

Analysis of location advantage of Hohhot based on transportation and economy

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Abstract

As a part of the suitability evaluation of urban construction in the ' double evaluation ', the evaluation of location advantage has great support for the adaptability evaluation of land space development. It is an important element of urban development scale, development direction and development potential. This paper takes Hohhot as the research area, starting from the important road network elements such as airport, railway, expressway, national highway and provincial highway, selecting three factors of environment, transportation and economy, constructs the evaluation model of Hohhot's location advantage, establishes the evaluation index factors such as accessibility of traffic trunk lines, accessibility of central urban areas and accessibility of surrounding central cities, and combines Hohhot's GDP, primacy and other economic indicators and topographic conditions. GIS technology is used to quantitatively analyze the research area, and the location advantages of Hohhot are evaluated from two aspects of internal advantages and external advantages. It is concluded that the location advantage of Hohhot is gradually weakening from the central area to the surrounding area. The farther away from the central urban area of Hohhot, the worse the location advantage. The area of poor, poor, general, good and good grade areas accounted for 56.9 %, 20.6 %, 14.6 %, 4.2 % and 3.7 %, respectively. The regional difference of comprehensive dominance is obvious.

Keywords

Double evaluation ; Location advantage ; Territorial space planning.

1. Introduction

At present, ' double evaluation ' has become the foundation of national territorial space planning, laying a solid foundation and providing data support for the construction and improvement of a harmonious pattern of territorial space development and protection between man and nature. As an important factor in urban construction, the evaluation of location advantage plays an important basic role in the healthy and rapid development of the city and the evaluation of the potential of the city. The evaluation of location advantage is more and more important in the planning of urban and rural system^[1]. At the same time, it can also determine the urban development space with more development value, which will play an increasingly important role in the strategic positioning and development prospects of a region, and also help to evaluate the existing situation of the town, so as to point out the direction of its future development. The higher the location advantage, the stronger the spatial connection between the study area and the outside^[2-3]. The lower the location advantage, the lower the level of spatial connection between the study area and the outside. The analysis of the location advantage degree not only has important practical significance for making full use of resources and conditions to continuously gain advantages, thus promoting the sustained, stable and healthy development of the regional economy, but also provides important data support for improving the construction of national channels and hub functions^[4-5]. At the same time, it can

also strengthen the spatial connection between the region and the outside. Therefore, it is of great practical significance to study the location advantage of a region.

2. Materials and Research Methods

2.1. Overview of the study area

Hohhot, Inner Mongolia Autonomous Region, located in North China, Eurasia, in the central Inner Mongolia Autonomous Region. The territory is mainly divided into two major geomorphic units: mountainous terrain and plain terrain. Hohhot belongs to the mid-temperate continental monsoon climate^[6]. The climate change in the four seasons is obvious. It is characterized by long and cold winter and short and hot summer. The climate change in spring and autumn is the most obvious, and the annual average temperature rises from north to south. Hohhot currently has 4 districts, 4 counties, 1 banner and 1 national economic and technological development zone. At present, the traffic in Hohhot is developing rapidly, and a three-dimensional traffic network supporting each other in the city, air and ground has been initially formed. External traffic includes aviation, railways and highways. However, in the construction of external transportation, the regional hub function is weak, the provincial transportation system needs to be further improved, and the urban and rural infrastructure coverage and transportation rate are still low.

