



Research on the Supply and Demand Synergy of Smart Tourism: Theoretical Framework and Evaluation System

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Abstract. Smart tourism is the strategic direction of tour informatization development in China, and the dislocation of supply and demand is the basic problem to be solved in the early days of development. The paper constructs the model and evaluation system of smart tourism supply and demand system, expounds the components and relationship between the demand and supply of smart tourism from a theoretical point of view, then selects the relevant data of Beijing, Tianjin and Hebei from 2012 to 2019 to analyze the time, space and structure evolution characteristics of the demand and supply of smart tourism. The results show that the overall synergy between the demand and supply of smart tourism in Beijing, Tianjin and Hebei is constantly improving. At present, the tourism demand is strong and the supply is relatively lagging behind. On the basis of tapping demand potential, tourism supply side reform should focus on strengthening government guidance, promoting technological innovation and improving the efficiency of smart tourism industry.

Keywords: smart tourism · tourism demand · tourism supply · synergy

1 Introduction

Smart tourism is a new form of tourism generated with modern information technology such as Internet of things and big data to systematically integrate tourism physical resources and information resources and serve the society [1–3]. The continuous acceleration of global information technology has made it necessary to transform traditional tourism into smart tourism. In 2011, China proposed smart tourism as the strategic direction of China's tourism development. At the same time, 33 national pilot cities and 22 national pilot scenic spots for smart tourism were created to gradually promote the global development of smart tourism. In the past ten years, the construction of smart tourism cities has achieved initial results. However, the construction of smart tourism system still has a long way to go due to the restriction of diversification of tourism demand and differentiation of tourism supply [4–6].

Beijing, Tianjin and Hebei, as important areas for the construction of National Smart City groups, have continuously advanced the process of tourism integration, making the

role of smart tourism in promoting the supply side reform of tourism industry and accelerating the development of digital economy increasingly prominent. At the same time, the differences in the level of economic development and informatization in Beijing, Tianjin and Hebei have hindered the coordinated development of regional smart tourism to a certain extent, so it has a strong practical significance to study the development of smart tourism in Beijing, Tianjin and Hebei from the perspective of supply and demand coordination [7, 8]. In this paper, based on the construction of the theoretical model of smart tourism system, the smart tourism evaluation system is established, and the time, space and structure collaborative development level of smart tourism in Beijing, Tianjin and Hebei from 2012 to 2019 is measured by using the coupling coordination theory, so as to analyze the current situation of the development of smart tourism in Beijing, Tianjin and Hebei and put forward optimization countermeasures. Data are collected from *China Travel Statistical Yearbook* and copies, *Beijing Statistical Yearbook*, *Tianjin Statistical Yearbook* and *Hebei Statistical Yearbook* from 2012 to 2020. Some indirect data are calculated by SPSS software, and the missing data in individual years are supplemented by interpolation method.

2 Construction of Theoretical Model

2.1 Smart Tourism System Model

The tourism system consists of 3 major system elements, i.e. tourism subject, tourism object and tourism intermediary. From the perspective of tourism economics, the economic activities of the tourism subject are reflected by the tourism demand, and the tourism products provided by the tourism object and the tourism intermediary to the tourism market form the tourism supply in a certain period of time. At the same time, the government plays an important macro-control role in the construction of smart tourism [9, 10]. Based on the above ideas, the smart tourism system model is constructed to reflect the role of the two major functional elements of demand and supply in the tourism system, of which the former is reflected by the scale and characteristics of demand of tourists, while the latter jointly promotes the supply side reform through government agencies and tourism industry. The theoretical model is shown in Fig. 1.

2.2 Coupling Synergy Model

The degree of coupling and coordination of elements in the smart tourism system is quantitatively reflected by the synergy model. Referring to the concept of capacity coupling and the capacity coupling coefficient model in physics, a coupling synergy model is built based on the measurement of tourism element coupling. The coupling model is

