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Analysis on the Structure of Integrated Traffic Network in Hu-bao-E-yu Urban Agglomeration

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Abstract

Hu-Bao-E-Yu urban agglomeration is in the northern section of the vertical axis of Bao-Kun corridor under the strategic pattern of "two horizontal and three vertical" urbanization. It plays a very important role in promoting the open development of backward cities and improving the urbanization of northern areas. The planning scope includes Hohhot City, Baotou City, Ordos City and Yulin City in Shaanxi Province. Transportation is the lifeblood of the tertiary industry and national economy. The tightness of traffic network connection has an extremely important impact on economic exchanges and interaction between urban agglomerations. In this paper, the pajek software is used to construct the network model. By calculating the number of network nodes and the median, the important network hub of Hubao-Eyu urban agglomeration is analyzed, and the comprehensive traffic network structure is evaluated.As a result, all the important hubs are located on the "two horizontal and three vertical" lines. If several passenger transport hubs, logistics parks and container transfer stations are built on the important hubs. It can greatly improve the effectiveness of network transportation and strengthen economic exchanges between Hubao, Hubei and Yulin cities.

Keywords

Baotou Eerduosi Huhehaote Yulin node degrees clustering coefficient Transportation network hub.

1. Introduction

With the rapid development of China ' s economy, the influence of central hub cities is growing. To promote the development of surrounding towns and strengthen economic exchanges between provinces and cities, various urban agglomerations have been formed. The construction of Hubao Eyu urban agglomeration is to promote the construction of energy, transportation, water conservancy and other facilities. It is necessary to build a modern infrastructure system with reasonable layout, safe and efficient, and high-quality service, to improve the support ability of coordinated development and open cooperation of urban agglomerations.

Gothman first proposed the concept of urban agglomeration, pointing out that urban agglomeration is the necessary trend of human development and an important method of human progress. Wang Qingguo through to the Wuhan city road network structure characteristic research, through constructs the Wuhan city public transportation, the rail transit network topology graph, obtains the Wuhan city transportation network data, calculates the network parameter, the goal is discusses the city development and the urban transportation relations, finally obtains the Wuhan city road network belongs to the typical scale-free network. Chen Wenhui introduced the development status and development status of Hubao Eyu urban agglomeration, and through the analysis of Hubao Eyu industrial structure and strategic position. This paper introduces the importance of urban agglomeration in the whole northern region, the current situation of urban agglomeration development and the leading industry of

urban agglomeration, which is of great significance to the study of the overall situation of Hubao Eyu urban agglomeration. Based on the overall planning of Hubao Eyu urban agglomeration, Yao Li used SWOT to evaluate the development path of new urbanization in Ordos City, and put forward a series of improvement measures and methods, such as balancing urban and rural development, improving the expansion breakpoint, and developing new leading industries. It has very important reference significance for other cities like Ordos. Sun et al. analyzed and studied the network characteristics of public transportation in Xi' an, used the modeling method to construct the topological graph of public transportation network, and used the software to observe the distribution characteristics of different transportation network data by calculating the aggregation coefficient, average degree and average path length of public transportation and rail transit nodes. The purpose was to explore the public transportation network in Xi' an.

The improvement of Hohhot-Baotou-Eyukou comprehensive transportation network can orderly and orderly promote the construction of railways such as Beijing-Baotou, Baotou-Yinchuan, and Baotou-Xi'an (Xi'an). It can also improve the Baotou-Maozhou Expressway, Qingyin Expressway and national-level provincial trunk roads, unimpeded the intermodal transport channels of public railways and railways to ports such as Erlianhaote and Mandula and ports along Qinhuangdao and promote the close connection with Beijing-Tianjin-Hebei, Guanzhong Plain, Ningxia along the Yellow River and central Shanxi and other urban agglomerations.

2. Analysis of Traffic Network in Hubao, Eyu Urban Agglomeration

2.1. Data

This paper mainly through the map of China, Inner Mongolia railway distribution map, Shaanxi province railway distribution map and in Inner Mongolia statistical annual inspection[7], Shaanxi province statistical annual inspection[8] to find relevant site data. The data of the last year are 2020. I iteratively predict the overall data of 2022 with the same growth rate and add the newly opened and to be opened lines to make the data more accurate and the statistical results closer to the facts.