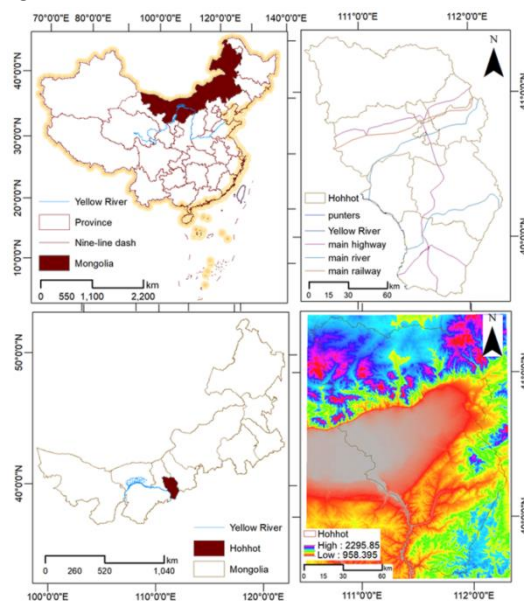


Fig. 1 Geographical location map of the study area

2.2. Data sources

The data used in this paper include highways, national highways, provincial highways, county highways and other road networks, railway stations, airport transportation facilities, GDP, POI, topography and other socio-economic statistical data in Hohhot. The basic data and economic statistical data are from the Resource and Environmental Science Data Center of the Chinese Academy of Sciences, including 'China's administrative division data', 'social and economic data', 'global 1 million basic geographic data', etc., and the first degree statistical data are from 'Hohhot People's Government'. Terrain data comes from the planning cloud platform^[7-8].

2.3. Model construction

GIS technology is not only limited to spatial location and attribute data, but also can be combined with economic and social data to achieve spatialization^[9]. In this paper, the grid analysis method is used to divide the study area into seamless grids. Combined with economic

data, GIS technology is used to calculate the indicators in each grid, and the calculation results are normalized to obtain the comprehensive grid score of the study area and realize the spatialization of the comprehensive score^[10].

The location advantage of a region is related to many factors, including traffic conditions, network density, and the influence of surrounding cities. At the same time, considering the economic situation of the region, it also restricts the development and construction of the region^[11]. Based on this, this model starts with three index factors of economy, environment and traffic, including traffic trunk accessibility, central city accessibility, traffic hub accessibility, surrounding central city accessibility, traffic network density, POI, economic level, economic vitality, topographic conditions and urban primacy, as the basic indexes of location advantage model research^[12].

2.4. Research content

2.4.1. Traffic trunk accessibility

The accessibility of traffic trunk lines refers to the distance from grid units to traffic trunk lines at all levels after considering the technical levels of different traffic trunk lines. The farther away from the center of the road, the smaller the influence on the center of the calculation unit until it disappears. Firstly, the central city is extracted, and the network analysis is carried out according to the distance between the grid unit and the traffic trunk lines of different technical levels. The scores are assigned from 1 to 5, and the indexes are weighted and summed to calculate the accessibility of the traffic trunk lines.

$$TI = \sum f(x), f(x) = ax + \max \quad (1)$$

Which: TI—influence degree of traffic trunk line, $f(x)$ —influence of a road on the calculation unit, a —traffic trunk influence attenuation coefficient ($a < 0$), x —shortest distance from the center of the unit to the road is calculated, \max —assignment of the road level, i.e. the maximum influence range of the road.

2.4.2. Accessibility of central city

The accessibility of the central urban area reflects the cost of the spatial connection between the grid unit and the central urban area. It is derived from the traffic time distance of the central urban area, and the evaluation results are divided into five levels. Firstly, the central urban area is extracted, and the road network duration is calculated according to the distance of the third-class highway. Then, the network analysis model is constructed and the time analysis is carried out. The accessibility of the central urban area is calculated by using the identification grading assignment 1 to 5.

$$\begin{aligned} & [\text{Accessibility of central city}] \\ & = f([\text{Central city traffic time distance}]) \end{aligned} \quad (2)$$

2.4.3. Accessibility of transportation hub

The accessibility of transportation hubs reflects the potential of urban agglomeration development along the hub under the trend of informatization. It refers to the distance from grid units to important transportation hubs such as aviation, railway, port, highway and urban rail transit in the region. Firstly, the extraction of each transportation hub is carried out, the length of the road network is calculated, the network analysis model is constructed, the time range of the railway station and the airport is calculated respectively, and then the weighted summation is carried out, and the equal interval is used to analyze the assignment, and the accessibility of the transportation hub is calculated.

$$\begin{aligned} & [\text{Accessibility of transportation hub}] \\ & = f([\text{Airport traffic distance}], [\text{Railway traffic distance}]) \end{aligned} \quad (3)$$

