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Transportation Development in Chengdu-Chongqing City Cluster Under the Strategy of Yangtze River Economic Belt

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Abstract: The current new development concept has new requirements for the city clusters' transportation development. As an important city cluster among the metropolitan areas along the Yangtze River Economic Belt, Chengdu–Chongqing City Cluster possess the strongest economic strength in the western China. This paper first analyzes the three distinctive development features of Chengdu–Chongqing City Cluster: high ranking status, entire inland type, and abundant tourism resources among other things. The paper identifies three transportation issues—badly needed improvement on the international travel connectivity, imbalance and ineffective transportation services, and severe problems in lacking of communications among administrative offices as well as the unnecessary internal competitions. Finally, the paper proposes five strategies of future transportation development for this city cluster: strengthening the large intra- and inter-modal terminals' development, improving intercity railway network, enhancing the functionality of secondary terminal functionality, promoting the joint development and sharing of infrastructure facilities and policies, and supporting the transportation development in the metropolitan areas of Chengdu and Chongqing. **DOI:** 10.13813/j.cn11-5141/u.2019.0503-en

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The Yangtze River Economic Belt contains a world-class city cluster in the Yangtze River Delta and several developing city clusters, namely Middle Yangtze River City Cluster, Chengdu–Chongqing City Cluster, Central Yunnan City Cluster, and Central Guizhou City Cluster. They constitute the core competency of the Yangtze River Economic Belt, which are important hubs and gateways for internal and external connections. Although these city clusters only account for 45.31% of the land in the Yangtze River Economic Belt, they carried 70.98% of the population, 82.85% of the GDP, 77.75% of the fixed asset investment, and 93.04% of the total utilized overseas investment in 2014. However, the development level of the city clusters in the Yangtze River Economic Belt still needs to be improved. Their international competitiveness needs to be strengthened, and their regional coordination capacity needs to be enhanced. In the symposium on the development of the Yangtze River Economic Belt held on April 26, 2018, President of the People's Republic of China, Xi Jinping,

imposed requirements for the three major city clusters on the Yangtze River. He asked whether these city clusters could set new goals and take new measures for differentiated and coordinated development based on their location conditions, resource endowments, and economic foundation in their own development processes, in the context of the overall goal for a high-quality development of the Yangtze River Economic Belt. He also asked whether the cities of all sizes in a city cluster could determine their development orientations and directions based on the development orientation and direction of the city cluster, and whether they could stagger their key development directions to solve the problem of homogeneous development. In this context, based on the special transportation study in the *Land and Space Planning of the Yangtze River Economic Belt* sponsored by the Ministry of Natural Resources, this paper takes the Chengdu–Chongqing City Cluster^[1] in the Yangtze River Economic Belt as an example to discuss the transportation development of city clusters in the new era.

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1 Development characteristics of Chengdu–Chongqing City Cluster

1.1 Chengdu and Chongqing with extremely high urban primacy in Chengdu–Chongqing City Cluster

There are two megacities in Chengdu–Chongqing City Cluster, namely the main city of Chongqing and the main city of Chengdu. The number of large cities with a population of more than 1 million is small, while the number of medium-sized cities with a population of 500,000–1,000,000 is large. According to the *Report on the Urban Primacy of Capital Cities in China* issued at the end of 2018, the top three cities that have the highest overall score are Chengdu, Hangzhou, and Wuhan, if the four centrally administered municipalities, i.e., Beijing, Shanghai, Tianjin, and Chongqing, are not considered. The higher urban primacy of a capital city can lead to the more concentrated resources in transportation, medical care, and education.

Although Chengdu has high urban primacy, its service for and attractiveness to the city cluster is far behind that of Shanghai [2]. For example, for Kunshan in Yangtze River Delta City Cluster, Shanghai is the first choice for investment, living, services, population outflow, and industrial chain connection. However, for Meishan in Chengdu–Chongqing City Cluster, Chengdu is the first choice only for living and services, while Shanghai and Shenzhen are the first choices for investment. Moreover, the cities in the Yangtze River Delta and the Pearl River Delta are the first choices for industrial chain connection and population outflow.

