

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

Yunhao Yao*, Xianke Han and Xinyang Li

Institute of Transportation Development Strategy & Planning of Sichuan Province
Chengdu, China

*Corresponding Author Email: yao_yunhao@sctsp.net

Abstract. As a basic, strategic and leading industry, transportation is not only an important content of regional integration development, but also a key support for realizing regional integration development. On the basis of clarifying the connotation of integration and the characteristics of transportation integration, analyzing the evaluation index system and calculation method for the development of regional transportation integration, and taking the Chengdu Plain Economic Zone and Southern Sichuan Economic Zone in Sichuan Province as examples to verify the evaluation index system and calculation method. The advantages and disadvantages of transportation integration development are analyzed, and the direction and path for the next integrated transportation development are pointed out.

Keywords: Transportation integration; Evaluation method; Evaluation system.

1. Introduction

Regional transportation integration is the prerequisite and foundation for realizing regional economic integration. The implementation of transportation integration is an inevitable requirement of social and economic development for the transportation industry. In the purpose of fully grasping the development status of regional transportation integration, accurately judging the restrictive factors of the transportation integration development, and scientifically formulating methods and strategies for the transportation integration development, it is of great significance to clarify the basic connotation of transportation integration and to establish a set of applicable and feasible transportation integration evaluation index systems and evaluation methods.

Oliver, who conducted a research on the development of German transportation integration policies, points out that the European Union regards transportation integration policy as the core tool to realize the development of transportation integration [1]. Besides, Harry Geerlings and other scholars conducted relevant sorting and research on the integration progress of land use, transportation and environmental policies in Europe [2]. Scholars such as Hull focused on the practice of transportation operation in the British transportation integration planning as well as the plan of integrated land use construction, and they studied transportation integration planning from the perspective of the integration of transportation, environmental and social policies across Europe [3]-[5]. At present, there are no scholars who have precisely defined the connotation of transportation integration, and there are few scholars discussing the evaluation indicators and methods of transportation integration.

2. The Concept of Transportation Integration

Integration is the concept of geographic economy and the specific form of regional coordination strategies in different regions and different development stages of the same region. Based on the research of domestic and foreign scholars, we refine and summarize the concept of integration as follows:

Integration. For different cities in the region, through the reasonable allocation of resources and elements, and the formation of a reasonable division of labor in infrastructure construction and industry, the unified planning and layout, configuration control, and organization management of the

region can be achieved. As far as transportation integration is concerned, it mainly solves the traffic problems between "city and city", and focuses on the intercity traffic and the interconnection of transportation facilities in urban agglomerations to guarantee urban agglomerations of the division of labor and cooperation as well as the development of clusters.

3. Evaluation Index System of Transportation Integration

The integration mainly studies the inter-city traffic problems of urban agglomerations in different economic zones such as the Chengdu Plain and southern Sichuan, and supports the urban agglomerations for division of labor and coordination. It focuses on fast lanes, hub conversion, and convenient transportation, and pays close attention to the three indicators of corridor comprehensive transportation capacity index, hub conversion time index, and business traffic efficiency index.

3.1 Corridor Comprehensive Transportation Capacity Index

The corridor comprehensive transportation capacity index is used to measure the amount of passenger and freight transportation that can be completed within a certain period of time between different adjacent cities in the urban agglomeration through intercity railways, expressways, and fast lanes, thereby reflecting the inter-city corridor transportation capacity level in the urban agglomeration. It focuses on the calculation of the average railway transportation capacity density, the average expressway transportation capacity density, and the average ordinary national and provincial highways transportation capacity density. The corridor comprehensive transportation capacity index is obtained through normalization. The calculation formula is as follows. A subsection. The paragraph text follows on from the subsection heading but should not be in italic. When receiving the paper, we assume that the corresponding authors grant us the copyright to use the paper for the book or journal in question. Should authors use tables or figures from other Publications, they must ask the corresponding publishers to grant them the right to publish this material in their paper.

$$MTD = \frac{(\alpha_r + \alpha_o + \alpha_e)}{\max_{i=1}^n (\alpha_r + \alpha_o + \alpha_e)} \quad (1)$$

where:

α_r is the average railway transportation capacity density,

α_e is the average expressway transportation capacity density,

α_o is the average ordinary national and provincial highways transportation capacity density,

i is a certain urban agglomeration,

and

n is the total amount of urban agglomerations.

3.1.1 Average Railway Transportation Capacity Density

Average railway transportation capacity density represents the average linear density of passenger and freight volumes completed within a certain period of time between adjacent cities within the urban agglomeration through direct link railways.

$$\alpha_T = \frac{\sum_{j=1}^m E_K + \sum_{j=1}^m E_H}{(L \times m)} \quad (2)$$

where:

E_K is the railway freight volume between adjacent cities within the urban agglomeration,

E_H is the railway passenger volume between adjacent cities within the urban agglomeration,

L is the length of the boundary between adjacent cities within the urban agglomeration,

and

m is the number of adjacent cities within the urban agglomeration.