2.4.4. Accessibility of surrounding central cities

The accessibility of surrounding central cities reflects the cost of spatial connection between grid units and the outside world. According to the degree of population connection of population migration big data, corresponding to the accessibility weights of different regions, the evaluation results are divided into 5 to 1 levels according to the natural fracture method, and the accessibility degree of surrounding central cities is calculated.

$$\begin{aligned} & [\text{Accessibility of surrounding central cities}] \\ & = f([\text{Traffic time distance around the central city}]) \end{aligned} \quad (4)$$

2.4.5. Traffic network density

The traffic network density is the ratio of the length of all roads in the calculation unit to the area of the calculation unit. It reflects the density of regional traffic and the accessibility of traffic routes between cities. The main body of traffic network density evaluation is highway network. The evaluation method is linear density analysis method. The evaluation factors mainly consider highway, national highway, provincial highway, county highway and railway. Finally, the classification assignment is reclassified to calculate the traffic network density.

$$TD = L/A \quad (5)$$

Which: TD—traffic network density, L—total length of highway mileage in the field of grid unit, A—area of grid unit domain

2.4.6. Economic viability

A POI (information point) is a business, school, catering, tourist attractions, etc., using the distribution density of POI in the study area to analyze the economic vitality of the whole region. According to the actual development of Hohhot, five POIs of schools, catering, transportation stations, enterprises and scenic spots are selected to calculate the global POI density and analyze the economic vitality of Hohhot.

2.4.7. Economic level

The per capita GDP of Hohhot from 2000 to 2019 is selected as the economic evaluation index, and the economic development of each district and county in Hohhot is calculated by the comprehensive index method. The evaluation results are divided into high-level areas, higher-level areas, medium-level areas, lower-level areas and low-level areas.

2.4.8. Urban primacy index

The city with the largest population in a region has become the first city, and the ratio of the largest city to the second largest city has become the first degree of the city. It has become a common indicator to weigh the distribution of urban scale. On the whole, the more developed the economy, the smaller the urban primacy. Therefore, this paper reflects the level of urban economic development with the first degree of Hohhot, so as to analyze the location advantage of Hohhot.

2.4.9. Topographic condition

Based on the topographic map of Hohhot, the contour line is generated. Combined with DEM, the DEM of Hohhot is made, and the topographic slope is calculated. According to $\leq 2^\circ$, $2^\circ \sim 6^\circ$, $6^\circ \sim 15^\circ$, $15^\circ \sim 25^\circ$, $> 25^\circ$, five grades are divided, the slope grading map is generated, and the topographic relief is generated. Using reclassification and grading assignment, the topographic relief analysis map of Hohhot is generated to study the characteristics and value of urban landform.

2.5. Evaluation index analysis

According to the classification standard of location advantage degree in the 2019 Technical Guide for the Evaluation of Resource and Environmental Carrying Capacity and Land Space Development Suitability (Trial), the evaluation indexes at all levels are classified and processed.

Finally, the accessibility of traffic trunk lines, the accessibility of central urban areas, the accessibility of traffic hubs, the accessibility of surrounding central cities and the density of traffic networks are integrated to form a discriminant matrix. Combined with economic indicators and topographic conditions, the location advantage degree is analyzed^[13].