$$C = \{(u_1 \times u_2) / [(u_1 + u_2) \times (u_1 + u_2)]\}^{1/2} \tag{1}$$

$$u_{i=1.2} = \sum_{j=1}^n w_{ij}x_{ij}, \sum_{j=1}^m w_{ij} = 1 \tag{2}$$

where,

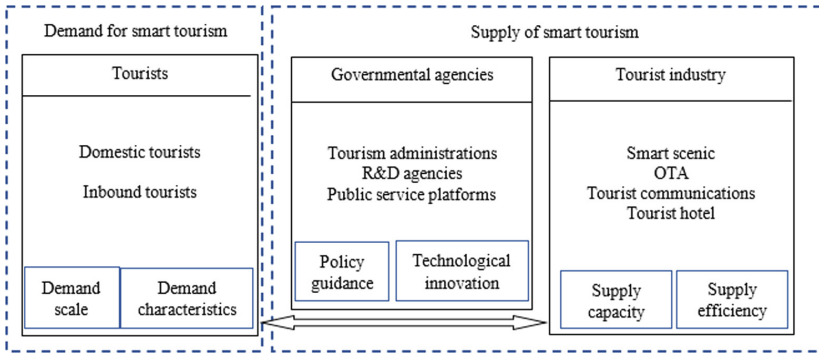


Fig. 1. Theoretical model of smart tourism system

C = the coupling of smart tourism demand and tourism supply;

u_1, u_2 = the development level index of the above smart tourism demand and supply system, respectively;

x_{ij} = the detailed index of each system;

w_{ij} = the weight corresponding to each index.

Further, the coupling synergy model of supply and demand of smart tourism is established by coupling and comprehensive evaluation index of supply and demand of smart tourism, as follows:

$$D = (C \cdot T)^{1/2} \tag{3}$$

$$T = \alpha \cdot u_1 + \beta \cdot u_2 \tag{4}$$

where,

D = the coupling synergy degree of supply and demand of smart tourism;

C = the coupling degree;

T = the comprehensive evaluation index of tourism supply and demand, which is used to reflect the overall development of the regional smart tourism supply and demand, obtained by summing the weighted demand development level index u_1 and supply development level index u_2 ;

α, β = the weight of tourism demand and supply.

Based on the research of existing scholars and the opinions of consultants and professionals, the two systems are considered equally important, given $\alpha = 0.5$ and $\beta = 0.5$.

Coupling synergy evaluation is divided into ten grades from 0–1 according to the numerical range of coordination degree, referring to the widely used grade standard at present, which reflects the balance of tourism supply and demand system in a specific period, as shown in Table 1.

Table 1. Division of system balance

SN	Range	Balance	Stage of Development
1	0–0.09	Extremely imbalanced	Primary development stage
2	0.1–0.19	Seriously imbalanced	
3	0.2–0.29	Moderately imbalanced	
4	0.3–0.39	Slightly imbalanced	Intermediate development stage
5	0.4–0.49	Almost imbalanced	
6	0.5–0.59	Barely balanced	
7	0.6–0.69	Preliminarily balanced	
8	0.7–0.79	Moderately balanced	Advanced development stage
9	0.8–0.89	Well balanced	
10	0.9–1.00	Excellently balanced	

3 Evaluation System

On the basis of the theoretical model, the evaluation system of smart tourism is determined according to the principles of comprehensiveness, representativeness and data availability of index selection, combining with literature statistics and on-the-spot research methods [10–15]. 9 indexes are selected for the demand system to reflect the scale and characteristics of demand for smart tourism, and 17 indexes are selected for the supply system to comprehensively reflect policy guidance, technological innovation, supply capacity and supply efficiency in the supply of smart tourism. The weights of evaluation indexes are calculated by using the method of entropic value weighting, i.e. dimensionless treatment and specific gravity transformation are carried out on the evaluation indexes according to the information provided by the observed values of each index, thus the index weights are finally determined by calculating the index entropic value and the degree of difference, thus improving the objective accuracy of the evaluation, see Table 2.

4 Analysis on Empirical Results

4.1 Characteristics of Spatial-Temporal Variations

Based on the above analysis, the characteristics of spatial-temporal variations of supply-demand coordination development of smart tourism in Beijing, Tianjin and Hebei from 2012 to 2019 are obtained, as shown in Fig. 2. Smart tourism in Beijing, Tianjin and Hebei has a good overall development level of supply and demand and the year by year increasing comprehensive evaluation index of tourism, which are always closely related and gradually enter the intermediate stage of development from the preliminary stage. At the beginning of smart tourism launch in Beijing, Tianjin and Hebei in 2012, the evaluation index of tourism demand development level u_1 is significantly lower than that

