Study on evaluation of provincial tourism sustainable capacity by MFA model

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ABSTRACT

Tourism has become a pillar industry in developing provincial economies with the growth of the social economy and people's demand. However, ecological protection and supporting infrastructure are prerequisites accompanied by the rapid development of tourism. To measure the tourism potential, we intend to analyze the sustainable development of tourism and get the related countermeasure for policy-making assistance. The sustainable development of tourism potential in Shanghai is measured by the MFA evaluation model based on the construction of 3 core systems in sustainable development. According to the evaluation results, we analyzed the reason for the score's decline of the sustainable development ability of provincial tourism of Shanghai is from a shortage of industrial positioning, insufficiency, insufficient fusion, and obliterated cooperation in this industry. Countermeasures for provincial tourism development from perspectives of economy, culture, society and political technology could be given as economic mutual promotion and reflection, adjustment of tourism industrial development pattern, improvements in the policy guidance and regulation of tourism investment.

Keywords: MFA, tourism industry, sustainable development.

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INTRODUCTION

Tourism has become one of the supporting businesses of China's economy with the adjustment of the Chinese industrial structure. As new goals for China's ecological economy were set in the Third Plenary Session of the 18th CPC Central Committee, tourism has become a strategic pillar industry in provincial economic development. A comprehensive evaluation of provincial tourism's development potentials is important for provincial tourism resource distribution. China's tourism total revenue was 2.57 trillion yuan in 2012. The improving tourism industry has become an important part of the national economy. The government of China is currently facing important issues related to the sustainable development of the local area tourism industry and the ways to strengthen provincial cooperation links between tourism resources. Garrod and Fyall (1998), Miller (2001), Tepelus and Córdoba (2005), Ko (2005), Tsaur et al. (2006), Castellani and Sala (2010) constructed analysis indicators of continuous progress in

the field of tourism from multiple perspectives of economy, demography, and environment. Scholars made exploration and analysis of tourism sustainability assessment methods in depth (García-Melón et al., 2012; Forsyth, 1997; Liangjian, 2001).

In recent years, Blancas et al. (2018) used multiple benchmarks to make a dynamic evaluation of tourism. Luo (2018) expanded the sustainability concept to evaluate the tourism performance of the destination. Torres-Delgado and Palomeque (2018) and Liu et al. (2018) made measurements and predictions of China's regional tourism sustainability. Zha et al. (2019) took Hubei province as an example to evaluate tourism development efficiency. Alfaro Navarro et al. (2020) developed an approach to measure local sustainable tourism in Europe.

Material flow analysis (MFA), is a method to quantify flows of substances in a system. It is a core method of industrial ecology, used to study product flows within

ecosystems. MFA is an important tool to study the circular economy and to devise material flow management. It is used in the study of circular economy (Tang et al., 2020), urban administration (Wang et al., 2020), and waste recycling (Guo and Huang, 2019).

Thus, it is meaningful to apply Material flow analysis in the sustainable development capacity evaluation of the tourism industry. This paper applied the MFA model to make a statistical analysis of tourism sustainable development to get the countermeasure of provincial tourism development.

METHODOLOGY

In this paper, we analyzed the structure and operational mechanism of the sustainable development system of the tourism industry and built up 3 main systems for MFA model application to make the analysis.

Constitution of a sustainable tourism industry development system

Provincial tourism sustainable development system refers to the system which includes the elements that influence the provincial sustainable development of tourism, and ought to have effective coordination. It should be able to achieve the purpose of sustainable tourism development. Provincial tourism sustainable development system should not only have the characteristics of a typical system, but also an interaction mechanism between the internal structure of its system and subsystems, which is much more complex than the general system. Figure 1 shows the structure diagram of the system of Provincial Tourism Sustainable Development System.

As can be seen from Figure 1, the provincial tourism sustainable development system consists of four major subsystems:

(1) Ecological subsystem,
(2) Economic subsystem,
(3) Social subsystem,
(4) Technology policy subsystem.

The operating mechanism for tourism industrial sustainable development system

Provincial Tourism Industry Sustainable Development Mechanism refers to the inner workings and process of sustainable development of the tourism industry. The planning, construction and implementation of sustainable development of the tourism industry is a dynamic long-term process. We could only achieve public participation and decision-making consultations through the participation and "Round Table conference" of the

tourism management department, the transport sector, the forestry sector of agriculture, urban planning and management department, the environmental sector, industry associations and other related organizations. Then we could achieve the target of sustainable development of the provincial tourism industry by enhancing its internal operating mechanism for vigorous and harmonious development.