Table 1 Hohhot evaluation index analysis table at all levels

Evaluation content	Evaluation index	Grading reference threshold	Assignment
Accessibility evaluation of traffic trunk lines	First-class highway	Distance to first-class highway $\leq 3\text{km}$	5
		$3\text{km} < \text{distance to first-class highway} \leq 6\text{km}$	4
		Distance to first-class highway $> 6\text{km}$	1
	Secondary road	Distance to secondary road $\leq 3\text{km}$	4
		$3\text{km} < \text{distance to secondary road} \leq 6\text{km}$	3
		Distance to secondary road $> 6\text{km}$	1
	Third-class highway	Distance to third-class highway $\leq 3\text{km}$	3
		$3\text{km} < \text{distance from the third-class highway} \leq 6\text{km}$	2
		Distance to third-class highway $> 6\text{km}$	1
	Fourth-class highway	Distance from the fourth grade highway $\leq 3\text{km}$	2
		Distance four kilometers $> 3\text{km}$	1
		Distance ≤ 30 minutes	5
Accessibility evaluation of central urban area	Accessibility of central city	$30 \text{ minutes} < \text{driving distance} \leq 60 \text{ minutes}$	4
		$60 \text{ minutes} < \text{driving distance} \leq 90 \text{ minutes}$	3
		$90 \text{ minutes} < \text{driving distance} \leq 120 \text{ minutes}$	2
		$> 120 \text{ minutes by car}$	1
		Distance ≤ 60 minutes	5
		$60 \text{ minutes} < \text{driving distance} \leq 90 \text{ minutes}$	4
Accessibility evaluation of transportation hub	Airport	$90 \text{ minutes} < \text{driving distance} \leq 120 \text{ minutes}$	3
		$> 120 \text{ minutes by car}$	0
		Distance ≤ 30 minutes	5
	Railway site	$30 \text{ minutes} < \text{driving distance} \leq 60 \text{ minutes}$	4
		Journey > 60 minutes	0
		Higher	5
Evaluation of traffic network density	Traffic network density	High	4
		Medium	3
		Low	2
		Lower	1

Table 2 Hohhot location advantage evaluation discriminant matrix

traffic network density	Good	Better	General	Poor	Poorer
Higher	Higher	Higher	High	Medium	Lower
High	Higher	Higher	High	Low	Lower
General	Higher	High	Medium	Low	Lower
Low	High	High	Medium	Lower	Lower
Lower	Medium	Medium	Low	Lower	Lower

2.6. Evaluation method

This paper collects and collates the basic data of geographic information, economy, society, population and other basic data of Hohhot City and its adjacent areas, as well as the special data of Hohhot City, and compiles the base map. With the help of GIS spatial development software, multi-index superposition, comprehensive index method, classification, natural breakpoint method and other technical means are adopted^[14]. Finally, the normalization processing is carried out, and the research scheme is finally generated in combination with the actual spatial situation of the current surface.

(1) Carry out the classification of various indicators of regional traffic, and analyze the location conditions of Hohhot from the aspects of airports, highways, and highways.

(2) Analyze the comprehensive location advantages of Hohhot from the internal and external aspects.

A comprehensive analysis of the location conditions of Hohhot, combined with economic conditions and terrain advantages, to support the ' double evaluation ' ^[15].

3. Results and analysis

3.1. Accessibility evaluation of traffic trunk lines

The overall traffic trunk accessibility in Hohhot is poor. The accessibility of the central urban traffic trunk line is better than that of other surrounding areas, showing a differentiated spatial distribution. The areas of poor, poor, general, good and good grades accounted for 32.9 %, 43.0 %, 17.5 %, 4.9 % and 1.8 %, respectively.

3.2. Accessibility evaluation of transportation hub

The accessibility of the overall transportation hub in Hohhot is poor. The accessibility of the transportation hub in the central urban area shows a decentralized spatial distribution due to the poor accessibility of the surrounding areas. The areas of poor, poor, general, good and good grades accounted for 42.2 %, 18.0 %, 17.6 %, 9.3 % and 13.0 %, respectively.

3.3. Accessibility evaluation of central urban area

The accessibility of the central urban area of Hohhot is poor. With the central city as the center, it shows a trend of radial decline. Huimin District, Yuquan District and Saihan District are all in good accessibility areas, and the accessibility of the new urban area is poor. The areas of poor, poor, general, good and good grades accounted for 46.1 %, 3.8 %, 14.4 %, 22.5 % and 13.2 %, respectively.

3.4. Accessibility evaluation of surrounding central cities

The accessibility of central cities around Hohhot is poor. The surrounding areas are mainly the central areas of Guyang County, Tumend Right Banner, Zhungeer Banner, Zhuozi County and Liangcheng County, with good accessibility. However, the accessibility of the central area of Hohhot is poor, and the degree of contact and communication with the central city is low. The areas of poor, poor, general, good and good grades account for 39.5 %, 6.9 %, 18.2 %, 21.5 % and 14.0 % respectively.

