction results, reasonable planning of the spatial layout of logistics industry is conducive to enhance the spatial connection between the core city and the surrounding counties and cities, and promote the common development of the surrounding areas.

2. Significant/interesting aspects

2.1 Study Area

As the core city of the urban agglomeration in Central China, Zhengzhou City (in addition to the municipal district, it also has jurisdiction over Xinzheng City, Xinmi City, Xingyang City, Zhongmou County, Gongyi City and Dengfeng City) has become an important national logistics hub center by virtue of its geographical center advantage. The transportation facilities have been built, in addition to the expressway network, also includes the meter-shaped high-speed railway network and the airport

economic pilot zone. The completion and improvement of such transportation infrastructure have greatly enhanced the connection between Zhengzhou and the outside world, and laid a solid foundation for the development of modern logistics industry.[1]

2.2 Research Methods

2.2.1 Huff Model

In 1963, Professor David Huff, an economist from the University of California, proposed the Huff model, which is a model for predicting the size of business circles in urban areas. The basic rule of the Huff model is still to refer to the principle of universal gravity. It proposes that the attraction of various conditions in shopping places on consumers and the various resistance felt by consumers to shopping places determine the size of business circles. From the point of view of consumers, Harf believes that the probability of consumers going to a certain commercial facility to consume depends on the business area, scale strength and time of the commercial facility. At the same time, Huff model also considers the utilization probability of commercial equipment and goods of different nature in different areas. The difference between Huff model and other models is that the probability of various conditions is taken into account in the model. The size of the shop area is directly proportional to the attraction of the shopping place to the consumers, and inversely proportional to the time distance resistance of the consumers to the shopping place. [2]The larger the attraction of various factors in the shopping place is, the larger the scale of the shopping circle is. The longer it takes for consumers to get to the business place from the starting point, the smaller the scale of the business area will be.

2.2.2 Space Syntax Theory

First proposed by Bill Hillier of Bartlett School of Architecture at University College London in the 1970s. Its main idea is that individual spatial elements cannot completely affect social and economic activities, and the complex relationship between the overall spatial elements is the spatial factor of social and economic activities, and the factor that affects and determines social and economic phenomena.[3] This spatial analysis method is often used in buildings and cities, spanning different scales, from a single building to an area of the city, the whole city, and even the whole region.

2.2.3 Evaluation index system of comprehensive logistics strength

It includes three categories of indexes: intensity of social activities, spatial distribution of logistics elements and spatial accessibility. After determining the weight, grid division, data link and spatial weighted superposition, the static spatial distribution form of comprehensive logistics strength can be revealed.

3. Personal opinions

3.1 Understanding of Zhengzhou as a city logistics center portrait

Zhengzhou city as the national central city, the core city of the Central Plain urban cluster, with the advantages of geographical center, has become an important national logistics hub center, has built transportation facilities in addition to the highway network in all directions. It also includes the meter-shaped high-speed rail network and the airport economic pilot zone. The completion and improvement of such transportation infrastructure have greatly enhanced the connection between Zhengzhou and the outside world, and laid a solid foundation for the development of modern logistics

industry. This paper takes Zhengzhou City as the research object, through the analysis of the gravity sphere of influence and spatial interaction strength portrait of urban logistics center to study, improve the development level of the central city to give full play to its leading role, constantly increase "quantity" and improve "quality", accelerate the layout and agglomeration of high-end intelligent service industry and major emerging industries in the central city. [4]We will fully utilize radiation and driving functions of central cities, strengthen the transmission of enterprise services and scientific and technological services to surrounding areas, continuously optimize development space and layout of the central city, improve its internal spatial structure, promote coordinated complementary and benign linkage development between the central city and outer suburbs, and form a new pattern of high-quality and coordinated development led by innovation demonstration, and radiation.

3.2 Shortcomings of the article

(1) Since government policies, social environment, personal factors and natural factors may all have an impact on the comprehensive strength of logistics center, the index system and evaluation method of the comprehensive strength of logistics center need to be further strengthened.

(2) The logistics trajectories studied in this paper are mainly medium and short distance trajectories, and the logistics trajectories between central cities and counties and cities need to be enriched to further expand the spatial scale.

(3) This paper analyzes the external factors of the spatial dynamic and static law of urban logistics center, but does not conduct in-depth research on its internal system and mechanism.

4. Views on the article

4.1 Application value

By utilizing the Huff gravity model, logistics comprehensive strength evaluation index system, and other methods to determine logistics center distance parameters and comprehensive strength parameters, as well as conducting experiments and spatial statistical verification on the static location of logistics elements and dynamic characteristics of logistics trajectories, an accurate portrayal of the dynamic characteristics of urban logistics industry is achieved.This paper provides a reference for the process evaluation and performance evaluation in the transformation and development of modern logistics industry, which has certain theoretical significance and application value.[5]

Zhengzhou is a national central city. With the support of its policies, the urban industrial upgrading drives the economic development, and the city's attraction is continuously enhanced. Besides the population, various industries and resources are attracted to the city. The development of port area and its interconnectivity with the main city has become an important direction of urban development.

(1) Urban logistics center can effectively connect different transportation modes such as railway and highway, and even air transportation, and further realize the effective connection of different nodes and different users.

(2) Urban logistics center not only provides new development space for the surrounding areas, but also creates new possibilities for the optimization of urban layout. It not only stimulates the demand of the surrounding areas, but also increases the employment of the surrounding areas, thus driving the development of the surrounding economy.

(3) Urban logistics center can improve logistics level, connect logistics park, distribution center, logistics center and freight yard station, promote the cooperation between warehousing and transportation, freight forwarding, express mail and other industries and logistics industry, and achieve comprehensive economic and social benefits.

(4) Urban logistics center can reduce the pollution of exhaust gas, noise and goods to the environment by large-scale and intensive operation.

(5) Urban logistics center can build a logistics big data information platform, strengthen the application of advanced information technologies such as Internet of Things, cloud computing, big data and mobile terminals in the field of logistics, realize real-time update of logistics information, and avoid invalid inventory, empty driving and convective transportation caused by poor information.

(6) Urban logistics center reduces the logistics burden of enterprises, improves social labor productivity and capital utilization rate, and promotes urban development through the reduction of logistics cost.

4.2 Suggestions

(1) Zhengzhou government should create a favorable business environment and continue to introduce relevant laws, regulations, and various normative documents to promote the development of the logistics industry.

(2) Zhengzhou government should continuously improve the spatial layout of the logistics industry and enhance operational efficiency in terms of collection, distribution, and travel distribution.

(3) Zhengzhou government should continuously optimize road infrastructure construction.

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