1.2 As an inland city cluster, Chengdu–Chongqing City Cluster with a prominent characteristic of restricted external connections and strong internal connections

Restricted by the region and terrain, the construction of high-speed railways in Southwest China is backward. For a long time, the connection between Chengdu and the whole country mainly relies on the east–west corridor. However, the design speed of the current Shanghai–Wuhan–Chengdu express passenger corridor varies, and it is only 120–160 km·h⁻¹ on the segment between Hubei Province and Chongqing City. The design speeds of the high-speed railwayways that are recently completed or under construction are high, but the number of high-speed railwayways with a design speed of more than 300 km·h⁻¹ is still small. For example, the Chengdu–Xi'an high-speed railwayway was open to traffic at the end of 2017 with a design speed of 250 km·h⁻¹; the Chongqing–Guiyang railway was open to traffic at the beginning of 2018 with a design speed of 200 km·h⁻¹; the Chengdu–Guiyang high-speed railwayway is under construction with a design speed of 250 km·h⁻¹. Inside

Chengdu–Chongqing City Cluster, the operation speeds of intercity railways (some are using national railway trunk lines) are low, especially in the northeast of the city cluster where the operation speed of intercity railways is about 120–160 km·h⁻¹.

Chengdu–Chongqing area is relatively closed in transportation connection, with a high proportion of internal trips [3]. The proportion of internal freight trips of all transportation modes is as high as 83%, ranking second in China, only after Xinjiang. In terms of passenger transportation, the southwest region has the highest proportion of internal trips, as high as 44%. The integration of Sichuan Province and Chongqing City is the main factor driving the increase in the proportion of internal connections.

1.3 Chengdu–Chongqing City Cluster with rich tourism resources, including plains, rivers, and mountains

Plains, rivers, and mountains coexist in Chengdu–Chongqing City Cluster, with sensitive ecology, rich tourism resources, and high requirements for ecological environment protection. In 2017, Sichuan Province received 670 million tourists, ranking the fourth nationwide. At present, Chengdu is the main organization center of tourism in Sichuan Province, while only few main scenic spots are close to high-speed railway hubs. According to the big data of tourism in Sichuan Province in 2017, 2.14% of China's tourists arrived in Sichuan Province by high-speed railways, 2.27% by aviation, 15.04% by general rails, and 80.55% by other transportation modes (self-driving, long-distance passenger bus, etc.).

2 Transportation development

2.1 Chengdu and Chongqing's functions as international hubs to be improved

With an average annual growth of more than 10 international routes, Chengdu Shuangliu International Airport has become the fourth largest international airport in China. Behind the rapid growth are high subsidies from local governments. Chengdu and Chongqing are two important aviation hubs in Southwest China, but their international passenger throughputs only accounted for 11.34% and 7.79% of their total passenger throughputs in 2018, far lower than those of Shanghai (51.86%), Beijing (26.59%), and Guangzhou (24.81%) [4].

Since the first China–Europe train [5] was successfully launched in March 2011, Chengdu, Zhengzhou, Wuhan, Suzhou, Guangzhou and other cities have successively launched container trains to Europe. By the end of June 2018, Chongqing and Chengdu simultaneously became the first city in China that accumulated 2,000 China–Europe train trips. Although the traffic volume of China–Europe trains grows

rapidly, the operation of return trains is far from ideal. After the launch of China–Europe (Chongqing) trains, the first return train trip officially started in February 2013. By the end of 2015, only 1/3 of the 490 China–Europe return train trips were loaded with goods.

