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Research on the Connotation and Evaluation System of Regional Transportation Synergy Development

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Abstract: *As a basic, strategic and leading industry, transportation is not only an important content of regional coordinated development, but also a key support for realizing regional coordinated development. The article takes the connotation of transportation synergy and the characteristics of transportation synergy as the starting point, and on this basis, analyzes the evaluation index system and calculation method of the development of regional transportation coordination. Taking the five major economic regions of Sichuan Province as examples, the evaluation index system and the calculation method was verified, the advantages and disadvantages of the development of transportation synergy were analyzed, and the direction and path for the coordinated development of the five major economic zones were pointed out.*

Keywords: *Transportation synergy, evaluation system, synergy development level*

1. Introduction

Tsportation synergy development is the key to regional coordinated development. SU F, DONG H, JIA L [8] In order to accurately measure and evaluate the traffic state, use the fuzzy C mean algorithm (FCM) and fuzzy entropy rights to construct urban road traffic Status evaluation index system. MA J, SUN W, HAN B [9] mainly uses hierarchical analysis and multi-horizontal fuzzy comprehensive evaluation model to evaluate the safety of road traffic. Currently the connotation of transportationc synergy is not accurately defined for, and there are also less scholars to discuss the evaluation indicators and methods of transportation synergy.

2. The Concept of Transportation Synergy

Synergy is the concept of geographic economy and an important part of regional coordination strategy. Based on the research of domestic and foreign scholars, the concept of transportation synergy is refined and summarized as follows: Synergy can be divided into two levels: broad sense and narrow sense. Narrow synergy is the concept of synergetics, which refers to various systems composed of a large number of subsystems under certain conditions, through the synergy between the subsystems, in a macroscopic order, forming a self-organizing structure with certain functions mechanism. Generalized synergy is embodied in two aspects, namely dislocation and linkage. As far as transportation synergy is concerned, it mainly solves the traffic problems between "districts" and focuses on cross-district transportation corridors and transportation hub hierarchical systems in order to promote the free and high-efficient flow of production factors across regions.

3. Transportation Synergy Evaluation Index System

Synergy mainly studies the problems of coordinated development between the five major economic zones and between regions and outside the province and mainly cares about the "district-to-district" transportation problem, to coordinate the allocation of regional resources and the construction of cross-regional transportation facilities, to narrow the gap in transportation development between regions, and to promote the free flow of production factors across regions. Focusing on transportation corridors, major hubs, and transportation efficiency, Synergy mainly cares about three indicators:corridor comprehensive transportation capacity index, hub connectivity index, and long-distance transportation

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efficiency index.

3.1. Corridor Comprehensive Transportation Capacity Index

The corridor comprehensive transportation capacity index is used to measure the channel capacity level of large-volume and rapid transportation methods such as railways and highways between regions. Focusing on the calculation of the railway transportation capacity density and the highway transportation capacity density, the corridor comprehensive transportation capacity index is obtained through normalization.

$$MZL=\frac{(\rho_R+\rho_O)-min_{i=1}^{n}(\rho_R+\rho_O)}{max_{i=1}^{n}(\rho_R+\rho_O)-min_{i=1}^{n}(\rho_R+\rho_O)} \tag{1}$$

MZL represents Corridor comprehensive Transportation capacity index, ρ_R represents Railway transportation capacity density, ρ_O represents Road transportation capacity density, i represents Economic zone, n represents Economic zone numbers.

(1) Railway transportation capacity density

This indicator represents the linear density of passenger and freight volumes completed within a certain period of time through direct link railways between adjacent economic zones.

$$\rho_R=(E1+ E2)/L \tag{2}$$

E1 represents Regional railway freight volume, E2 represents Regional railway passenger volume, L represents Regional adjacent boundary length.

(2) Highway transportation capacity density

This indicator represents the linear density of passenger and freight volumes completed within a certain period of time through direct link highway s between adjacent economic zones.

$$\rho_O=(E3)/L \tag{3}$$

E3 represents Regional highway transfers passenger volume, L represents Regional adjacent boundary length.

3.2. Hub Connectivity Index

The hub connectivity index is used to analyze the connection strength of major economic zone transportation hubs that are connecting airports and railways of target areas and cities, and it reflects the comprehensive external connection capabilities of major economic zone transportation hubs. The regional pair with relatively high hub connectivity are found on the basis of mainly considering the followings:the number of cities with civil aviation service and the number of civil aviation flights which are between the Chengdu Plain Economic Zone and the four major economic regions of Southern Sichuan, Northeast Sichuan, Panxi, Northwest Sichuan, the number of prefectural administrative centers with railways, and the frequency of railways passing prefectural administrative centers with railways. The calculation formula is shown below.

$$K=KA\times \omega A+KR\times \omega R \tag{4}$$

K represents Hub connectivity Index;

KA represents Civil aviation connectivity index;

ωA represents Weight civil aviation connectivity index;

KO represents Railway connectivity index;

ωO represents Weight railway connectivity index.