3.5. Evaluation of traffic network density

The density of traffic network in Hohhot is poor. The traffic network density in the central and southern regions is better, while that in the northern region is worse, showing a divergent spatial distribution pattern with good center and poor periphery. The areas of poor, poor, general, good and good grades accounted for 72.0 %, 8.3 %, 15.3 %, 3.1 % and 1.3 %, respectively.

3.6. Evaluation of the area position

The location conditions of Hohhot are poor. The location conditions of the central urban area are better, and the location conditions of the surrounding central urban area are poor, showing a distribution of outward divergence with the central city as the core. The areas of poor, poor, general, good and good grades accounted for 45.9 %, 12.9 %, 25.2 %, 8.7 % and 7.3 %, respectively.

3.7. Economic Level and Vitality

The overall economic development level of Hohhot is low. The vast majority of the city 's unit economic development level stays in low-level areas and lower-level areas, mainly distributed in the surrounding areas outside the central area ; the high-level areas are distributed in the central urban area, including Saihan District, Huimin District, Yuquan District and Xincheng District. The distribution is obviously different, the economic level is quite different, and the spatial pattern of economic development level is not balanced. The areas of low level area, lower level area, medium level area, higher level area and high level area account for 57.3 %, 30.8 %, 6.0 %, 4.8 % and 1.1 % respectively.

POI can be used as an important indicator to reflect the vitality of regional economic development, including shops, enterprises, schools, catering and so on. Crawl the global POI of Hohhot, including schools, enterprises, catering, scenic spots and traffic stations, so as to analyze the economic vitality of the whole region. The economic vitality of the main urban area of Hohhot is good, the economic development is mostly concentrated in the main urban area, and the economic vitality of the surrounding areas is poor. According to POI, there are 50 schools, 110 enterprises, 144 traffic stations, 150 restaurants and 150 scenic spots.

3.8. Urban primacy index

This paper mainly uses the following methods, the first city concentration (marked as $P1 / P$), with the largest urban population and the provincial total urban population ratio to measure the importance of the first city in the urban system, the higher the $P1 / P$, the more important the first city. According to the sixth census bulletin, Hohhot has a population of 2.866615 million, a total urban population of 95.5841 million, and a $P1 / P$ ratio of 2.9991 %. Hohhot city primacy is low.

Table 3 Hohhot City Area and Population Scale

region	Area (sq. km)	Population (10,000 people)
Hohhot	17271	286.6615
wuchuan county	4885	17.8726
tuoketuo county	1313	20.0840
qingshuihe county	2859	9.3887
helingeer county	3401	16.9856
tumed left banner	2712	31.2532

3.9. Integrated evaluation of location advantage degree

Based on the evaluation results of location conditions and traffic network density, combined with economic level, economic vitality, primacy and topographic relief, the evaluation results of location advantage are determined. The overall location advantage of Hohhot is poor. The location advantage of Hohhot City radiates outward with the central urban area as the core. The location advantage of the central urban area of Hohhot City is better. The economically developed areas are concentrated in the central urban area. The dominance of the south and the north is poor. The urban and township areas obviously exceed other areas and are the center of social activities and economic development. The areas of poor, poor, general, good and good grades accounted for 56.9 %, 20.6 %, 14.6 %, 4.2 % and 3.7 %, respectively^[16-18].

