Research on the Evaluation Index System of Guangxi Construction of Strong Transportation Areas

Anyu Wang

anyuwang96@qq.com

China Academy of Transportation Science, Beijing, China

Abstract: The evaluation system is an information processing system, and its essence is a process of ordering disordered information. The evaluation index system for the construction of a strong transportation country is to objectively evaluate the process of building a strong transportation country, give full play to the role of the evaluation index system as a "ruler" and "baton", and scientifically guide the construction of a strong transportation country. This paper proposes the establishment and measurement method of AHP-based index system, applies it to Guangxi as an example, and puts forward development suggestions.

Keywords: transportation, evaluation index system, Guangxi construction

1 Introduction

In order to thoroughly implement the "Outline for the Construction of a Powerful Transportation Country" and the "Outline of the Planning of the National Comprehensive Three-dimensional Transportation Network", objectively evaluate the process of building a strong transportation country, give full play to the role of the "ruler" and "baton" of the evaluation index system, and scientifically guide all regions and industries to accelerate the construction of a powerful transportation country, it is necessary to establish a scientific index system for evaluation.

The evaluation system is an information processing system, and its essence is a process of ordering disordered information. It is a quantitative description of the evaluation object, and its evaluation structure points out the direction for the structural optimization of the evaluation object. To evaluate an object, it is first necessary to clarify the purpose of evaluation, evaluation position, evaluation period and evaluation scope. At present, there are many research practices of index systems. Fu Jiafeng et al. have built a multi-level evaluation index system and corresponding evaluation methods based on low-carbon output, low-carbon consumption, low-carbon resources, low-carbon policies and low-carbon environment[1]. Xie Min et al. constructed an urban land use intensity evaluation index system, which is composed of three spatial scales: urban built-up area, urban land use type area and parcel[2]. Xi Lei et al. combined the characteristics of Shanghai's coastal sea environment, and established an evaluation index system for the livable environment of Shanghai's coastal sea from five aspects: social civilization, economic wealth, environmental beauty, public safety and living cheapness[3].

In the field of transportation, Gu Baonan et al. summarized the existing urban rail transit evaluation index system, and on the basis of analyzing and comparing various indicators,

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proposed a set of evaluation index system suitable for the optimal selection of China's urban rail transit road network planning scheme[4]. On the basis of analyzing the content of urban traffic quality evaluation, Liang Jun et al. proposed a road traffic quality evaluation index system and discussed the meaning of various indicators[5]. Starting from the service function analysis of urban rail transit line network and the theory of traffic supply and demand, Chen Xumei and others formulated a comprehensive evaluation index system of urban rail transit line network scheme[6]. With the goal of improving the efficiency and effectiveness of transportation services, Li Liancheng established an evaluation index system with the five characteristics of speed, economy, safety, sustainability and autonomy[7]. T.A. Shiau et al. propose an indicator system to measure and monitor the sustainability of transportation at the county (or city) level. The 21 indicators are categorized into economic, environmental, social and energy aspects[8]. RCW Kwok develop a sustainable transport development indicator by making use of the concepts of accessibility and geographical information systems[9]. An alternative - 'relative speed of transit to traffic' - is shown to be more related to sustainability goals and to be more reflective of community values as it assists cities to control growth in car use[10].

The current research on the index system focuses more on a specific content and less on macro development. This paper focuses on the coordination of transportation with economy, society and ecological environment, besides development and safety. An index system is established to measure the development process of transportation in the whole region, together with an evaluation index to reflect the development effect more intuitively.

2. Research methods

2.1 Selection Principles

In this paper, the index system is constructed around the five basic characteristics of "safety, convenience, efficiency, Sustainability, and economy", and the construction principles are as follows:

- Representativeness. The index system can accurately describe the blueprint and goal of building a strong transportation area in Guangxi, and can accurately reflect the stages and characteristics of Guangxi's transportation development.

