

Evaluation and Analysis of Airside Economic Zone based on GIS Technology

-- Taking Daxing Airport as an Example

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Abstract: The purpose of this paper is to establish a feasible indicator evaluation system for the Daxing Airport Airside Economic Zone, so as to make suggestions for the land development of Daxing Airport. The land use of Daxing Airport Airside Economic Zone may lack a reasonable planning and indicator evaluation system. Based on the results of indicator calculation, combined with the spatial analysis function of GIS, it explains the reasons for some uncoordinated development of the area, and makes targeted suggestions for improvement of the problems in each land use segment. This study aims to comprehensively assess the integrated benefits of commercial service utilization in the airport and airside areas, and therefore constructs a multi-faceted indicator evaluation system to comprehensively measure the advantages and disadvantages of land use.

Keywords: Daxing Airport Airside Economic Zone; Indicator Evaluation System; Land Development; GIS Technology; Data Analysis.

1. Introduction

The importance of city airports is growing as the global economy grows and the mobility of the population increases. As gateways and transportation hubs for cities, airports have a wide-ranging impact on airside economic zones. As the city population grows and urbanization accelerates, the rational use and planning of land resources becomes particularly important. In the vicinity of airport construction, the planning and management of land is critical to providing convenient commercial and service facilities to meet people's needs. As one of China's important international aviation hubs, the construction and development of Daxing Airport has had a far-reaching impact on the economy, transportation and land use of Beijing and the surrounding areas. Therefore, taking Daxing Airport as an example to study the impact of airports on land use can provide empirical cases and experiences about the construction and development of airports in large cities, and provide references for other studies in similar contexts.

WW Linthacum [1] takes Santa Barbara Municipal Airport in California and Denver Stapleton International Airport in Colorado as examples, suggesting that governments may often consider economic incentives for land-use development around airports as outweighing considerations of airport land-use compatibility, and making recommendations for land-use planning and construction of China's Daxing Airport and subsequent airports. Zhang Yicheng [2] combines the planning practice of Changshui LinKong Economic Zone, studies the practice in both industrial development and spatial planning, and evaluates the rationality of the practice. Feng Xiaomei [3], in view of the shortcomings of the traditional public transportation evaluation index calculation method in China, gave a GIS-based calculation method of line density, line repetition coefficient and station coverage in different areas within the city. In this paper, the actual case of Daxing International Airport will be studied in depth to evaluate the

land use indicators in order to provide valuable reference for future land development. Based on the analysis, this paper will put forward targeted solution suggestions, including optimizing the land use structure, improving the efficiency of land resource utilization and promoting sustainable development. We hope that these recommendations will help guide the land use and development of Daxing International Airport and other similar airside areas to achieve diversified economic, social and environmental development.

2. Selection and Construction of Evaluation Indicators

In this paper, six indicators, namely road network density, population density, number of bus stops, transit coverage, degree of land development and information entropy of POIs, are selected. Road network density is the ratio between the total length of roads and the total area of the region in a given area. It reflects the sparseness of the road network and can assess the rationality of road distribution. The road network density is generally expressed by calculating the ratio between the total length of roads and the land area in the region.

The evaluation index system is to select and analyze the indicators from many aspects in the economic zone, and most of the selected indicators belong to quantitative indicators, in which some basic data can be analyzed and processed to get the quantitative value of the indicators by using GIS technology, and some of the indicators can be obtained by directly consulting the information. For the six indicators that can be calculated based on GIS, this paper analyzes and calculates them with ARCGIS and SPSS as research tools, and the meanings and calculation methods of each indicator are as follows:

2.1. Road Network Density

Road network density refers to the ratio between the total length of the road and the total area of the region in a specific

area. It reflects the sparseness of the road network and can assess the rationality of road distribution. The road network density is generally expressed by calculating the ratio between the total length of roads in the area and the land area.