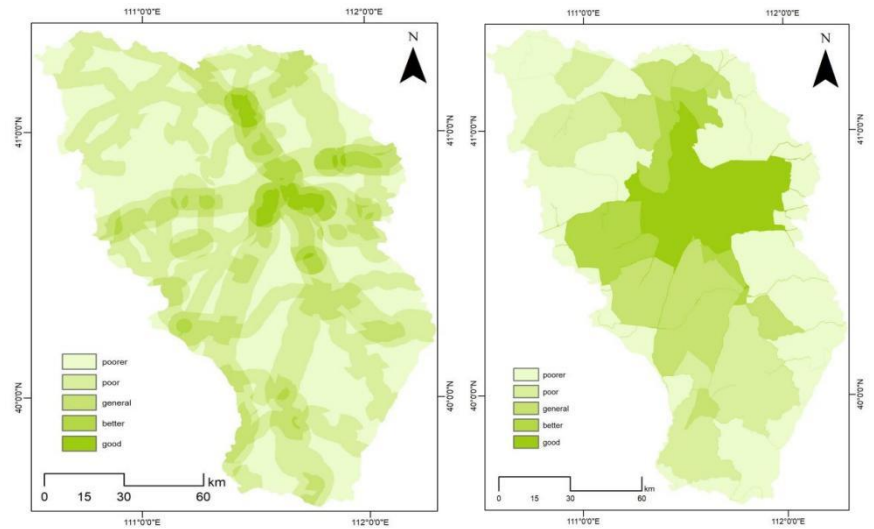


Fig. 2 Hohhot traffic trunk accessibility and transportation hub accessibility evaluation map

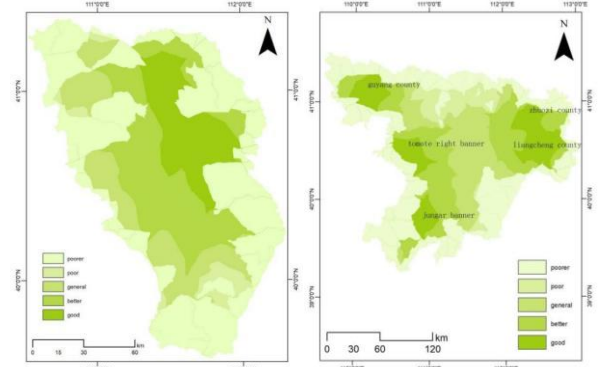


Fig. 3 Accessibility evaluation map of Hohhot central city and surrounding central cities

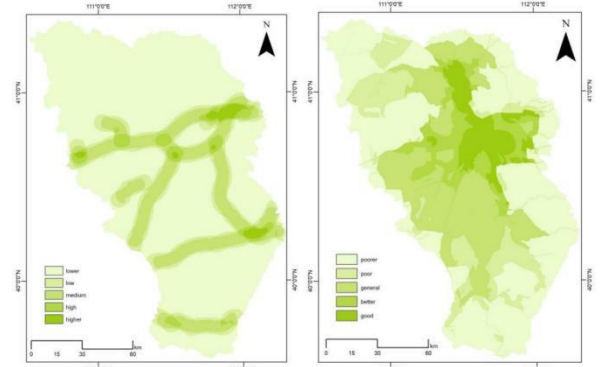


Fig. 4 Evaluation map of traffic network density and location conditions in Hohhot

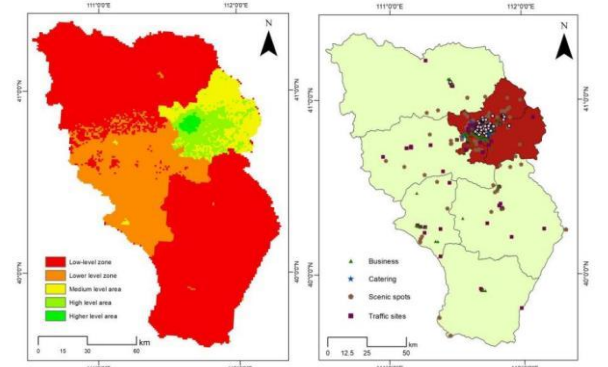


Fig. 5 Hohhot City economic level and economic vitality evaluation map

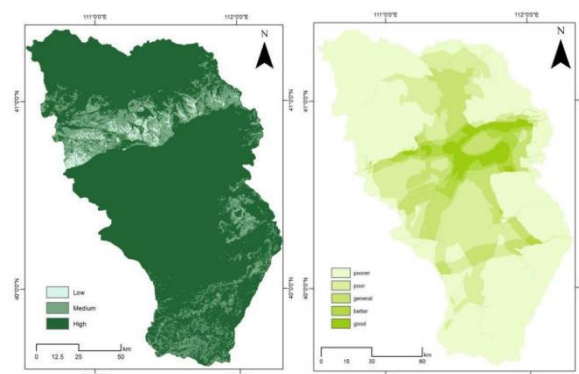


Fig. 6 Evaluation map of topographic relief and location advantage of Hohhot City

