

Research on the Coupled and Coordinated Development of Tourism and Transport in Chongqing Municipality

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Abstract: By examining the current status of tourism and transport research both domestically and internationally, and analyzing the development trends of Chongqing's tourism and transport industry, this study evaluates the weight indices and performs a coupling and coordination analysis of various indicators of Chongqing's tourism and transport industry from 2011 to 2019. The following conclusions are drawn: (1) The value of the comprehensive evaluation function for tourism is higher than that of the transport industry, indicating that Chongqing's tourism industry is in a period of vigorous development; (2) The degree of coupling coordination development between Chongqing's tourism and transportation industries from 2011 to 2019 is rising. As the coupling coordination stage continues to improve, the level of coupling coordination also improves, with the overall trend showing a progression from mild dysfunction to primary coordination. Based on these conclusions, corresponding countermeasures are proposed to promote the coupling coordination between tourism and transport in Chongqing, and suggestions are made for the overall improvement of the transport industry and the sustainable development of the tourism industry.

Keywords: Chongqing Municipality; Tourism; Transport industry; Comprehensive evaluation function value; Coupling coordination

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1. Introduction

In 2017, the National Tourism Administration issued "Several Opinions on Promoting the Integrated Development of Transportation and Tourism," which clearly stated that the tourism industry should be regarded as an important strategic and pillar industry of the national economy, and that transport is the fundamental support and prerequisite for its development. Achieving this goal is of great significance. In recent years, with the gradual improvement of the comprehensive transport system, the combination of tourism and transport has become a new trend.

China's tourism traffic research can be traced back to 1988 when Yu and others analyzed the current situation of China's tourism traffic and proposed relevant solutions^[1]. In 1989, Zhang discussed the synergistic

development of tourism and civil aviation in China after a seminar ^[2]. In the same year, Lin and Wang analyzed problems in China's tourism traffic and proposed improvement measures ^[3,4].

Tourism transport is one of the six indispensable factors of "food, accommodation, traveling, touring, shopping, and entertainment." It is the prerequisite for the occurrence and development of tourism and the lifeline of tourism development. Yang found that the tourism development level of 31 provinces and municipalities in China is closely related to geographical location and economic development level, emphasizing the important role of tourism transport in promoting tourism development ^[5]. Li, in his research on tourism in Enshi Prefecture, highlighted the impact of the opening of the "two roads" (the Yichang to Enshi section of the Shanghai–Chongqing Expressway and the Yichang to Wanzhou section of the Shanghai–Hanzhong High-Speed Railway) on the local tourism industry, demonstrating the significant impetus that improved transport infrastructure has on tourism development ^[6]. Li investigated the relationship between tourism development in southern Shaanxi Province and transport construction at both qualitative and quantitative levels, concluding that traffic construction increasingly supports tourism development ^[7]. Xu emphasized the importance of constructing a comprehensive and scientific tourism traffic system, providing important theoretical support for the sustainable development of tourism traffic ^[8].

The initial use of coupling models in social disciplines includes Zhang and Yuan's comprehensive analysis of the transport network and tourism industry coupling and coordination in Shandong Province, revealing spatial patterns and differences in development across various cities ^[9]. Gong, starting from tourist attractions in Shandong Province, combined traffic location factors with methods like the neighborhood index and the coupling coordination degree to construct a tourist attraction-transportation location neighborhood index and studied its degree of coupling and coordination with transportation ^[10]. Wang and others evaluated the coupling coordination degree of tourism economy development and urbanization in the ChangZhuTan urban agglomeration by constructing a coupling coordination evaluation index system and examining its spatial-temporal evolution characteristics ^[11].

The coordinated development of tourism and transport in Chongqing is crucial, especially in the context of the Chengdu–Chongqing Economic Circle (CCCEC). As an important node of the CCCEC, Chongqing's coordinated development of tourism and transport is particularly significant. Therefore, this paper aims to explore the level of coupling coordination between tourism and transport in Chongqing Municipality through empirical research, providing theoretical support for the further development of both industries.

2. Analysis of the development level of Chongqing's tourism and transport industry

2.1. Data sources

The data for this survey on Chongqing's tourism and transport industries were sourced from the "Chongqing Yearbook 2011-2021." Some data were also obtained from the data released by the Chongqing Municipal Commission of Culture and Tourism Development and the Chongqing Municipal Transportation Bureau.

2.2. Current development status of Chongqing's tourism and transport industries

In recent years, Chongqing's tourism and transport industries have shown a rapid development trend. With the continuous growth in the number of tourist receptions and the ongoing improvement of the transportation network, the development of tourism and transport in Chongqing has entered a new stage ^[12].