As the shipping center on the Upper Yangtze River, Chongqing's achievements have been remarkable, but its core port functions need to be strengthened. Chongqing ranks third in the container throughput among the main ports on the Yangtze River, reaching 1,417,600 TEU in 2017. The areas around each port have become new economic growth poles to attract and gather modern industry, commerce, and trade circulation industry [6]. However, some issues are prominent. For example, the ports are scattered; too much of the river bank is occupied; the land space of the core port is insufficient; the collection, distribution and transportation system is defective.

2.2 Imbalanced and ineffective transportation terminal services and urgent improvement required for secondary terminals

1) Limited scope of Chengdu and Chongqing dual-core organization

Large regional differences exist in the Chengdu metropolitan area. The districts with high economic development levels are concentrated in Chengdu and Deyang in the north and Leshan and Emei in the south. There is a large economic backward area on the east side of Chengdu [7], and Chengdu's economic driving effect on the metropolitan area is limited. The spatial agglomeration of economic development in the Chongqing metropolitan area is also obvious. The "core–periphery" structure is prominent [8]. Secondary nodes are lacking, and the boundary area with East Sichuan is an economic backward area.

Table 1 Travel time from several Sichuan's cities to Chengdu Shuangliu International Airport

City	Driving time	Time by public transportation
Yibin	3 h	Long-distance bus + high-speed rail + subway: about 4.5 h
Luzhou	3 h	Long-distance bus + high-speed rail + subway: about 4.0 h
Zigong	2 h 14 min	Long-distance bus + high-speed rail + subway: about 3.0 h
Neijiang	2 h 18 min	High-speed rail + subway: about 2.0 h

2) Functions of secondary urban terminals to be improved

The railway construction between secondary cities in the Chengdu–Chongqing area is lagging behind. The railway connection between cities in the central area of Chengdu–Chongqing City Cluster has not been established, and Luzhou even has not had passenger rails yet. At present, feeder airports have few flights. Passengers often need to transfer through Chengdu or Chongqing, and the transfer time is long. For example, although Yibin City has an airport,

the flight from and to Beijing only runs once a day; if passengers choose Chengdu Shuangliu International Airport, the driving time would be at least 3 h. Even for Neijiang City, where high-speed railway is available, it will take 2 h in total for a passenger to arrive at Chengdu Shuangliu International Airport by high-speed railways and subway. For passengers who live further away from Chengdu, the travel time is even longer by driving a car or taking a long-distance bus.

2.3 Administrative barriers and internal competitions

1) Severe homogeneous competition in ports

There are some administrative barriers between the port development in Sichuan Province and Chongqing City. When Chongqing was split from Sichuan Province and became a municipality administered directly by the central government, 80% of Sichuan's water transportation capacity and port facilities were allocated to Chongqing. For some time, Sichuan's status and image weakened among the provinces on the Yangtze River. To revitalize water transportation, Sichuan Province has developed a series of plans and set the goal to become a province with excellent port facilities in the Upper Yangtze River Basin and become the province with a strong water transportation capacity in Western China in about 10 years. Moreover, as the nearest port to Chengdu, Leshan Port will be upgraded as the port for Chengdu to make up for the lack of water transportation in Chengdu. However, there are also strong competitions among the ports on the Yangtze River and its tributary rivers inside Sichuan Province.

2) Prominent problems in planning and utilization of river bank along the Yangtze River and general excess production capacity of ports

In recent years, almost all ports on the Yangtze River have continued to enlarge infrastructure investment and build high-grade wharfs, which leads the port capacity far above the actual port throughput. In 2016, the ratios of port throughput to capacity were only 0.28, 0.53, and 0.32 [9], respectively, for the container ports in Chongqing, Sichuan, and Hubei.

3 Countermeasures for transportation development

3.1 Overall thoughts

Under the background that the national and regional transportation network planning is complete, the transportation development in city clusters needs to change the research philosophy of focusing on facility planning, expansion in scale, and efficiency improvement. It needs to establish the new research philosophy of differentiated transportation development paths that match with the development stages and characteristics of the city cluster. The connotation of this transformation can be summarized into the following four aspects:

1) The layout of comprehensive transportation corridors and the spatial construction of a networked multi-center city cluster: focusing on the goal of building the Yangtze River Economic Belt with coordinated development of the East, the West, and the Middle, combining the functions of the city cluster in the world urban system, the global industrial chain, and the national transportation network, and developing an appropriate transportation support system.