The Provincial Tourism Sustainable Development System mainly has the following five mechanisms:

(1) Driving mechanism. The driving mechanism is mainly generated in five aspects such as demand, media, supply, support and decision-making role.
(2) Balance mechanism. Balance mechanism is an important basis to ensure the harmony between customers, resources, ecological environment.
(3) Incentive mechanism. It means to set up an effective incentive system, in order to improve the sustainable benefit of tourism.
(4) Information feedback and regulatory mechanism. Through planning, operation, management and development of information, we could constantly discover obvious loopholes and defects existing in the process of tourism sustainable development, for improving and reforming the sustainable development policy and correction.
(5) Safeguard mechanism. Through security measures, we can ensure the normal operation of the provincial tourism sustainable development system.

The function and relationship of the above operation mechanism in provincial tourism sustainable development system relationship are shown in Figure 2.

Construction of provincial tourism industry sustainable development ability evaluation index system

This article refers to the research results home and abroad, combined with China's actual conditions. Based on the above analysis, we know that driving, motivation, balance, information feedback and regulation and safeguard mechanism within the provincial tourism sustainable development system decide the extent of the development direction, speed, and scale of the system. The discretion of the synergy degree between these mechanisms will turn out to be the external performance of the level of provincial tourism sustainable development ability. Therefore, according to the above five mechanisms, we can form five dimensions for a comprehensive evaluation of provincial tourism's sustainable development ability.

According to five specific requirements such as scientificity, comprehensiveness, operability, dynamics and comparability, preliminarily selecting from hundreds
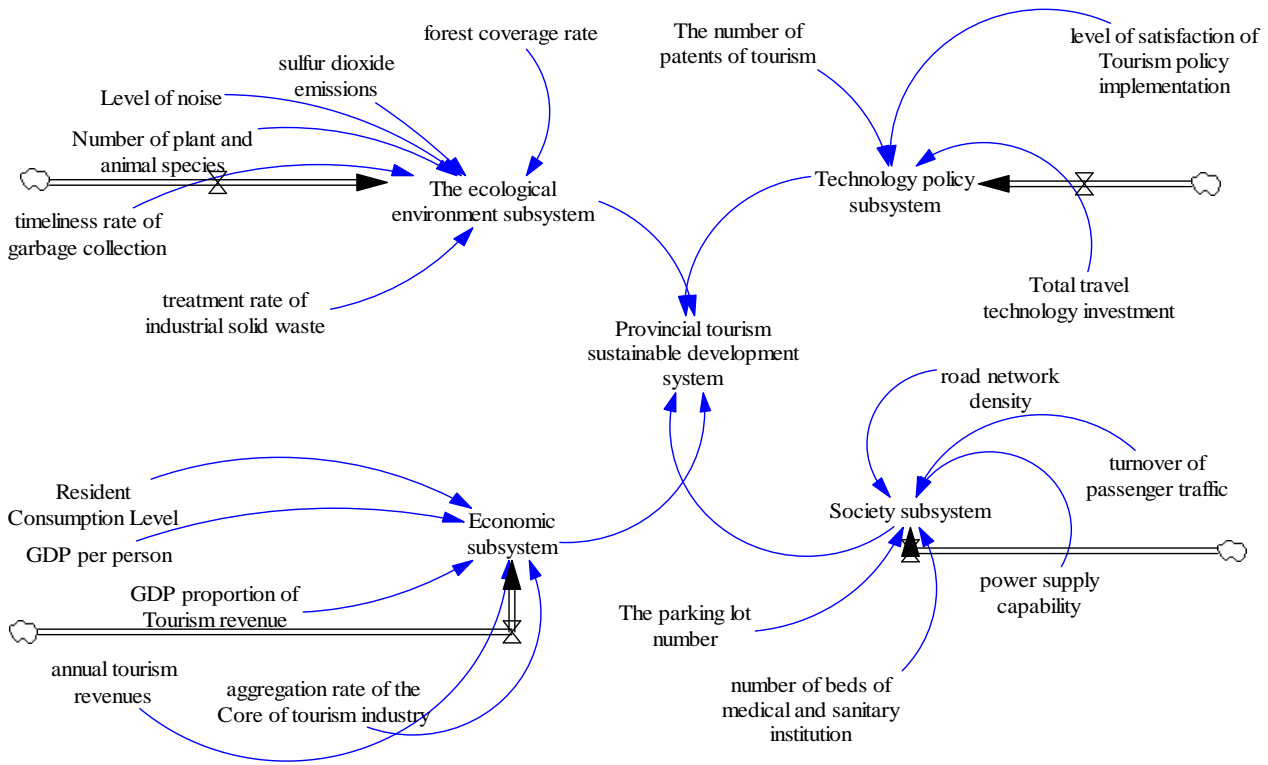
Figure 1. Provincial tourism sustainable development system structure.
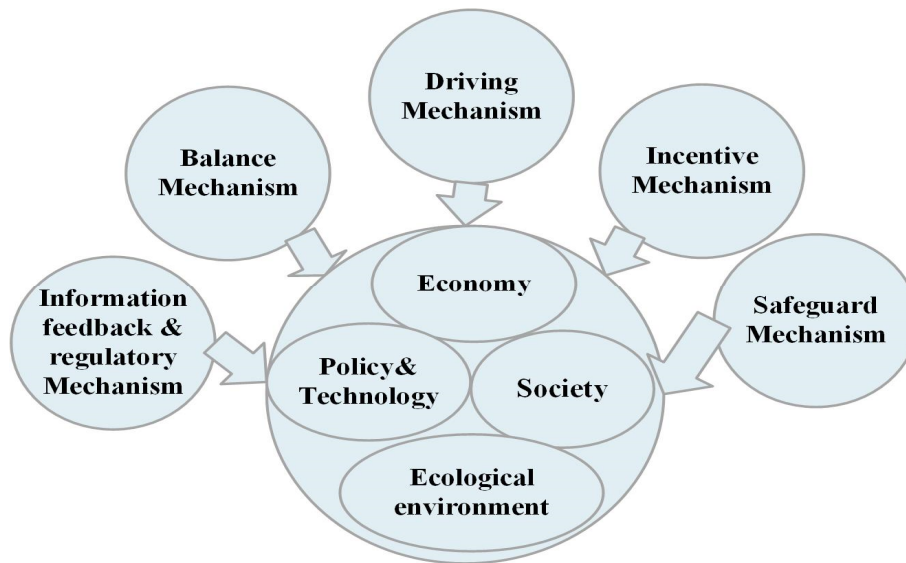