According to data released by the Chongqing Municipal Commission of Culture and Tourism Development, the number of tourist receptions in Chongqing has been steadily increasing over the past few years. The total number of domestic tourists grew from 597.23 million in 2018 to 657.08 million in 2019, while

the number of inbound tourists increased from 3.88 million to 4.11 million. This growth trend indicates that Chongqing's tourism resources are becoming increasingly attractive, and the attention and recognition from both domestic and international tourists are steadily rising. Correspondingly, Chongqing's tourism revenue also saw a substantial increase, rising from 434.4 billion yuan in 2018 to 573.9 billion yuan in 2019. This trend demonstrates that the tourism industry plays a significant role in driving economic growth in Chongqing. Additionally, the added value of tourism and related industries accounted for 3.9% of GDP in 2020 and 2021, further proving the tourism industry's importance in Chongqing's economy.

Chongqing's high-speed rail, expressways, trunk roads, aviation, and water transport systems connect tourist attractions throughout the city, providing strong support for the development of all-area tourism. This comprehensive transport network not only improves the travel efficiency of tourists but also expands the market coverage of tourism, promoting the sustainable development of the tourism industry. However, despite the continuous improvement of Chongqing's transport network, the total passenger volume in the city experienced a significant decline in 2020 due to the COVID-19 pandemic. It dropped from 636.59 million in 2019 to 397.97 million, and further to 211.49 million in 2022, a 40% decrease from 2021.

2.3. Selection of evaluation indicators

The tourism and transport industries are interdependent and inseparable. Based on the coupling analysis of these two industries, and considering the current status of Chongqing's tourism and transport industries, we constructed a comprehensive evaluation index system for both industries. This system was developed by referencing relevant scholars' index evaluation systems [13] and combining them with the actual conditions of Chongqing's tourism and transport industries, aiming to better assess the degree of coupling coordination between the two.

The tourism industry's system of indicators includes seven items: total tourism revenue (billion yuan), number of domestic tourists (million), tourism foreign exchange income (million USD), number of inbound tourists (million), number of star-rated hotels, number of travel agencies, and number of A-level scenic spots. The transport industry's system of indicators includes eight items: number of city buses in operation, mileage of highway routes (km), mileage of light rail in operation (km), railway passenger volume (million), highway passenger volume (million), waterway passenger volume (million), civil aviation passenger volume (million), and total passenger turnover (billion person-km).

3. Tourism and transport industry coupling and coordination model construction

3.1. Indicator selection

The data of each indicator has a difference in the scale, and it is necessary to carry out the standard treatment of the indicators without the scale. Assuming that the data for the j -th indicator in the year i of Chongqing Municipality is x_{ij} , set the maximum and minimum values of their indicator data to be respectively x_{max} and x_{min} . To avoid any meaningless scenario, add 0.0001 to the standardized full data. The final standardized value is obtained is $x'_{ij}(1)$, where year $i = 2011, 2012, 2013, \dots, 2019$, and serial number of the indicator $j = 1, 2, \dots, m$.

The standardized value:

$$x'_{ij} = \frac{x_{ij} - x_{min}}{x_{max} - x_{min}} + 0.0001 \quad (1)$$

Share of indicator j in the year i in that indicator:

$$p_{ij} = \frac{x'_{ij}}{\sum_{i=2011}^{2019} x'_{ij}} \quad (2)$$

Information entropy of the j -th indicator:

$$e_{ij} = -\frac{1}{\ln m} \sum_{i=2011}^{2019} (p_{ij} \times \ln p_{ij}) \quad (3)$$

Utility value of indicator j :

$$d_j = 1 - e_j \quad (4)$$

Weight of indicator j :

$$w_j = \frac{d_j}{\sum_{j=1}^m d_j} \quad (5)$$

The weights of the indicator system are calculated through the entropy method and the obtained data is as follows in **Table 1**:

Table 1. Indicator system and weights

Subsystems	Indicators	Unit	Weight	Type
Tourism system	Gross tourism income	Billions	0.068	+
	Domestic tourist arrivals	All the people	0.048	+
	Foreign exchange earnings from tourism	Billion USD	0.052	+
	Number of inbound tourists	All the people	0.044	+
	Number of star-rated hotels	Unit	0.033	+
	Number of travel agencies	Unit	0.043	+
	Number of A-class scenic spots	Unit	0.038	+
Transport system	Number of city buses in operation	Vehicle	0.041	+
	Mileage of highway routes	km	0.057	+
	Miles of light rail	km	0.034	+
	Railway passenger traffic	All the people	0.083	+
	Highway passenger traffic	All the people	0.268	+
	Waterway passenger traffic	All the people	0.113	+
	Civil aviation passenger traffic	All the people	0.044	+
	Total passenger turnover	Billion person-kilometres	0.035	+