$$X_1 = \frac{\sum L_i}{\sum S_i}$$

L_i — Path length of the i th path
 S_i — Indicates the area of each region

2.2. Public Transportation Accessibility

As far as urban transportation is concerned, the coverage of bus stops directly affects the number of residents who choose public transportation. Therefore, the accessibility of bus stops is also an important reflection of the accessibility of the road network. The specific calculation formula is as follows:

$$X_2 = \frac{\sum_{j=1}^n S_{ij}}{S_i} \times 100\%$$

R_{ij} — Total population in region j
 S_i — Total area

2.3. Land Development Intensity

Land development intensity is the ratio of the total amount of land in the study area to the total area of the area. It includes indicators such as volume ratio, building height, building density, etc., which reflect the degree of land utilization to a certain extent. Volume ratio is one of the key indicators and it is easy to obtain data. Floor area ratio refers to the ratio of the total floor area above ground to the net site area of a certain area, also known as gross floor area density. With a constant site area, a higher floor area ratio indicates a larger total building stock and a greater capacity for urban activity. However, if the degree of land development is too low, it will lead to a waste of land resources; while if the development intensity is too high, it will make the land carrying capacity too large, which is not conducive to human health and

sustainable development of the society. Therefore, this paper chooses the average value of the floor area ratio of each area as the reference basis [4], and the calculation formula is as follows:

$$X_4 = \frac{\sum_{j=1}^p Z_j}{S_a}$$

Z_j — Gross floor area above ground within the project site in Area j
 S_a — Total land area for regional projects

2.4. POI Information Entropy

The information entropy H [5][6] is a measure of system complexity and equilibrium, which is used to describe the diversity of POIs, and P_i is the proportion of the i th POI type. When no POI is retrieved in the specified range, its diversity index is 0, i.e., $H_{min} = 0$; on the contrary, when the more prosperous the social development in the specified range, the more each POI type has become stable and uniform and satisfies the condition of entropy maximization ($A_1 = A_2 = \dots = A_m = A/N$), the diversity index is the maximum value $H_{max} = \ln(N)$. Therefore, the more POI categories there are, the smaller the difference in the number of POIs in each category, the greater the entropy value. The formula is as follows:

$$X_5 = - \sum_i^N \frac{A_i}{\sum_i^N A_i} \log \frac{A_i}{\sum_i^N A_i}$$

A_i — Number of POIs by type

3. Calculation of Composite Indicators

3.1. Dimensionless Quantization of Indicators

In this paper, the Z-score standardized dimensionless method [7] is used, and the data of the indicators obtained by the above calculations are imported into the SPSS software for standardization. The results are shown in the table 1

Table 1. Evaluation index after standardization treatment

Region	Road network density	population density	Number of bus stops	Public transportation coverage	Volume ratio (degree of land development)	information entropy
0	1.054	1.065	1.097	1.151	-0.964	-0.127
1	-0.117	-0.145	-0.236	-0.497	-0.069	1.057
2	-0.936	-0.919	-0.861	-0.654	1.033	-0.931

3.2. Weight Calculation of Indicators

After obtaining the standardized data, continue to use SPSS

software to non-negative shift and entropy weight method [8] to calculate the weight data of each indicator data w . The results are shown in the table 2:

Table 2. Summary of the results of the entropy method of calculating weights

ITEM	The information entropy value e	Information utility value d	Weighting factor w
Road network density	0.5699	0.4301	14.83%
population density	0.5613	0.4387	15.12%
Number of bus stops	0.5265	0.4735	16.32%
Public transportation coverage	0.2911	0.7089	24.43%
Volume ratio (degree of land development)	0.583	0.417	14.38%
information entropy	0.5671	0.4329	14.92%

The entropy method is used to calculate the weights of six items, as can be seen from the above table: road density, population density, public transportation coverage,

volumetric rate (degree of land development), information entropy, and the number of public transportations stops, and their weights are 0.149, 0.152, 0.245, 0.139, 0.150, and 0.164,

respectively. uniform, all of them are in the range close to 0.167. This means that in the whole evaluation system, the weights of each indicator are relatively balanced, and there is no obvious bias in Favor of or against each other. In other words, the contribution of each indicator to the comprehensive evaluation is relatively balanced, and there is no situation in which an indicator is too prominent or neglected.