- Leadership. Starting from meeting the needs of economic and social development and the needs of the people for a better life, it is in line with the key tasks of the construction of strong transportation areas, and gives full play to the role of the index system as the "baton" to accelerate the construction of strong transportation areas.

- Comparability. Longitudinal comparison can monitor the changes in Guangxi's own transportation development level in different periods, and horizontal comparison can reflect the ranking and level of Guangxi's transportation in the country.

- Availability. On the basis of the existing statistical method data, try to use desirable, accessible, simple and easy to calculate data, and make full use of new technologies, new methods and new means to obtain data.

2.2 Weight determination method

The selection of indicator weights adopts the analytic hierarchy method, and AHP is a systematic analysis method that can provide a quantifiable method for the indicator system. The quantitative calculation obtained by using AHP is completed by a series of mathematical processing of the judgment matrix, which is the result of pairwise comparison of the parent elements of the target layer and the sub-elements of the factor layer. That is, starting from the second level of the hierarchy model, the factors below a certain level are compared in pairs to determine the relative importance of the factors of the same level to a factor in the upper layer, and the rating is rated according to the degree of importance, as shown in formula 1 to 5. For example, a certain level of one factor B1, the lower layer contains C1, C2, …, Cn and other factors, in order to obtain their weight for B1, first according to their importance to B1 to make two comparisons, that is, compare the relative importance of C1, C2, …, Cn, to constitute an n-order judgment matrix, where a_{ij} represents the proportion of the importance of Ci to Cj, also known as the scale. Judgment matrix A has the following properties: $a_{ij} > 0, a_{ij} = 1/a_{ji}, a_{ii} = 1$.

$$A = (a_{ij})_{n*n} \tag{1}$$

For criterion layer B of judgment matrix A, the lower layer has C1, C2, …, Cn a total of n indicators, for the relative weights of criterion B W1, W2, …, Wn, written in vector form, that is, W = [W1, W2, …, Wn]^T to calculate the geometric mean of each row element of the judgment matrix:

$$\overline{W}_i = \sqrt[n]{\prod_{i=1}^{n} b_{ij}} \tag{2}$$

(i=1,2, …, n) n is the order of the matrix

Normalize the vector W=[W1,W2,",Wn]T:

$$W_i = \overline{W}_i / \sum_{j=1}^{n} \overline{W}_j \tag{3}$$

(j=1,2…, n)where W_i is the weight coefficient and the weight vector is w=[w1,w2,",wn]^T

The consistency test finds the maximum eigenvalue λmax of the judgment matrix:

$$\lambda_{max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(BW)_i}{W_i} \tag{4}$$

(where n is the matrix order and W_i is the weight coefficient)

The consistency index CR=CI/RI, CI is the index that measures the deviation of the judgment matrix, and RI is the average random consistency index. An example is given in Table 1.

When the CR is less than 0.1, the judgment matrix is considered to have satisfactory consistency, and in some cases it can be relaxed to 0.2. The weight of the overall goal is to synthesize the index weights under each level from top to bottom, and the consistency test is carried out on each layer.

$$S = \sum Pi * Wi \tag{5}$$

Pi is the evaluation value obtained after dimensionless processing, and this value is multiplied by the corresponding weight Wi to obtain the score of a sub-index, and Wi is the weight value of the ith sub-index; After calculating the scores of each sub-index separately, they are summed up to obtain the comprehensive index of transportation power.

Table 1 An example of AHP

Formula 1	**Formula 2**	**Formula 3**	**Formula 4**
$A = \begin{pmatrix} 1 & 2 \\ 1/2 & 1 \end{pmatrix}$	$\bar{W}_1 = \sqrt{1 \times 2}$ $\bar{W}_2 = \sqrt{1/2 \times 1}$	$W_1 = \bar{W}_1/(\bar{W}_1 + \bar{W}_2) = 0.667$ $W_2 = \bar{W}_2/(\bar{W}_1 + \bar{W}_2) = 0.333$	$\lambda_{max} = \frac{1}{2} \times (\frac{(BW)_1}{W_1} + \frac{(BW)_2}{W_2}) = \left(\frac{1.333}{0.667} + \frac{0.667}{0.333}\right) = 2.001$

3. Results and analysis

3.1 Indicator selection and weighting

After data collection and expert consultation, the indicators and their weights are determined by the above methodology, as shown in Table 2.