(1) Civil Aviation Connectivity Index

The main parameters of the civil aviation connectivity index are the number of cities with civil aviation operations between the main transportation hubs of the economic zone and the number of civil aviation flights. The calculation formula is shown below.

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$$K=\frac{N_A-min_{i=1}^{n}N_A}{max_{i=1}^{n}N_A-min_{i=1}^{n}N_A}\times\omega_{AN}+\frac{Q_A-min_{i=1}^{n}Q_A}{max_{i=1}^{n}Q_A-min_{i=1}^{n}Q_A}\times\omega_{AF} \tag{5}$$

N_A represents The sum of the city number of direct flights from the main transportation hub between South Sichuan, Northeast Sichuan, Panxi, Northwest Sichuan and Chengdu Plain Economic Zone;

ω_{AN} represents Weight of the number of direct flight between city;

Q_A represents The sum of direct flights frequency from the main transportation hub between South Sichuan, Northeast Sichuan, Panxi, Northwest Sichuan and Chengdu Plain Economic Zone;

ω_{AF} represents Weight of the frequency of direct flight between city;

n represents the total number of economic zone.

(2) Railway Connectivity index

The main parameters of the railway connectivity index are the number of prefecture-level administrative centers with railways between the main transportation hubs of the economic zone and the frequency of railway passing by prefecture-level administrative centers. The calculation formula is shown below.

$$KT=\frac{N_R-min_{i=1}^{n}N_R}{max_{i=1}^{n}N_R-min_{i=1}^{n}N_R}\times\omega_{RN}+\frac{Q_R-min_{i=1}^{n}Q_R}{max_{i=1}^{n}Q_R-min_{i=1}^{n}Q_R}\times\omega_{RF}2 \tag{6}$$

N_R represents The sum of the city number of railway connection from the main transportation hub between South Sichuan, Northeast Sichuan, Panxi, Northwest Sichuan and Chengdu Plain Economic Zone;

ω_{RN} represents Weight of the number of railway connection between city;

Q_R represents The sum of railway frequency from the main transportation hub between South Sichuan, Northeast Sichuan, Panxi, Northwest Sichuan and Chengdu Plain Economic Zone;

ω_{RF} represents Weight of the frequency of railwayt between city;

n represents the total number of economic zone.

3.3. Long-distance Traffic Efficiency Index ("124 Traffic Circle")

The long-distance traffic efficiency index ("124 Traffic Circle") refers to the population covered by the long-distance traffic circle of 1 hour by air, 2 hours by high-speed railway, and 4 hours by highway . It reflects the efficiency of transportation between regions. The calculation formula is as follows.

$$W=W_A\times\omega_A+W_R\times\omega_R+W_H\times\omega_H \tag{7}$$

W_A represents Aviation 1 hour population coverage, ω_A is its weight;

W_R represents Highspeed railway 2 hour population coverage, ω_R its weight;

W_H represents Highway 4 hour population coverage, ω_H its weight;

4. Measurement of the Current Level of Transportation Synergy

Relying on the existing traffic construction situation, through the calculation of the corridor comprehensive transportation capacity index, the hub connectivity index and the long-distance transportation efficiency index of the Southern Sichuan, the northeastern Sichuan, the Panxi, the northwest Sichuan and the Chengdu Plain Economic Zone (selecting Chengdu as the destination), the coordinated development of transportation between each region and the Chengdu Plain Economic Zone will be comprehensively evaluated.

4.1. Calculation of Corridor Comprehensive Transportation Index

(1) Railway Transportation Capacity Density

5, 7, 1, 0 railway passages have been built between South Sichuan, Northeast Sichuan, Panxi, Northwest Sichuan and Chengdu Plain Economic Zone. Based on the national railway operation map, the railway transportation capacity density are 1498.3 persons/day/km, 5639.6 persons/day/km, 1754.4 persons/day/km, and 0 persons/day/km, respectively.

The calculation of railway transportation capacity density above takes 473 kilometers as the length of the boundary between northwest Sichuan and Chengdu Plain.

(2) Comprehensive Capacity Density of Highway s

5, 6, 1, and 2 highway s have been built between South Sichuan, Northeast Sichuan, Panxi, Northwest Sichuan and Chengdu Plain Economic Zone. Based on the three-level service level, the highway capacity density is 4,236.1 persons/day/km, 3855.6 people/day/km, 1200 people/day/km, 761.1 people/day/km, respectively.

(3) Corridor Comprehensive Transportation Capacity Density and Index Calculation Conclusion

After normalization processing of the railway transportation capacity density and highway transportation capacity density between Southern Sichuan, Northeastern Sichuan, Panxi, Northwest Sichuan and Chengdu Plain Economic Zone, the corridor comprehensive transportation capacity density is 0.37, 0.62, 0.19, and 0.05.

4.2. Calculation of Hub Connectivity Index

(1) Civil Aviation Connectivity

According to the number of cities with civil aviation service between Southern Sichuan, Northeastern Sichuan, Panxi, Northwest Sichuan and Chengdu Plain Economic Zone and the number of civil aviation flights thereof, the aviation connectivity indexes are 0, 0.47, 1, 0.99.