Table 2. Evaluation indexes and weights of smart tourism system

First-level indexes	Second-level indexes	Third-level indexes	Unit
Tourism demand	Demand scale	Total tourist visits (0.1147)	10,000 person-time
		Total tourism revenue (0.0944)	10,000 yuan
		Mobile Phone year-end users (0.1371)	10,000 people
		Number of Internet users (0.1317)	10,000 people
		Total revenue from telecommunication business (0.1078)	10,000 yuan
	Demand characteristics	Per capita cost of tourists (0.0983)	Yuan/person
		Average length of stay (0.0925)	Day
		Information consumption coefficient (0.1001)	–
		Tourists' satisfaction with smart tourism (0.1234)	–
	Tourism supply	Policy guidance	Perfection of smart tourism policies (0.0679)
Overall planning level of smart tourism (0.0521)			–
Local financial investment in science and technology (0.0492)			–
Construction level of public platform for smart tourism (0.0471)			–
Technological innovation		Investment in smart tourism (0.0613)	10,000 yuan
		Production value of high-tech industry (0.0452)	10,000 yuan
		R&D and experimental development funds (0.0549)	10,000 yuan

(continued)

Table 2. (continued)

First-level indexes	Second-level indexes	Third-level indexes	Unit
		Information industry education index (0.0512)	–
	Supply capacity	Online tourism development index (0.0682)	–
		Number of tourism portals (0.0614)	Number
		Construction level of smart scenic spots (0.0598)	–
		Intelligent level of tourist transportation (0.0684)	–
		Intelligence level of hotels (0.0682)	%
	Supply efficiency	Basic network coverage (0.0624)	%
		Profit margin of tourism enterprises (0.0592)	%
		Online travel penetration index (0.0632)	–
		Tourism big data utilization rate (0.0603)	%

of supply system development level u_2 , indicating that the level of smart tourism supply is continuously increasing at this stage, while the tourism demand has not been fully stimulated, with lagged demand performance, small value of coupling synergy, and poor balance of tourism demand and supply. However, with the continuous popularization of the Internet of Things, big data technology and the implementation of the integration strategy of Beijing, Tianjin and Hebei, smart tourism demand has been growing rapidly since 2015, but still lags behind in 2014–2016. After 2017, the index of tourism demand development level gradually exceeds the index of supply system development level, showing a trend of lagging supply. After that, the overall balance of tourism supply and demand has been continuously improved, and experienced a development process from moderate imbalance to barely balance.

At the same time, smart tourism in Beijing, Tianjin and Hebei shows different balance of supply and demand at a specific stage of development. Among them, the demand and supply index of smart tourism in Beijing is significantly higher than that in Tianjin and Hebei, where the balance of supply and demand has changed from slight imbalance to almost balance, and entered the intermediate stage of development at an early stage, showing a relatively significant supply lag since 2016. The degree of coupling required