2) The development mode of intercity transportation under the differences in spatial layout and development stage in a city cluster: promoting the development of intercity transportation to match with the population density and development stage.

3) The green transportation development mode of a city cluster under the constraints of resources and environment: proposing the optimization direction of the transportation system of the city cluster, strengthening the construction of the multimodal transportation system and policy support, and giving full play to green transportation modes such as railways and water transportation.

4) Coordination mechanism and implementation strategy: optimizing resource allocation through regional and industrial coordination.

3.2 Strengthening the construction of the Chengdu and Chongqing terminal and solving the inland dilemma

Chengdu and Chongqing should strengthen their functions as aviation hubs. Chengdu Shuangliu International Airport and Chengdu Tianfu International Airport which is under construction will make Chengdu the third city in China that has two airports in one city after Shanghai and Beijing. It is proposed to strengthen the coordination of the two airports in route organization, promote the integration of airports, high-speed railway, urban rail transit, and other modes, and build these two airports into the international aviation gateway of Sichuan and the whole southwest region of China. For Chongqing Jiangbei International Airport, on one hand, it should develop international routes steadily; on the other hand, it should focus on strengthening its air transfer organization in Southwest China.

It is proposed to promote the construction of high-speed railway corridors with Chengdu and Chongqing as the core (see Figure 1). First, the rapid transportation connections with the economically developed regions in China should be improved as soon as possible, including the planning of Chongqing–Xi'an high-speed railwayway, Zhengzhou–Chongqing–Kunming high-speed railwayway, Chongqing–Wuhan high-speed railwayway, Chongqing–Hunan high-speed railwayway, and Chengdu–Kunming high-speed railwayway. Second, Chengdu and Chongqing should undertake the strategic function to support the hinterland of the Tibetan Plateau, including Chengdu–Golmud–Korla Railway and Chengdu–Lhasa Railway. Third, the network services for the hinterland of the southwest region of China should be strengthened.

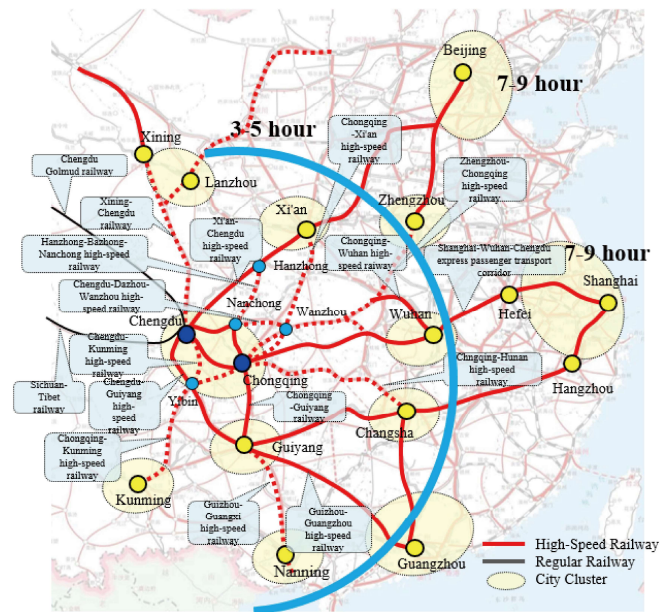


Figure 1 Railway network with Chengdu and Chongqing as hub locations

Efforts should be made to build the shipping center of the Upper Yangtze River in Chongqing, improve the port system, and establish a port organization model of shipping center–trunk port–feeder port on the Upper Yangtze River. This can give full play to the Yangtze River as the golden waterway [10].