Table 2 Guangxi Construction of Strong Transportation Area Evaluation Index System Index Weight

Feature	**Weight**	**No.**	**Indicator**	**Weight**
Safety	0.2	1	Death rate per 10000 vehicles in road traffic accidents (person)	0.0517
		2	Multi path connectivity ratio in key areas (%)	0.0682
		3	Highway Technical Condition Index (MQI) Excellent Road Rate	0.0801
Convenience	0.2	4	Integrated three-dimensional transportation network main skeleton physical mileage (kilometers)	0.0079
		5	The proportion of people who enjoy fast transportation services within one hour (%)	0.0049
		6	High quality accessibility ratio of rural roads (%)	0.0751
		7	Urban and rural transportation service level (%)	0.0129
		8	Proportion of newly added and updated public buses and trams equipped with accessible facilities (%)	0.0235
		9	Coverage rate of "123" transportation circle	0.0757
Efficience	0.2	10	Utilization rate of main framework capacity of comprehensive three-dimensional transportation network (%)	0.0298
		11	Average speed of urban road network operation during peak hours (km/h)	0.0280
		12	Transfer time for new comprehensive passenger transport hub (minutes)	0.0049

Feature	Weight	No.	Indicator	Weight
		13	Proportion of one-way or two-way mutual recognition between hub city rail transit and railway security inspection that meet the conditions (%)	0.0211
		14	1 hour completion rate of multimodal transportation reloading (%)	0.0205
		15	Railway arrival rate of major coastal ports (%)	0.0179
		16	Annual average growth rate of container rail water intermodal transportation volume (%)	0.0270
		17	Digital coverage rate of key tunnels, bridges, and Xijiang (Guangxi) trunk waterway (%)	0.0256
		18	Key operational vehicle networking and control system vehicle access rate (%)	0.0011
		19	ETC usage rate of highway buses (%)	0.0187
		20	The usage rate of electronic waybills in the transportation of dangerous goods (%)	0.0053
Sustainability	0.2	21	Reduction rate of carbon dioxide (CO_2) emissions per unit transportation turnover of operating vehicles and ships compared to 2020 (%)	0.0435
		22	Sustainable travel proportion in large and medium-sized cities (%)	0.0057
		23	New and updated urban logistics distribution vehicles, urban buses, cruise taxis, and the proportion of new and clean energy vehicles in the Gulf of Tonkin port truck (%)	0.0368
		24	Coverage ratio of charging infrastructure for passenger car parking spaces in Class I and Class II expressway service areas (%)	0.0345
		25	Recycling rate of road surface materials for trunk roads under renovation and expansion (%)	0.0281
		26	The proportion of increased comprehensive utilization rate of land space through multiple modes of transportation infrastructure added to major channels (%)	0.0513
Economy	0.2	27	Purchasing power of transportation and travel services	0.0869
		28	Ratio of total social logistics costs to GDP (%)	0.1131

3.2 index and analysis

It can be seen that the construction of Guangxi Transportation Strong Zone is vigorously advancing, and the current value has reached 66.93 in Table 3. In order to achieve the values of 80.39 points in 2025 and 95 points in 2035, the construction process still needs to be further accelerated.

Safety is an area of strength in Guangxi, as seen in Figure 1, which is close to the value of 2035, and Guangxi needs to maintain the safety of transportation. Convenience has been a key area of Guangxi's development in recent years, and it will be significantly improved in terms of improving accessibility and external connectivity in the past three years. The field of efficiency has been slightly below average, but is steadily developing. Sustainability is the short board of Guangxi, mainly because the development of new energy transportation tools is in its infancy, but with the vigorous development of new energy vehicles, the shortcomings in the sustainability field will be gradually filled. The development of the economic field has maintained a constant speed, which is relatively macroscopic, and needs the economic and social development of Guangxi as a support, while promoting the development of transportation.