3.1.2 Average Expressway Transportation Capacity Density

Average expressway transportation capacity density represents the average linear density of passenger and freight volumes completed within a certain period of time between adjacent cities within the urban agglomeration through direct link expressways.

$$\alpha_G = \frac{\sum_{j=1}^m E_{GK}}{(L \times m)} \quad (3)$$

where:

EGK is the inter-regional expressway converted passenger volume,

L is the length of adjacent boundaries between regions,

and

m is the number of adjacent cities within the urban agglomeration.

3.1.3 Average Ordinary National and Provincial Highways Transportation Capacity Density

Average ordinary national and provincial highways transportation capacity density represent the average linear density of passenger and freight volumes completed within a certain period of time between adjacent cities within the urban agglomeration through direct link ordinary national and provincial highways.

$$\alpha_{GS} = \frac{\sum_{j=1}^m E_{GSK}}{(L \times m)} \quad (4)$$

where:

EGSK is the ordinary national and provincial highways converted passenger volume,

L is the length of adjacent boundaries between regions,

and

m is the number of adjacent cities within the urban agglomeration.

3.2 Hub Conversion Time Index

The hub conversion time index is used to measure the transit time spent by passengers or cargo in the process of transferring between large-scale transportation hubs, reflecting the overall level of transportation hubs of urban agglomeration. The hub conversion time examines the operation efficiency and transit time of the connection between different transportation hubs, and reflects the smoothness of the transportation facilities connection between different transportation hubs. It is an important indicator to measure the continuity, compactness, adaptability of passenger transportation facilities and equipment, and the smoothness of passenger gathering and dispersing.

It focuses on calculating the shortest transfer time between civil aviation airports, inland river ports, dry ports, first-class railway stations, and highway passenger stations above second-class among cities within the urban agglomeration, and obtains the hub conversion time index through normalization. The calculation formula is as follows.

$$\beta = \frac{T_Z}{\max_{i=1}^n T_Z} \quad (5)$$

where:

T_Z is the average of the shortest transfer times between civil aviation airports, inland ports, dry ports, first-class railway stations and highway passenger stations above the second-class among cities within the urban agglomeration,

i is a certain urban agglomeration,

n is the total number of urban agglomerations.

$$T_Z = T_1 + T_2 + T_3 + T_4 + T_5 + T_6 + T_7 \quad (6)$$

T_1 is the average shortest travel time from civil aviation airports to inland ports,

T_2 is the average shortest travel time from civil aviation airports to dry ports,

T_3 is the average shortest travel time from first-class railway stations to dry ports,

T_4 is the average shortest travel time from first-class railway stations and dry ports,

T_5 is the average shortest travel time from first-class railway stations to civil aviation airports,

T6 is the average shortest time from railway first-class railway stations to expressway passenger stations,

and

T7 is the average shortest time from civil aviation airports to expressway passenger stations.

3.3 Business Traffic Efficiency Index (12 Traffic Circles)

The business traffic efficiency index is used to measure the number of people covered by the business traffic circle of intercity railways in one hour and two hours on highways between cities, reflecting the efficiency of intercity transportation in urban agglomerations. It focuses on calculating the one-hour population coverage rate of intercity railways and the two-hour population coverage rate of intercity expressways and obtains the business traffic efficiency index through normalization. The calculation formula is as follows.

$$W=W_r \times \omega_r + W_e \times \omega_e \quad (7)$$

where:

W_r is the one-hour population coverage rate of high-speed railway,

and

ω_r is its weight;

W_e is the two-hour population coverage rate of the expressway,

and

ω_e is its weight.

$$W_i = \frac{T_i}{D} \quad (8)$$

where:

W_i is the one-hour population coverage rate of high-speed railways

or

the two-hour population coverage rate of expressways,

T_i is the population covered by one-hour railway,

or the population covered by two-hour expressway,

D is the total population of the urban agglomeration,

and

i is the type of transportation mode.

4. Measurement of Transportation Integration Level

Relying on the existing traffic construction situation, through the calculation of the comprehensive transportation capacity index, hub conversion time index and business traffic efficiency index of the Chengdu Plain Economic Zone and the Southern Sichuan Economic Zone, the transportation integration development of the Chengdu Plain Economic Zone and the Southern Sichuan Economic Zone are comprehensively measured respectively.

4.1 Measurement of Comprehensive Transportation Capacity Index

4.1.1 Average Railway Transportation Capacity Density

A total of 6 railway passages have been built between the cities in the Chengdu Plain Economic Zone and only 1 between the cities in the Southern Sichuan Economic Zone. According to the national railway operation map, the average railway capacity density are calculated as 2090.52 persons/(day·km) and 1312.36 persons/ (day·km), respectively.

4.1.2 Average Expressways Capacity Density

14 expressways have been built in the Chengdu Plain Economic Zone and 7 in the Southern Sichuan Economic Zone, with an average of 2.1 and 1.4 expressways between cities, respectively. According to the calculation of the three-level service level, the average expressways capacity density are 7776.54 persons/day·km and 5,622.53 persons/day·km, respectively.