3.2. Measurement methodology

3.2.1. Calculation of the degree of development of the tourism and transport sectors

Comprehensive evaluation function of tourism:

$$T(x) = \sum_{j=1}^m w_x x'_{ij} \quad (6)$$

Comprehensive evaluation function for the transport sector:

$$R(y) = \sum_{j=1}^m w_y y'_{ij} \quad (7)$$

In the above formula, m represents the number of indicators for tourism and transport, w_x and w_y refer to the weighting of tourism and transport indicators, and x'_{ij} and y'_{ij} indicate the value of tourism and transportation obtained after a dimensionless process.

3.2.2. Tourism and transport development modes

The development of the tourism and transport industries can be categorized into three models: synchronous development of tourism and transport, tourism lagging behind transport, and transport lagging behind tourism. The synchronous development model can further be divided into high-level and low-level synchronous development.

By calculating and comparing the development levels of the tourism and transport industries, we can determine their relationship: when $T(x) < T(y)$, the tourism industry lags behind the transport industry; when $T(x) = T(y)$, the tourism and transport industries develop synchronously; and when $T(x) > T(y)$, the transport industry lags behind the tourism industry.

Table 2. Comprehensive evaluation function values of tourism and transport in Chongqing (2011–2019)

Year	Comprehensive tourism evaluation function value $T(x)$	Comprehensive evaluation function value of the transport sector $T(y)$	Development mode
2011	0.066	0.137	Tourism lags behind transport
2012	0.123	0.117	Transport lags behind tourism
2013	0.154	0.230	Tourism lags behind transport
2014	0.195	0.157	Transport lags behind tourism
2015	0.225	0.182	Transport lags behind tourism
2016	0.253	0.214	Transport lags behind tourism
2017	0.315	0.299	Transport lags behind tourism
2018	0.345	0.344	Transport lags behind tourism
2019	0.411	0.416	Tourism lags behind transport

From **Table 2**, it can be observed that the comprehensive evaluation function for the tourism industry showed an overall upward trend from 2011 to 2019, while the transport industry saw declines in 2012 and 2014 but performed more prominently in recent years. This improvement is likely related to Chongqing's recent efforts to promote transport infrastructure construction and optimize the transport network layout. These developments have also provided strong support for the further growth of the tourism industry.

Comparing the comprehensive evaluation function values of the two industries reveals that in 2011, 2013, and 2019, the tourism industry lagged behind the transport industry. In the other years, the transport industry lagged behind the tourism industry. The average growth rate of the comprehensive function value for the tourism industry was 0.195, while for the transport industry, it was 0.091, indicating that the tourism industry developed at a significantly higher level than the transport industry. Furthermore, from 2011 to 2019, the growth rates for the tourism industry were all positive, showing an overall upward trend, whereas the transport industry experienced negative growth in 2012 and 2014, further indicating that the transport industry's development lagged behind the tourism industry.

Both the comprehensive evaluation function values and their annual growth rates indicate that the tourism industry outperformed the transport industry. This suggests that Chongqing's tourism industry was in a period of rapid development during this time, while the transport industry maintained a stable growth trajectory.

4. Analysis of the coupling coordination between Chongqing's tourism and transport industries

The coupling coordination model involves the calculation of three indices: the coupling degree C value, the coordination index T value, and the coupling coordination degree D value. By combining the D value with the

coordination level classification standards, the degree of coupling coordination for each aspect is ultimately determined.

4.1. Coupling degree model

The coupling degree refers to the extent of coupling between two subsystems and whether they exhibit synergy. However, when the comprehensive development levels of both subsystems are either very high or very low, the coupling degree might appear falsely elevated. The coupling degree C is calculated, where a higher value indicates a greater degree of system coupling, and a lower value indicates a lesser degree of coupling.

Coupling degree formula:

$$C = 2 \left\{ \frac{T(x)T(y)}{[T(x)+T(y)]^2} \right\}^{\frac{1}{2}} \quad (8)$$

The above formula indicates the coupling degree between tourism and transport, and the size of its value can intuitively reflect the coupling degree between the two systems of tourism and transport, and the value of C ranges from $[0,1]$. When its value tends to 1, it means that the degree of coupling between the two is high, and vice versa, it means that the degree of coupling between the two is low.