2.2. alculation of clustering coefficient

Clustering coefficient is the reflection of the cohesion density between adjacent nodes in the network.[6] Its definition is as follows:

Let the degree of node X be X_k, that is, node X has X_k adjacent nodes. If the $X_k$adjacent nodes are also adjacent to each other, then there can be at most $X_k(X_k-1)/2$ edges between adjacent nodes. If the number of edges between these X_k nodes is Y_k the clustering coefficient C_k of node X is defined as 1：

$$C_k = \frac{Y_k}{\frac{X_k(X_k-1)}{2}} = \frac{2Y_k}{X_k(X_k-1)} \tag{1}$$

Average clustering coefficient, represented by C, formula 2：

$$\mathrm{C} = \frac{1}{N}\sum_{i=1}^{N} C_k \tag{2}$$

For the transportation network, the clustering coefficient and the average clustering coefficient represent the closeness of the local and overall connection of the road network, respectively.

2.3. Calculation of Degree and Average of Nodes

The shortest path between i and j nodes is called the path with the least number of edges connecting i and j nodes in the traffic network, and the longest path is called the path. The number of edges used by a path is called the distance between two nodes in D_{ij}. The average path length L of traffic network refers to the average distance between all nodes in the network, also known as the characteristic path length of traffic network.

Clustering coefficient and average path length are the most important topological structure characteristics in the study of traffic network connection factors. If the clustering coefficient distribution of a traffic network is uniformly distributed, the infrastructure distribution in the traffic network is uniform and the accessibility between nodes is good. If a traffic network has a smaller characteristic path length and a larger clustering coefficient, it is said that the traffic network is mostly satellite-like, and the traffic is very convenient in a region.

2.4. The calculation of center betweenness

Node centrality P refers to the reciprocal of the average distance between the node and all other nodes in the traffic network. Compared with the degree of nodes, node centrality can better describe the degree of connection between nodes and indirectly connected nodes. The larger the value is, the wider the influence and service range of the node is, and the higher the importance is. The calculation formula is Equation 3:

$$\mathrm{P} = \frac{1}{\sum_{i=1}^{j} D_{ij}} \tag{3}$$

3. Results analysis of important factors

3.1. Highway network data analysis

The road has the highest accessibility, and the shortest path exists between any two points. There must be path convergence between the two nodes. Through the study of highway network layout, using formula 1, formula 2 and formula 3, the calculation results are shown in table 1.

Table 1. Highway weighted network

hop	edge	Averagedegree	clustering	path
26	37	0.27907	0.25072	3.25692

Next, calculate the degree of each node and draw the table as shown in table 2.

Table 2. Node Degree Distribution Map

county	hop	county	hop
Wuchuan	4	Qingshui	2
TumoteL	4	Dalate	3
TumoteR	3	Rice fat	3
Ikinholow	4	Suide	4
Etok	3	Qingjian	2
Tocto	5	Wu Bao	5
Guyang	3	Jingbian	3
Helingel	3	Bordering	2
Jungar	2	Subcontinent	2

Fugu	3	Wushen	3
Shenmu	4	Hangjin	2
Jiaxian	3		

The average node degree of highway network is taken, and the result is 3.1304. In this result, the node degree of Tocto County and Wubao County is 5, and the map shows that the two counties are most adjacent to the county. These two counties play a very important role in road transit. Priority should be given to improving the layout strategy of highway network. Baomao Expressway runs through Tocto County and Wubao County, making these two counties have a very important geographical location.

3.2. Railway network data analysis

The distribution of railway stations in Hohhot-Baotou-Eyuji urban agglomeration is relatively scattered. Some counties have not arranged railway stations, and these counties without railway stations are merged into other similar stations. Finally, the railway network layout of 19 counties is obtained. After calculating the corresponding data, Table 3 and Table 4.

Table.4 Highway weighted network

hop	edge	Averagedegree	clustering	path
20	24	0.22642	0.37556	3.19883

The top three clustering coefficients are Hohhot, Baotou, and Tumote Left Banner, followed by Zhungeer and Shenmu. In the railway network structure, Hohhot, Baotou, and Hubei cities play a very important role in the convergence of the banners and counties in Inner Mongolia. At the same time, their node degrees are positively correlated with the clustering coefficient. The data of these 19 nodes (the removal of degree 1 is not counted) are imported into Origin software to draw a cylindrical scatter diagram to further observe the structural characteristics of the railway transportation network. The data are shown in Figure 1.