4.1.3 Average Ordinary National and Provincial Highways Transportation Capacity Density

An average of 2.5 ordinary national and provincial highways are built between the Chengdu Plain Economic Zone and the Southern Sichuan Economic Zone. According to the three-level service level, the average ordinary national and provincial highways capacity density are 1117.56 persons/day·km and 321.3 persons/day·km, respectively.

4.1.4 Corridor Comprehensive Transportation Capacity Index

According to the average railways transportation capacity density, the average expressways transportation capacity density, and the average ordinary national and provincial highways transportation capacity density of the Chengdu Plain Economic Zone and the Southern Sichuan Economic Zone, the average corridor transportation capacity density are calculated to be 10984.62 persons/day·km and 5,953.07 persons/day·km, the corridor comprehensive transportation capacity index are calculated to be 0.38 and 0.24, respectively.

4.2 Measurement of Hub Conversion Time Index

According to the average shortest travel time between urban civil aviation airports, inland ports, railway stations above first-class, and highway passenger stations in Chengdu Plain Economic Zone and Southern Sichuan Economic Zone, the average shortest travel times between hubs are calculated to be 55 minutes and 40 minutes, respectively. According to the normalization processing of formula, the hub conversion time indexes in the Chengdu Plain and the Southern Sichuan Economic Zone are 0.38 and 0.54, respectively.

4.3 Calculation of Business Traffic Efficiency Index (12 Traffic Circles)

4.3.1 One-hour Population Coverage Rate of High-speed Railways

The population covered by the one-hour high-speed railways in Chengdu Plain Economic Zone and Southern Sichuan Economic Zone are 12.9545 million and 0, respectively, and the one-hour population coverage rate of high-speed railways are 0.36 and 0, respectively.

4.3.2 Two-hour Population Coverage Rate of Expressways

The population covered by the two-hour expressways between cities within the Chengdu Plain Economic Zone and the Southern Sichuan Economic Zone are 36.4337million and 15.05 million, respectively, and the two-hour population coverage rate of expressways are 0.96 and 0.97, respectively.

4.3.3 Calculation Results of Business Traffic Efficiency Index

According to the calculation results of the one-hour population coverage rate of the high-speed railways and the two-hour population coverage rate of the expressways between the cities in the Chengdu Plain Economic Zone and the Southern Sichuan Economic Zone (the weights are calculated as 0.6 and 0.4 respectively), the business traffic efficiency index of the Chengdu Plain and the South Sichuan Economic Zone are calculated to be 0.85 and 0.55 respectively.

4.4 Calculation Results of Transportation Integration Level

According to the calculation results of the corridor comprehensive transportation capacity index, the hub conversion index and the business traffic efficiency index of the Chengdu Plain Economic Zone and Southern Sichuan Economic Zone (the weights are calculated as 0.4, 0.3, and 0.3), the integration indexes of Chengdu Plain Economic Zone and Southern Sichuan Economic Zone are 0.54 and 0.41 respectively.

5. Analysis of Calculation Results

5.1 Advantages of Transportation Integration Development

(1) The high-grade highway network in the Chengdu Plain is relatively complete. On average, 2.1 highways and 2.5 ordinary national and provincial highways above the second level have been built between urban pairs in the Chengdu Plain. 96% of the population in the economic zone can connect to Chengdu by expressways within two hours.

(2) The level of connection and conversion of internal hubs in the Southern Sichuan is relatively high. The transferring time between the first-class railway stations and above, civil aviation airports, dry ports, inland ports, highway high-grade passenger stations and other hubs of the Southern Sichuan is relatively short, the hub layouts are more reasonable, and the hub connection and conversion level is relatively high.

5.2 Bottlenecks of Transportation Integration Development

(1) The distribution of high-speed railway channels is uneven. High-speed railways have been built between Chengdu-Deyang, Chengdu-Ziyang, Chengdu-Meishan, and Deyang-Mianyang. There is no high-speed railway channel between the remaining 7 city pairs. 36% of the population in the economic zone can connect Chengdu by high-speed rail within one hour. There is no one-hour high-speed railway traffic circle between the cities in Southern Sichuan.

(2) The conversion efficiency of hubs in Chengdu Plain is not high. Affected by factors such as imperfect layout and relatively long spatial distance, the transition time between civil aviation airports, railway freight stations and inland river ports in the region is relatively long. Among them, it takes 126 minutes from Chengdu North Freight Station to Leshan Port.

6. Conclusions

(1) Based on domestic and foreign scholars' research, the basic concepts of integrated development are proposed, and the basic connotation of traffic integration is proposed.

(2) According to the concept of traffic integration, the three-layer evaluation index system integrating regional traffic is proposed, and the calculation method of each indicator is given.

(3) Taking the Chengdu Plain Economic Zone and the Southern Sichuan Economic Zone as example, the transportation integration level of Chengdu Plain Economic Zone and the Southern Sichuan Economic Zone is analyzed, and the feasibility and rationality of the evaluation index system and method are verified.

(4) According to the calculation results, the advantages and bottlenecks in the Chengdu Plain Economic Zone and the Southern Sichuan Economic Zone Traffic Integration Development are proposed, and the basic direction is clearly improved in the next step.

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