4.2. Coupling coordination degree model

Comprehensive coordination index:

$$P = \alpha T(x) + \beta T(y) \quad (9)$$

Degree of coupling coordination:

$$D = \sqrt{C \times P} \quad (10)$$

Here, α and β in the comprehensive coordination index refer to the contribution coefficient of the tourism and transport industry in the process of coupling coordination. The two contributions are set as the same ($\alpha = \beta = 0.5$). In the formula of the coupling degree of coordination, D stands for the degree of coupling coordination, C stands for the degree of coupling, and P stands for the comprehensive evaluation index between the two industries, namely, the tourism and transport industries. The value range of coupling coordination degree D is $[0,1]$. When the value of the coupling coordination degree D is closer to 1, the coupling coordination between the two industries is better, and vice versa is worse. Referring to Marina's ten-point method of coupling coordination degree evaluation criteria^[8], it is divided into ten levels as shown in **Table 3**.

Table 3. Coupling coordination degree evaluation criteria ten-point method

Indicators	Level classification	D
Extreme imbalance	Emergent stage	(0.0000, 0.1)
Severe imbalance		(0.1001, 0.2)
Moderate imbalance		(0.2001, 0.3)
Mild imbalance		(0.3001, 0.4)
Nearly imbalance	Initial stage	(0.4001, 0.5)
Barely coordinated		(0.5001, 0.6)
Primary coordination	Stable stage	(0.6001, 0.7)
Intermediate coordination		(0.7001, 0.8)
Good coordination	Mature stage	(0.8001, 0.9)
High-quality coordination		(0.9001, 1.0)

4.3. Analysis of coupling degree

According to the coupling degree formula and the value of the comprehensive evaluation function, the degree of coupling between the tourism and transport industry in Chongqing from 2011 to 2019 is calculated, as shown in Table 4.

Table 4. Coupling and coordination degree of Chongqing tourism and transport industry

	Year	Coupling degree C	Composite coordination index P	Coupling coordination degree D	Coordination stage
Chongqing	2011	0.937	0.102	0.309	Mild imbalance
	2012	1.000	0.120	0.346	Mild imbalance
	2013	0.980	0.192	0.434	Nearly imbalance
	2014	0.994	0.176	0.419	Nearly imbalance
	2015	0.994	0.204	0.450	Nearly imbalance
	2016	0.997	0.233	0.482	Nearly imbalance
	2017	1.000	0.307	0.554	Barely coordinated
	2018	1.000	0.345	0.587	Barely coordinated
	2019	1.000	0.413	0.643	Primary coordination

From the above table, it can be seen that the coupling degree between Chongqing's tourism and transport industries increased gradually from 2011 to 2019, with most values ranging between 0.9 and 1, indicating a strong coupling relationship. Additionally, analyzing the coupling coordination degree reveals a clear upward trend, indicating an increasing degree of coupling coordination between Chongqing's tourism and transport industries.

Considering the coupling coordination degree and coordination stage, from mild imbalance in 2011 and 2012 to near imbalance in 2013, 2014, 2015, and 2016, although the coordination stage did not change over these four years, its value slightly increased from 0.419 in 2014 to 0.482 in 2016. By 2019, the coordination reached a primary level. From mild imbalance in 2011 to primary coordination in 2019, the coupling coordination degree between Chongqing's tourism and transport industries improved slowly but steadily, as shown in Figure 1.