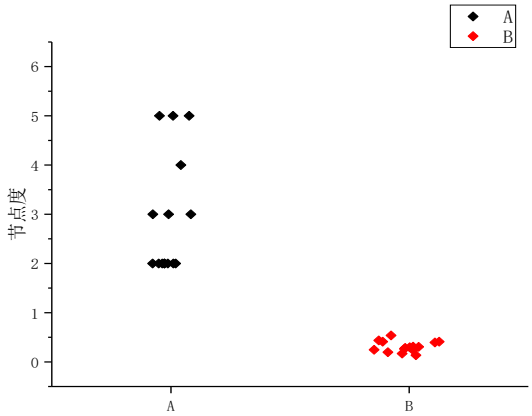

Figure 1. Railway node- Clustering Coefficient

Column A represents the node-clustering coefficient relationship diagram, and Column B represents the scatter distribution of clustering coefficient. It can be seen from Fig. 7 that there are more flag counties with node degree 2 and the clustering coefficient is very dense, while the distribution spans of node degrees 3 and 5. This is because the smaller the node degree is, the fewer the nodes are connected, and the surrounding counties are scattered. The clustering coefficient is not much different due to the small clustering degree, while the larger the node degree is, the more the counties are directly related, and the influence of the surrounding counties is received, so the clustering coefficient span is large.

The calculation shows that the average node degree of the railway network is 2.5263 compared with 3.1304 of the highways. The accessibility of the railway network is inferior to that of the highway network. It is difficult or even impossible to achieve direct access between counties and banners, and transit must be carried out. During the transit, Zhungeer Banner and Suide passed the most, and Hohhot and Baotou started the most. Zhungeer Banner and Suide are both on the economic transport corridor along the Yellow River. In the process of strengthening the construction of railway network, these four counties and cities can be given priority.

4. Comprehensive Traffic Network Analysis

Network clustering coefficient represents the relationship between all nodes in the network. The larger the clustering coefficient is, the higher the degree of node aggregation is and the smaller the world. It can be seen from table 2 and table 3 that the clustering coefficient of railway network is larger than that of highway network, indicating that the network is closer. In some areas of the railway, the aggregation coefficient is 0, because most of them are single lines, isolated stations are more, and the distribution is remote. This shows that the railway traffic network structure is more unstable than the highway, if these isolated nodes such as fixed side failure will directly lead to fixed side railway blocked. At present, Dingbian and Qingjian highway travel accounts for a large proportion. Through the cooperation and connection between highways and railways, the comprehensive transportation network combines the advantages of high-cost performance, good safety, large volume of transportation, convenient highways and door-to-door transportation. Therefore, the highway railway transportation of Hubao Eyu urban agglomeration undertakes the task of communication between counties and is also an important network of development priorities. Integrated transport networks versus single networks, as shown in table 5.

Table 5. Network Contrast Diagram

net	hop	edge	Averagedegree	clustering	path
highway	26	37	0.27907	0.25072	3.25692
railway	19	24	0.22642	0.37556	3.19883
integrated	29	52	0.3264	0.5394	3.38528

5. Conclusion and suggestion

Speed up the construction of highway network. The highways along the Yellow River economic belt in the region are connected, and the Baomao Expressway is reconstructed and expanded. The highways of Etuoke Qianqi-Yinchuan and Zhungeerqi-Hequ are constructed, and the highways of Baode-Yulin, Hohhot-Shuozhou and Saihantala-Elianhaote are planned and constructed. Speed up the upgrading of provincial trunk highways in Hubao Eyu urban agglomeration. The central urban area to the location of Qixian County should be connected by highways above the first level, and the completed highways and provincial trunk roads should be maintained and renovated. The urban agglomerations such as Beijing-Tianjin-Hebei and the Yellow River Economic Belt should be connected to form a smooth, fast, and convenient highway network inside and outside the region.

The Hohhot-Taiyuan, Baotou-Yinchuan and Baotou-Xi ' an railway are constructed to repair the Hohhot-Baotou-Eyu express railway network. The construction of Zhungeer-Shuozhou and Mengxi-Huazhong railway is accelerated. The ordinary railways such as Shenmu-Watang promote the upgrading of Hohhot-Zhungeer railway, join the Hohhot-Zhangjiakou high-speed rail system as soon as possible, and become an important transit hub to strengthen the influence on the surrounding counties.

Strengthen the construction of key node hub, improve traffic infrastructure. Especially the realization of highway and railway transit flag county, to comprehensively enhance the Hohhot national transportation hub city function, promote Baotou, Ordos construction of regional transportation hub city. Smooth access to Erlianhaote, port highway railway, railway maritime transport corridor, promote the Beijing-Tianjin-Hebei, Ningxia along the Yellow River, the central city group of Shanxi close connection.

Since railways and highways are responsible for the efficient operation of integrated transport networks, it is necessary to strengthen the construction of intermodal hubs, such as Zhungeer, Toketo, Shenmu and other flag counties. The effective connection of highways and railways plays a vital role in promoting the development of urban agglomerations.

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