4. Discussion

At present, there are few studies on the location advantage degree, most of which are concentrated on the provincial scale and have a wide range of research, and use the location advantage degree as the basic conclusion to carry out other research. Zhang Jing et al. selected traffic trunk accessibility, transportation hub accessibility, central city accessibility, location conditions and traffic network density evaluation factors to analyze the location advantage evaluation in the correlation analysis of location advantage and regional economy in Fujian Province^[19-20]. Finally, the conclusion of location advantage in Fujian Province is drawn, and discussions and suggestions are given. In addition to the above evaluation factors, this paper also includes the evaluation factors of accessibility, economic conditions, economic vitality, urban primacy and terrain advantage of surrounding central cities. According to the evaluation index, based on the grid idea, using GIS spatial analysis and graphic expression function, the location advantage of Hohhot is analyzed and the conclusion is drawn. The evaluation factors selected in this paper are more comprehensive and specific^[21]. It is more convincing to analyze the location advantage of Hohhot from various angles, which improves the accuracy of evaluation. It also explains the problems existing in the study of location advantage, analyzes the reasons, summarizes the conclusions, and analyzes the location conditions and development of Hohhot^[22]. In the follow-up study, more representative evaluation indicators should be selected for more comprehensive analysis. Therefore, there are still many problems in the study of Hohhot's location advantage. In the future research, we should improve the efficiency, clarify the research objectives, select more representative and more comprehensive evaluation factors according to the situation of the study area, and use the location advantage evaluation to promote the rapid economic development of Hohhot's districts and counties, and form a good economic development pattern of overall development^[23].

5. Conclusion

(1) The location advantage of Hohhot is poor. The spatial distribution of is quite different, showing a distribution of outward divergence with the central city as the core, and the location advantage of the outward diffusion area centered on the municipal district is gradually reduced. The urban central area represented by the central urban area has a high location advantage, while the location advantage of the southern and northern areas is relatively low, and the development is uneven. The development potential of the northern and southern regions is relatively weak, and the location advantage of the northwest and southeast corners is the lowest, and the level of economic development needs to be further improved^[24]. By constructing the evaluation index model of location advantage degree, the above evaluation indexes are integrated to describe the location advantage degree of Hohhot City, and according

to the final evaluation results, the location advantage degree of the whole region is divided into poor area, poor area, general area, good area and good area.

(2) The accessibility of the five counties around Hohhot is good. It includes Guyang County, Tumote Right Banner, Zhungeer Banner, Zhuozi County and Liangcheng County. The accessibility of the central city is higher than that of the surrounding area, showing the distribution of the central area as the core to the surrounding area. On the whole, the accessibility of the northwest, west, southwest and south is very poor, the connection with the outside is relatively weak, and the development is not balanced^[25].

(3) Although the traffic network pattern of Hohhot has been established, there are still some problems in the existing traffic network, such as insufficient capacity of some built channels, low operation efficiency of local road network and inconvenient connection between nodes. It is necessary to strengthen intercity transportation links, further improve the road network system, expand the coverage of the transportation network, gradually form a transportation network with fast trains as the skeleton, and build a highway ' six vertical and ten horizontal ' and railway ' three vertical and six horizontal ' road network pattern. In view of the blank areas of urban and county road networks^[26], we should continue to improve the road network framework, improve the quality of the road network, establish a high-speed, fast, intercity, freight and other all-round and fast transportation system, promote the economic development and social exchanges in the surrounding areas, promote urban development, improve external communication, and enhance the overall location advantage of Hohhot.

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