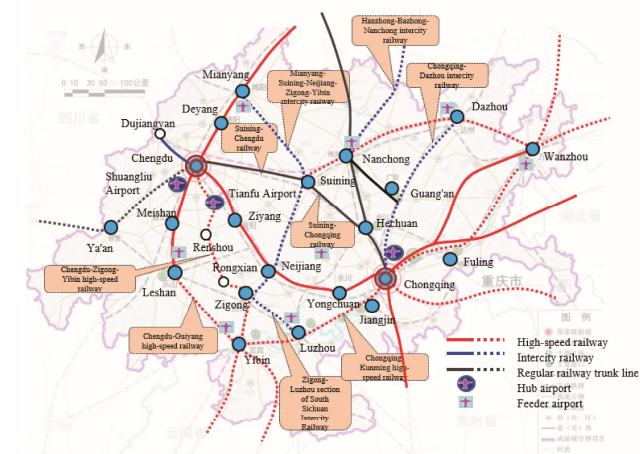


Figure 2 Intercity transportation network in city cluster supported by high-speed railway, intercity railway, and regular corridor railway

Source: Reference [1].

3.3 Establishing an intercity transportation network suitable for city cluster's population and space

3.3.1 Making full use of existing facilities to form an intercity railway network serving city cluster

Based on the national high-speed railwayway network,

several intercity railways should be built, and the regular railway trunk lines should be fully utilized to form an intercity railway network that serves the city cluster (Figure 2). The intercity railways that should be built include Mianyang–Suining–Neijiang–Zigong–Yibin Intercity Railway, Zigong–Luzhou Intercity Railway, Hanzhong–Bazhong–Nanchong Intercity Railway, and Chongqing–Dazhou Intercity Railway. It is suggested to increase the train speed on the existing regular railways, i.e., Suining–Chongqing Railway and Lanzhou–Chongqing Railway (Guangyuan–Nanchong–Chongqing), in Northeast Sichuan to improve the transportation efficiency inside the city cluster.

3.3.2 Building a composite corridor of high-speed railway, intercity rail, and regular railway between Chengdu and Chongqing

Among the railway corridors between the major cities within the three city clusters, the corridors between Shanghai and Nanjing and those between Beijing and Tianjin are composite corridors (see Table 2). There are two routes between Chengdu and Chongqing: The north route passes through Suining, and the south route passes through Neijiang. At present, the corridor between Chengdu and Chongqing is a composite corridor that consists of three railways. Chengdu–Chongqing high-speed railwayway and Chengdu–Chongqing Railway use the south route. Chengdu–Suining–Chongqing Railway uses the north route, and the operation speed of the Electric Multiple Unit (EMU) trains on this railway is basically above $180 \text{ km} \cdot \text{h}^{-1}$. In terms of G-series trains and D-series trains that are currently in operation, the number of trains between Chengdu and Chongqing is far lower than that between the major cities of other city clusters. Chengdu and Chongqing are both megacities with more than ten million residents, between which four high-speed or fast railway passages are planned, including Chengdu–Neijiang–Chongqing Railway Passage, Chengdu–Suining–Chongqing Railway Passage, Chengdu–Zigong–Luzhou–Chongqing Railway Passage, and Chengdu–Leshan–Yibin–Luzhou–Chongqing Railway Passage. These passages will further split the traffic demand (see Figure 2). Therefore, it is not necessary to add new intercity railways along Chengdu–Chongqing high-speed railwayway during the planning period.