4. Daxing International Airport Airside Economic Zone Land Use Evaluation and Analysis Results and Recommendations

4.1. Analysis of Evaluation Results

The land development intensity of area A is relatively high, indicating that the development and utilization of building land is relatively high, which is more in line with the regional positioning of the service guarantee area; the development intensity of areas B and C is relatively low, the low land development intensity of area B is not conducive to the turnover of logistics and transportation, and area C lacks the infrastructure construction of the high and new technology industrial park.

4.2. Suggestions for Improvement

Based on the above analysis, the following recommendations can be drawn:

4.2.1. Suggestions for Improvement in Area A (Service Guarantee Area):

Upgrade the service facilities and further expand the commercial service facilities, such as residences, supermarkets, financial institutions, etc., in order to meet the needs of residents and travellers in the surrounding areas of the service guarantee area. Strengthen logistics support construction, work closely with the aviation logistics area, optimize the logistics and distribution network, and provide efficient logistics and distribution services within the service guarantee area.

4.2.2. Improvement Suggestions for Area B (Aviation Logistics Area):

Enhance traffic planning, carry out road network planning and optimization according to traffic flow and demand to ensure smooth logistics operation and improve traffic efficiency. Enhance the level of public transportation, improve the coverage and frequency of public transportation, and provide convenient and fast transportation modes to facilitate the travel of people and the transportation of goods within the logistics zone. Increase the intensity of land development, build logistics supporting infrastructure, and attract the development of tertiary industries, such as tourism and exposition, office and conference services, etc., in order

to enhance the comprehensive economic strength and regional competitiveness of the aviation logistics zone.

4.2.3. Suggestions for Improvement of Area C (Science and Technology Innovation Zone)

Strengthen the transportation infrastructure and carry out further road planning and construction in order to increase the density of the road network in the Science and Technology Innovation Zone, improve transportation connectivity, and attract more innovative enterprises and R&D institutions. Improve the public transportation system and build an efficient and convenient public transportation network to facilitate the travel and communication of people within the STI zone and promote STI activities. Strengthening the construction of science and technology parks, actively promoting the construction of science and technology parks, providing comprehensive infrastructure and service support, attracting high-tech enterprises and R&D organizations to move in, and improving the efficiency of land use. Provide innovative space, build innovative office buildings and R&D centers, provide flexible land use planning to meet the needs of high-tech industries, and create an environment conducive to innovation and technology exchange.

References

- [1] Linthacum, W.W. (1975) Transportation Corridor Planning for Arizona Regional Airport. *Transportation engineering journal of ASCE*, 101(3):415-423.
- [2] Zhang Yicheng. (2018) Research on the interaction between industrial development and spatial planning in the airside area of Kunming Changshui Airport. Thesis of Kunming University of Science and Technology, 1:175.
- [3] Feng Xiaomei. (2008) Research on evaluation of urban public transportation system based on GIS. Thesis of Beijing Jiaotong University, 8:65.
- [4] Niu Xiaotong. (2020) Research on traffic impact evaluation of high-speed rail station and surrounding land use based on GIS. Thesis of Beijing Jiaotong University, 3:91.
- [5] Chen Yanguang, Liu Minghua. (2001) Entropy law of urban land use structure. *Human Geography*, 04:20-24.
- [6] Huang Xiaobing, Chen Zhongnuan. (2014) Research on the retail species structure of metro station point shopping areas based on information entropy--taking 15 metro station point shopping areas in Guangzhou as an example. *Economic Geography*, 34(03):38-44.
- [7] Liu Hui. (2022) Research on land use evaluation of areas around high-speed railway station under TOD concept. Thesis of Chongqing University, 4:103.
- [8] Chen, W., Xia, J. (2007) An optimal combination assignment method synthesizing subjective and objective weighting information. *Practice and Understanding of Mathematics*, 37(001):17-22.