Figure 2. Provincial tourism sustainable development system structure map projection.

of statistical projects originating from the tourism market, we consider the no-dimensional form to work out 14 ratio indexes, which can not only enable the indexes to include relevant information as much as possible but have dynamic comparability.

EMPIRICAL ANALYSIS-TAKES SHANGHAI AS AN EXAMPLE

To make an empirical analysis of the sustainable development capacity of Shanghai, we carry out the

analysis by 5 core steps.

Calculation of the eigenvalue of the correlation coefficient matrix and determine the common factors that are supposed to be extracted

All the original index variances that can be explained by each public factor are listed in Table 1.

Calculation of the factor loading matrix after rotation and the maximum variance orthogonal rotation matrix C

The factor loading matrix of the MFA model is a matrix formed by the first 5 columns of the factor loading matrix after rotation, B=(B₅, B₉), as in Equation 1.

$$B_5 = A_5 \begin{pmatrix} \sqrt{\lambda_1} & & \\ & \ddots & \\ & & \sqrt{\lambda_{14}} \end{pmatrix} C_{5\times5} \tag{1}$$

The specific numerical value of B₅ is as shown in Table 2.

The maximum variance orthogonal rotation matrix:

$$C_{5\times5} = \begin{pmatrix} 0.864 & 0.445 & 0.133 & -0.083 & -0.176 \\ 0.225 & -0.610 & 0.737 & -0.088 & 0.159 \\ 0.202 & -0.334 & -0.160 & 0.829 & -0.367 \\ -0.299 & 0.562 & 0.579 & 0.483 & 0.162 \\ 0.270 & -0.043 & -0.279 & 0.255 & 0.884 \end{pmatrix}.$$

Factor naming and interpretation

According to the analysis and index selections of five dimensions, we can set public factor as F_1, F_2, …, F_5 respectively stands for driving factor, balance factor, incentive factor, information factor, safeguard factor, according to the factor loading matrix of MFA model (Table 3), we can see that each public factor has original indexes with strong correlation. Considering the actual situation of the Chinese tourism market, we can generate a comprehensive evaluation index system of the single provincial tourism sustainable development. In this system, we have driving factors as X_1, X_{10}, X_{11}, balance factors as X_2, X_6, X_7, motivating factors as X_3, X_5, information factors as X_8, X_9, security factors as X_4, X_{12}, X_{13}, X_{14}.

Table 1. All of the original index variance that the common factor can explain.