Table 2 Railway corridors among three major cities of city cluster

Railway corridor	Railway line	Daily number of trains in operation (pair)
Chengdu–Chongqing	High-speed Railway, Chengdu–Suining–Chongqing Railway (the train speed can reach $180 \text{ km} \cdot \text{h}^{-1}$), Chengdu–Chongqing Railway (regular rail)	77
Beijing–Shijiazhuang	Beijing–Guangzhou High-speed Railway, Beijing–Guangzhou Railway (regular rail)	94
Shanghai–Hangzhou	Shanghai–Kunming High-speed Railway, Shanghai–Hangzhou Railway (regular rail)	136
Shanghai–Nanjing	Beijing–Shanghai High-speed Railway, Shanghai–Nanjing Intercity Railway, Beijing–Shanghai Railway (regular rail)	221
Beijing–Tianjin	Beijing–Tianjin Intercity Railway, Beijing–Shanghai High-speed Railway, Beijing–Shanhaiguan Railway (regular rail)	162

Source: <https://www.12306.cn/index/>.

3.4 Mitigating imbalance and inefficiency and cultivating secondary terminals

3.4.1 Improving regular rail network, national highways and provincial highways, and mitigating imbalance and inefficiency

The improvement of the regular rail network includes three aspects: 1) improving the external travel and goods transportation services for residents in areas along secondary transportation corridors and areas not covered by high-speed railwayways, such as planning the Luzhou–Zunyi railway; 2) optimizing the utilization of existing local railways and branch railways. These railways were initially built as coal transportation railways or special lines for mining and industrial development. However, with the change of industrial structure, most of these railways are now idle. On one hand, they can be transformed to serve rural tourism. On the other hand, they can be incorporated into the national railway network after appropriate renovation to improve the external connections. For example, Yibin–Gongxian Railway and Jinshawan–Junlian Railway in Yibin are being transformed to provide city tourism services, and it is planned to connect them with the existing Neijiang–Kunming Railway by building Junlian–Yanjin Railway to strengthen the external railway connection of Gaoxian County, Gongxian County, and Junlian County along the line; 3) upgrading the existing regular railways, especially Chengdu–Chongqing Railway and Neijiang–Kunming Railway. These two railways are part of the southbound railway passage connecting Chengdu and the Maritime Silk Road, but they are currently single-track railways with a running speed of only about $60\text{--}80 \text{ km} \cdot \text{h}^{-1}$.

The upgrade of the national and provincial highways should be strengthened. The focus should be the regular highways connecting urban areas and counties and regular highways connecting key scenic spots (especially the scenic spots with the level above 3A). These highways should be above Class II.

3.4.2 Improving comprehensive transportation hub function of secondary terminals

Relying solely on the two core terminals of Chengdu and Chongqing, the service for the region declines with the increase in distance, and it is difficult to provide efficient services for the whole city cluster. It is therefore necessary to cultivate secondary terminals and build a comprehensive balanced transportation service network in the city cluster through the support of secondary terminals. The potential secondary terminals include Yibin, Luzhou, Nanchong, Wanzhou, Mianyang, and Leshan.

3.5 Promoting the joint development and sharing of transportation infrastructure and policy resources

There is disorderly competition among the major ports in Sichuan Province, so it is urgent to integrate resources and

share policies. The Beibu Gulf Port integration project^[10] in Guangxi Province achieved outstanding results, which is worthy of reference. In December 2009, Fangcheng Port, Qinzhou Port, and Beihai Port of Guangxi were integrated. In January 2016, the “four unified” management model was officially launched, i.e., unified planning, construction, management, and operation. After the integration, the efficiency of handling break bulk cargo and containers in Guangxi Beibu Gulf Port increased by more than 30% compared with that before the integration. The throughput of the three ports increased from 40.4943 million tons in 2007 to 160 million tons in 2017, with an average annual growth of 14.84%. Moreover, the container throughput increased from 274,000 TEU to 2,413,000 TEU (including Guigang Port), with average annual growth of 24.30%^[11].