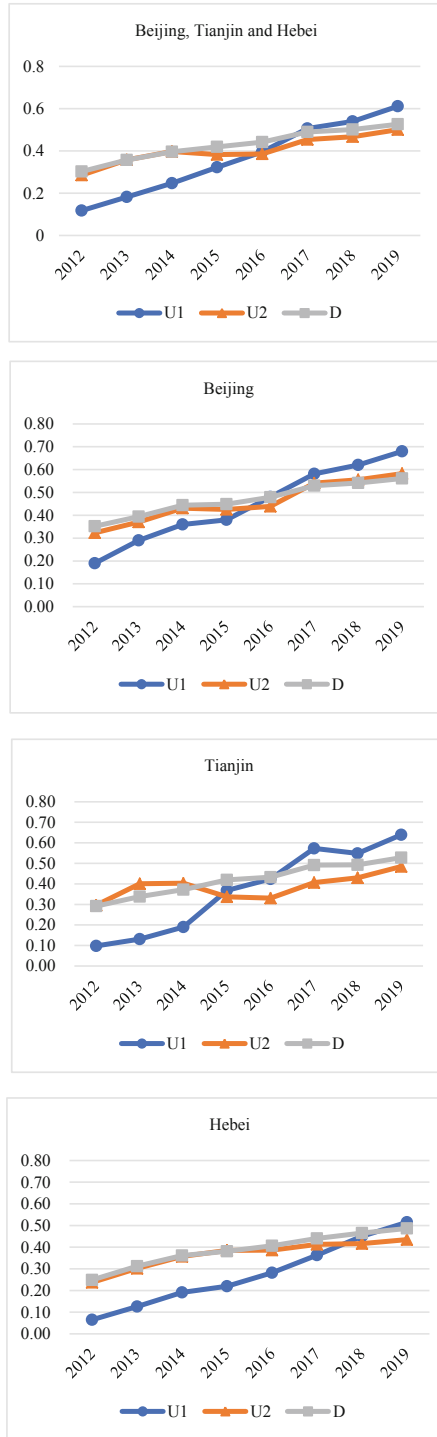


Fig. 2. Space-time variation of supply and demand of smart tourism in Beijing, Tianjin and Hebei from 2012 to 2019

for smart tourism in Tianjin is stable, reflected by the low level and gap between supply and demand development for smart tourism in 2012–2014, the unclear interactive relationship, and the obvious demand lag. Since 2015, the demand for smart tourism in Tianjin has grown rapidly, which highlights the continuous lag of tourism supply, indicating that the scale and efficiency of tourism supply need to be improved. The supply and demand of smart tourism in Hebei has undergone a transition from moderate unbalance to almost unbalance with relatively low balance of supply and demand. It has always been in a lagging state of demand in 2006–2017. From 2018, supply and demand have been in a stagnant state, which is the demarcation line between the two states, followed by a lagging of supply and demand.

4.2 Characteristics of Structural Evolution

In view of the relatively lagging supply of smart tourism in Beijing, Tianjin and Hebei at the early stage of development, the structural evaluation on the balanced development of the elements of the tourism supply and demand system is further analyzed to find the shortcomings of the tourism supply system, as shown in Fig. 3. In general, from 2012 to 2019, the coupling and coordination between the demand and supply of smart tourism in Beijing, Tianjin and Hebei continued to improve, showing a stable growth trend, while the balance between each supply subsystem and tourism demand is different. Comparing the average values of D_i , $D_4 < D_1 < D_2 < D_3$ can be obtained, indicating that the balance between supply efficiency and demand of smart tourism in Beijing, Tianjin and Hebei is relatively low at the current stage. The development level index of the system shows that the supply efficiency index of smart tourism has been significantly lower than the tourism demand development index since 2017, as shown in Fig. 3d. Relatively, the balance between supply capacity and demand of smart tourism is relatively high, and the coupling synergy D_3 increases from 0.2664 in 2012 to 0.5339 in 2019, indicating that the smart tourism industry products are operating well, see Fig. 3c. The development of smart tourism in Beijing, Tianjin and Hebei is strongly policy-oriented. Figure 3a shows that the policy guidance index has been higher than the demand index from 2012 to 2016, and the policy has lagged since 2017, indicating that the top-level design of the smart tourism needs to be improved in order to meet the fast-growing market demand. Figure 3b shows that technological innovation is the guarantee system for the development of smart tourism. Driven by the demand for smart tourism, the technological innovation of smart tourism in Beijing, Tianjin and Hebei is progressing in fluctuations, and the balance between the two is increasing year by year.