(2) Railway Connectivity

According to the number of cities opening high-speed railway between Southern Sichuan, Northeastern Sichuan, Panxi, Northwest Sichuan and Chengdu Plain Economic Zone and the frequency high-speed railway runs, the railway connectivity index is calculated to be 0.24, 1, 0, and 0, respectively.

(3) Conclusions of Hub Connectivity Index

According to the civil aviation connectivity index and railway connectivity index between Southern Sichuan, Northeast Sichuan, Panxi, Northwest Sichuan and Chengdu Plain Economic Zone, Hub Connectivity Index between South Sichuan, Northeast Sichuan, Panxi, Northwest Sichuan and Chengdu Plain Economic Zone are calculated to be 0.43,1,0.57,0.62, respectively.

4.3. Calculation of Long-distance Transportation Efficiency Index ("124 Traffic Circle")

(1) Population Coverage Rate by 1-hour Aviation

According to the number of people covered by direct flights between Southern Sichuan, Northeastern Sichuan, Panxi, Northwest Sichuan and Chengdu Plain Economic Zone, the population coverage by 1-hour aviation is calculated to be 0, 0.07, 0.17, and 0.14, respectively.

(2) Population Coverage Rate of 2-hours High-speed Railways

According to the number of people covered by 2-hours high-speed railways between Southern Sichuan, Northeast Sichuan, Panxi, Northwest Sichuan and Chengdu Plain Economic Zone, the population coverage rate of 2-hours high-speed railways are calculated to be 0.31, 0.37, 0, and 0, respectively.

(3) Population Coverage Rate of 4-hours Highway s

According to the number of people covered by 4-hours highway s between Southern Sichuan, Northeast Sichuan, Panxi, Northwest Sichuan and Chengdu Plain Economic Zone, the population coverage rate of 4-hours highway s are calculated to be 0.98, 0.71, 0, and 0.23, respectively.

According to the formulas and the population coverage by 1-hour aviation , the population coverage rate of 2-hours high-speed railways, the population coverage rate of 4-hours highway s between Southern Sichuan, Northeast Sichuan, Panxi, Northwest Sichuan and Chengdu Plain

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Economic Zone, the long-distance transportation efficiency indexes are calculated to be 0.78, 0.72, 0.1, 0.21, respectively.

According to the corridor comprehensive transportation capacity index, the hub connectivity index and the long-distance transportation efficiency index between Southern Sichuan, Northeast Sichuan, Panxi, Northwest Sichuan and Chengdu Plain Economic Zone, the synergy index is 0.54, 0.7, 0.19, and 0.16, respectively.

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5. Analysis of Calculation Results

5.1. Advantages of Transportation Synergy Development

The structure of the comprehensive transportation corridor in Northeast Sichuan to Chengdu Plain is balanced. Six highway s, three high-speed railways, and three railways have been built between the Northeast Sichuan and Chengdu Plain Economic Zone. Among them, regular direct flights have been opened between Dazhou, Bazhong and Chengdu. The development of various transportation channels is relatively balanced. The development of high-speed railway corridors is significantly better than other regions.

The Panxi and Northwest Sichuan to Chengdu Plain air corridors are relatively complete. The number of navigable flights and the number of navigable cities between Northwest Sichuan, Panxi and Chengdu Plain are relatively large. The external connectivity of aviation corridors and aviation hubs and the level of population coverage by one-hour aviation are significantly better than those of Northeast Sichuan and Southern Sichuan.

5.2. Bottleneck of Transportation Synergy Development

The railway passage between each area and the Chengdu Plain is insufficient. There are two high-speed railway passages between Southern Sichuan and Chengdu Plain; the passenger and cargo transportation capacity between Panxi and Chengdu Plain is limited; and there is no railway coverage between Northwest Sichuan and Chengdu Plain. Restricted by the railway corridor, the "124 long-distance transportation" between Panxi, Northwest Sichuan and Chengdu Plain has a low level of efficiency, making it inconvenient for long-distance passenger and cargo travel.

The highway network in Panxi and Northwest Sichuan is imperfect. The highway passages between Panxi, Northwest Sichuan and Chengdu Plain are severely lacking and are easily restricted by weather, natural disasters and other factors, and their traffic capacity is limited. The coverage rates by four-hours highway s are 0.2 and 0, respectively, and the efficiency level of long-distance traffic by four-hours highway s is low.

6. Conclusions

Based on synergy theory, the basic concepts of regional synergy development are proposed, and the basic connotation of traffic synergy is proposed.

According to the concept of traffic synergy, the three-layer evaluation index system of regional transportation synergy is proposed, and the calculation method of each indicator is given.

Taking the five major economic districts of Sichuan Province, the synergy level of South Sichuan, Northeast Sichuan, Panxi, Northwest Sichuan and Chengdu Plain Economic Zone arecalculated, the feasibility and rationality of evaluation index system and method verified.

According to the calculation results, the advantages and bottleneck in the synergy development of South Sichuan, Northeast Sichuan, Panxi, Northwest Sichuan and Chengdu Plain Economic Zone are proposed, and the transportation synergy development direction is clearly given.

Acknowledgments

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