Table 3 Measurement of the evaluation index system of Guangxi construction of strong transportation areas

No.	Feature	Year 2021	Year 2025
1	Safety	15.76	16.97
2	Convenience	12.78	16.75
3	Efficience	12.08	15.84
4	Sustainability	11.23	14.24
5	Economy	15.08	16.58

Under the convenience characteristics, the proportion of barrier-free facilities is low, the development needs to be accelerated, and the level of infrastructure coverage and connection is high, but the external connectivity still needs to be strengthened, reflecting the overall performance of fast and smooth indicators, which is still in the stage of stable development.Under the characteristics of high efficiency, the level of passenger intermodal transportation is obviously short, and it is in the early stage of development, especially in terms of mutual recognition of security checks. In contrast, the level of comprehensive transportation intelligence has developed well and is the leading dimension under the characteristics of high efficiency.Under the sustainable characteristics, the carbon dioxide emission level is obviously short, and there is a big gap from the 2035 target value. On the other hand, the coordinated development level of Sustainable equipment, transportation and environment is relatively high, which contributes greatly to the dimensions of ecological environmental protection and intensive conservation.Under the economic characteristics, the three selected indicators are relatively stable and in a healthy stage of development, which needs to be maintained.

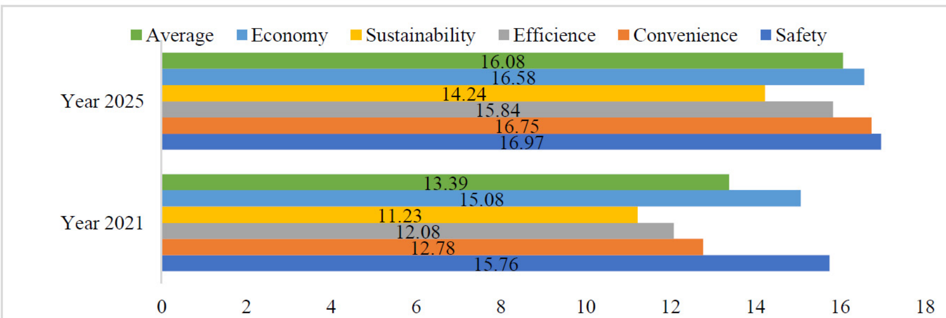

Figure 1 Comparison of indicators and characteristics of the evaluation index system of Guangxi construction of strong transportation areas

4 Conclusion

The results show that Guangxi has made great progress in promoting the construction and development of a transportation power, but the overall level is still lagging, and the follow-up task is still arduous. According to the results of the indicator system, the following suggestions are made:

1. For areas such as safety advantages, it is necessary to maintain comparative advantages and play a leading role. In the future, Guangxi needs to continue to improve the comprehensive traffic emergency management system, further improve the intrinsic safety level of transportation infrastructure, strive to maintain a relative leading position in the field of safety, and play a leading role in the index system.

2. For high-efficiency potential areas, it is necessary to take the focus of the transportation industry to narrow the gap with the leading provinces. In the future, Guangxi needs to take the high-efficiency field as the focus of the work promotion of the transportation industry, promote the vigorous development of passenger intermodal transportation and intelligent development of transportation equipment, and strive to develop the high-efficiency field into Guangxi's advantageous field, narrowing the gap with the leading provinces.

3. In the field of sustainability shortcomings, it is necessary to formulate targeted policies, make long-term efforts and make up for shortcomings. In the future, Guangxi needs to pay more attention to ecological environmental protection and intensive utilization of resources, transform the mode of transportation development, vigorously promote energy-saving and low-carbon transportation equipment, make up for shortcomings in the long term, and realize the harmonious development of transportation and nature as soon as possible.

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