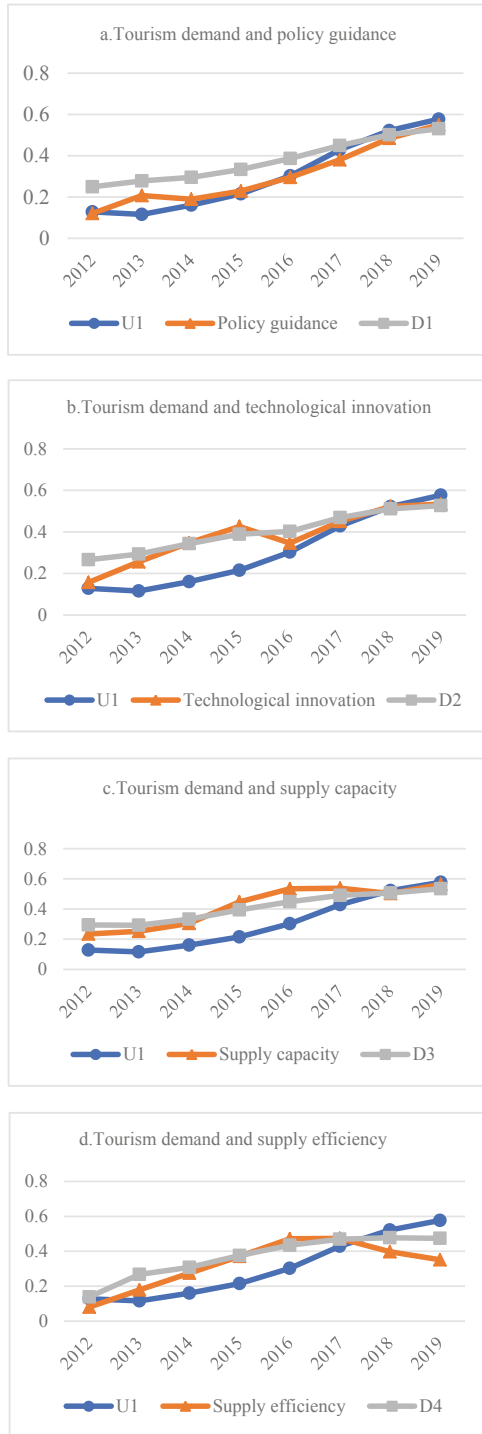


Fig. 3. Space-time variation of supply and demand of smart tourism in Beijing, Tianjin and Hebei from 2012 to 2019

5 Conclusions and Suggestions

Smart tourism is an important means of high-quality development of the tourism industry and a new reform way to realize the highly systematic integration and in-depth development and activation of tourism physical resources and information resources. At the early stage of development, clarifying the relationship between demand and supply is conducive to promoting the development of smart tourism towards a more market-oriented direction, so as to achieve comprehensive and integrated transformation and upgrading of tourism industry.

Coupling synergy model is an effective method to evaluate the level of tourism supply and demand coordination. From the perspective of space-time and structure, this paper studies the evolution characteristics of supply-demand coordination of smart tourism in Beijing, Tianjin and Hebei and draws the following conclusions: ① From the characteristics of time evolution, the supply and demand of tourism in Beijing, Tianjin and Hebei experienced a stage from moderately unbalanced to barely balanced development between 2012 and 2019, and the overall balance has been continuously improved. Since the supply development index has been lower than the demand development index with a typical supply lag from 2016, the reform of the tourism supply side becomes the main task of the smart tourism collaborative development in Beijing, Tianjin and Hebei. ② From the characteristics of spatial evolution, the balance state of tourism supply and demand in Beijing, Tianjin, and Hebei remains the same as that of the regional whole, but the development state of tourism in each of the three places has its own characteristics, with the highest supply-demand index and balance in Beijing, the slower development in Tianjin, and the relatively low supply-demand development index and balance in Hebei where it is still on the verge of unbalance. ③ From the characteristics of structural evolution, the structure balance of tourism supply and demand is consistent with the overall balance of the system, and the balance of supply capacity and tourism demand is high, indicating that the overall size is considerable, but the current supply efficiency is low. Therefore, it is necessary to continuously improve the ability of technological innovation and policy guidance on this basis.

Supply and demand synergy is a long-term mechanism to promote the development of smart tourism. In the process of constructing the smart tourism system in Beijing, Tianjin and Hebei Province, the first thing is to ensure the long-term development of the smart tourism. On the one hand, it is necessary to innovate the smart tourism products continuously to meet the personalized needs of tourists and integrate the tourism service terminals; on the other hand, it is necessary to broaden the smart tourism marketing channels with the help of new media, so as to transfer the information of tourism products to tourists more quickly and effectively, and to enhance the utilization value of portals and tourism e-commerce platforms. Secondly, the public service system of tourism information should be improved through the government led formulation of tourism information standards, so that the public service platform can effectively connect the online virtual environment with the offline physical environment through intelligent client, intelligent voice interpretation, intelligent navigation and other functions, to improve the convenience and experience of the tour. Thirdly, the top-level design of technology innovation system should be strengthened from the government level, and the construction of intelligent tourism enterprises should be encouraged. Technological innovation capability

should be continuously improved from the aspects of construction of tourism data center, function development of intelligent terminal equipment and intelligent operation of tourism enterprises, so as to comprehensively realize quality and efficiency improvement of intelligent tourism industry.

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