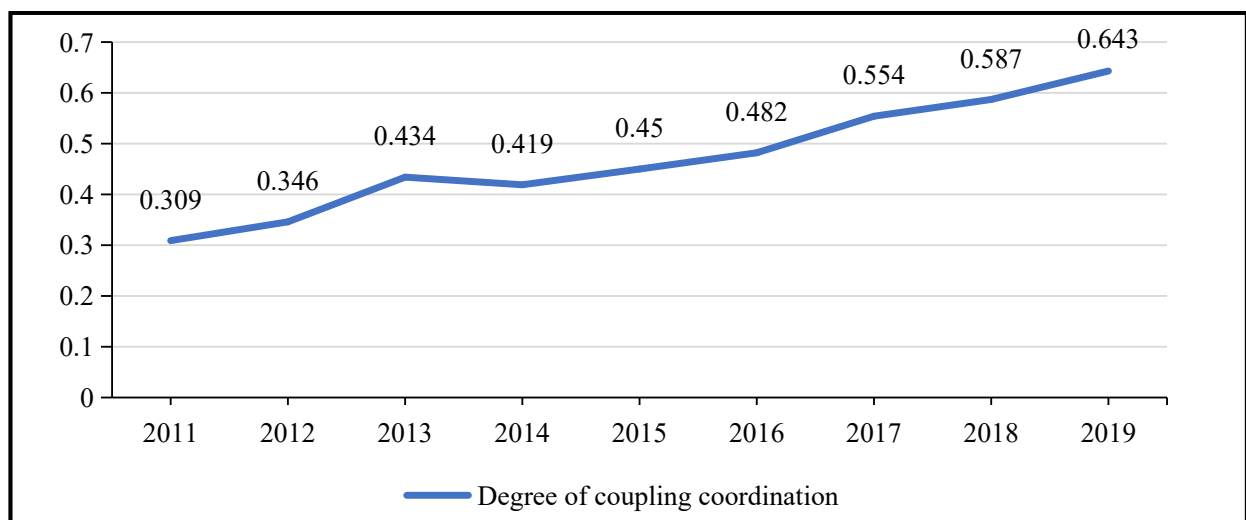


Figure 1. Degree of coupling coordination between tourism and transport industry in Chongqing (2011–2019)

Overall, the degree of coupling coordination between Chongqing's tourism and transport industries increased continuously from 2011 to 2019. As the coupling coordination stage improved, the coupling coordination level also rose, progressing from mild imbalance to primary coordination, indicating a positive overall trend.

5. Conclusion

Research on the coupling coordination degree between Chongqing's tourism and transport industries reveals an overall upward trend. The growth rate of the comprehensive evaluation function values indicates that the development of Chongqing's tourism industry has significantly outpaced that of the transport industry.

A detailed analysis of the comprehensive evaluation function values for Chongqing's tourism and transport industries over the past nine years shows significant differences in their development trajectories. Data indicates that the tourism industry has performed markedly better than the transport industry. Specifically, the comprehensive function value for the tourism industry increased from 0.066 in 2011 to 0.411 in 2019, a substantial rise of 83.9%, highlighting the impressive achievements of Chongqing's tourism industry in recent years. Meanwhile, the comprehensive function value for the transport industry also grew, from 0.137 in 2011 to 0.416 in 2019, an increase of 67.1%, although this growth was somewhat slower than that of the tourism industry.

These data reveal the developmental differences between Chongqing's tourism and transport industries. The rapid growth of the tourism industry has not only driven local economic growth but also provided richer tourism experiences for visitors. While the transport industry has also progressed, it has lagged in meeting the transportation demands brought about by the rapid development of the tourism industry. To promote coordinated development between Chongqing's tourism and transport industries, effective measures must be taken to enhance their interaction. In the transport sector, key focus areas should include reducing transportation costs, expanding transport scale, optimizing the road network structure, and improving transport accessibility. These measures can enhance the efficiency and service quality of the transport industry, further promoting the development of the tourism industry and achieving positive interaction between the two industries.

There is an inseparable relationship between the transport and tourism industries. On one hand, the development of the transport industry provides essential support and guarantees for the tourism industry, enabling tourists to reach their destinations more conveniently and enjoy their travel experiences. On the other hand, the prosperity of the tourism industry drives the evolution and upgrade of the transport network, offering a vast market and motivation for the transport industry's development.

In recent years, Chongqing's tourism industry has achieved remarkable results. The scale of the tourism industry has continuously expanded, and the number of tourists received has steadily increased, injecting new vitality into the local economy. At the same time, the construction of transport infrastructure has gradually improved, with significant advances in the length of graded roads, urban bus networks, operational mileage, the number of regularly scheduled flight destinations, and transport investments. These improvements have not only enhanced the efficiency and convenience of transportation but also provided robust support for the tourism industry's development.

However, it should be noted that although road transport still holds a relative advantage in passenger transportation structure, its share is gradually decreasing, while the shares of rail and air transport are increasing. This change reflects the diversification and personalization of passenger transport demand, posing higher requirements for the industry. It is necessary to further improve the transport network and service quality

to meet the transportation demands brought about by the rapid development of the tourism industry.

With the deepening of globalization and economic integration, the integration of the tourism and transport industries has become a crucial driver of economic growth and an improvement in people's quality of life. Especially under the "Tourism+" integration model, transport, as a key tool for tourist travel, has brought unprecedented opportunities to the tourism industry. However, achieving this deep integration requires continuous adjustments and optimizations by the government and related departments, as well as strengthened cooperation and communication between the two industries, to jointly promote coordinated development.

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