3.6 Building transportation systems that support development of Chengdu and Chongqing metropolitan areas

3.6.1 Transportation system supporting development pattern of “axis + belt + multiple centers” in Chengdu

According to *Chengdu City Master Plan (2016–2035)*^[12], it is necessary for Chengdu to jump out of the central urban area and develop into a metropolitan area. First, expansion around a single city center leads to the lack of urban space and results in urban issues that become prominent gradually. Second, Jianyang is now administrated by Chengdu, and the overall administrative scope of Chengdu is further enlarged. Third, the establishment of Tianfu New Area promotes the development of Chengdu from the central urban area to the south, and the construction of Tianfu International Airport further guides the city to develop across Longquan Mountain to the east. The following suggestions are made for the construction of the transportation system in the Chengdu metropolitan area:

1) Strengthening the development model of “axis + belt” in the transportation system: It is suggested to form the green wedge system, strengthen the support of intercity railway to Chengdu–Mianyang–Leshan Railway Corridor, Chengdu–Jianyang Corridor, and Chengdu–Huaizhou Corridor at the metropolitan level and consider to provide intracity rail services in the areas not covered by intercity rails.

2) Supporting the multi-center development: It is suggested to gradually change Chengdu’s single-center radial pattern through the construction of the metropolitan area to support the formation of new urban functional centers in Tianfu New Area and the airport area.

3) Integrating transportation hubs: It is suggested to strengthen the integration of Shuangliu International Airport, Tianfu International Airport, major national railway passenger transportation hubs, and urban rail transit and lay out multiple intercity railway hubs to improve the service for the main functional nodes of the metropolitan area.

3.6.2 Transportation system supporting development pattern of “pole-axis” in Chongqing

The terrain of Chongqing is composed of typical U-shaped valleys. In recent years, the city has expanded northward to the Jiangbei New Area and stridden over the Zhongliang Mountain to the valleys in the west. Along with the movement of the industry to the west, Chongqing’s westward development becomes obvious. After the opening of high-speed (fast) rails on the Chengdu–Suining–Chongqing Corridor and the Chengdu–Neijiang–Chongqing corridor, some districts, such as Hechuan and Jiangjin, have shown strong commuting connections with the central urban area^[13], which echoes the “pole-axis” trend of the Chongqing metropolitan area to a certain extent. Suggestions for the transportation development of the Chongqing metropolitan area are listed as follows: 1) Considering the mountain terrain of Chongqing, it is suggested to strengthen the main development axis, expand the urban area space to the main development axis by making the best of high-speed railways and intercity rails, and promote the “pole-axis” connection. 2) It is suggested to build a networked multi-center urban transportation structure through the measures such as industrial division of labor and district planning.

4 Conclusions

Chengdu–Chongqing City Cluster is considered to be the fourth largest city cluster in China after the Pearl River Delta, Yangtze River Delta, and Beijing–Tianjin–Hebei city clusters. It is an inland city cluster on the Upper Yangtze River, which is obviously different from other developed city clusters in local conditions, development characteristics, development requirements, and development strategies. Under the requirements of ecological civilization development, the construction of the transportation system in Chengdu–Chongqing City Cluster should focus on the following three aspects. First, the internationality should be highlighted. As the most densely populated and economically developed region in the west, Chengdu–Chongqing City Cluster must solve the inland dilemma and improve the transportation condition by improving the regional aviation and high-speed railway networks and facilities to strengthen the international and regional connections. Second, the coordinated development of the city cluster should be promoted. While the “leading position” of Chengdu and Chongqing is ensured, the intercity railway network of the city cluster should be improved to promote the flow of resources and elements and to drive the development of the whole city cluster. Moreover, basic travel service should be provided to the ethnic minority areas and rural areas not covered by the intercity railway network. Third, the intensive and economical construction of transportation facilities and the comprehensive utilization and sharing of transportation resources should be promoted.

The national high-speed and fast railway networks should be given higher priority to serve the city cluster and the metropolitan areas. It is inappropriate to construct independent intercity railway networks to serve megacities way ahead of the actual needs. Existing transportation resources should be given higher priority and full play, such as existing wharf facilities and railway facilities, to avoid the waste caused by excessively advanced construction.

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