Components	Initial Eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	Variance (%)	Cumulative variance (%)	Total	Variance (%)	Cumulative variance (%)	Total	Variance (%)	Cumulative variance (%)
1	4.608	32.911	32.911	4.608	32.911	32.911	3.935	28.109	28.109
2	3.493	24.948	57.859	3.493	24.948	57.859	3.030	21.643	49.752
3	2.659	18.991	76.850	2.659	18.991	76.850	2.669	19.063	68.815
4	1.640	11.716	88.565	1.640	11.716	88.565	2.327	16.620	85.435
5	0.899	6.421	94.987	0.899	6.421	94.987	1.337	9.551	94.987
6	0.375	2.679	97.666						
7	0.199	1.421	99.087						
8	0.068	0.486	99.573						
9	0.060	0.427	100.000						

Calculate rotation factor score of the MFA model

By the rotating factor score coefficient, we can get the rotation factor score function of the MFA model in Equation 2 to 6

$$F_1 = -0.007X_1 - 0.06X_2 + 0.326X_3 - 0.257X_4 + 0.115X_5 + 0.258X_6 + 0.061X_7 - 0.055X_8 - 0.054X_9 + 0.131X_{10} - 0.101X_{11} - 0.034X_{12} - 0.183X_{13} - 0.024X_{14} \tag{2}$$

$$F_2 = 0.283X_1 + 0.305X_2 - 0.026X_3 + 0.045X_4 - 0.151X_5 + 0.006X_6 + 0.099X_7 + 0.052X_8 - 0.006X_9 + 0.041X_{10} + 0.058X_{11} + 0.112X_{12} + 0.259X_{13} - 0.301X_{14} \tag{3}$$

$$F_3 = 0.242X_1 - 0.017X_2 - 0.107X_3 + 0.164X_4 - 0.037X_5 - 0.01X_6 - 0.006X_7 + 0.401X_8 - 0.173X_9 + 0.055X_{10} + 0.408X_{11} + 0.001X_{12} - 0.016X_{13} + 0.021X_{14} \tag{4}$$

$$F_4 = -0.009X_1 - 0.104X_2 + 0.097X_3 + 0.174X_4 + 0.354X_5 + 0.174X_6 - 0.139X_7 + 0.024X_8 - 0.087X_9 + 0.021X_{10} - 0.007X_{11} + 0.417X_{12} + 0.2X_{13} - 0.169X_{14} \tag{5}$$

$$F_5 = -0.137X_1 + 0.02X_2 + 0.356X_3 - 0.077X_4 + 0.057X_5 + 0.124X_6 - 0.41X_7 - 0.061X_8 + 0.36X_9 + 0.647X_{10} - 0.061X_{11} + 0.058X_{12} + 0.21X_{13} - 0.099X_{14} \tag{6}$$

Table 2. The MFA model factor loading matrix.

Variables	Factor1	Factor2	Factor3	Factor4	Factor5
X6	0.948	0.137	0.064	0.052	0.189
X3	0.912	0.157	0.150	0.316	-0.085
X4	-0.838	-0.207	0.167	0.423	0.034
X13	-0.677	0.531	-0.290	0.322	0.232
X7	0.599	0.501	-0.163	-0.171	-0.552
X9	-0.550	-0.024	-0.334	-0.319	0.489
X2	0.007	0.910	-0.240	-0.325	0.026
X14	-0.245	-0.871	0.225	-0.263	0.047
X1	0.456	0.741	0.416	-0.094	-0.153
X8	0.134	-0.122	0.972	-0.019	0.086
X11	-0.036	-0.140	0.964	-0.087	0.131
X12	-0.133	0.176	-0.164	0.917	-0.121
X5	0.221	-0.455	0.010	0.833	-0.135
X10	0.171	0.025	0.458	-0.290	0.782

Table 3. Public factor scores of the sustainable development of tourism in 2003-2012 in Shanghai.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Fac1	-0.601	-1.361	-0.473	-0.791	-0.349	-0.478	1.668	1.557	0.557	0.270
Fac2	0.535	1.174	-0.416	-0.602	-0.877	-1.599	-0.827	0.520	0.639	1.453
Fac3	0.591	0.929	-0.811	0.267	-0.882	0.656	-0.058	1.683	-1.497	-0.878
Fac4	0.277	1.184	-0.180	-0.112	0.742	-1.477	1.767	-0.781	-0.665	-0.756
Fac5	1.114	0.096	-0.194	-0.754	0.075	-0.016	-0.405	0.209	1.797	-1.923

Any $X_j (j=1,2,…, 14)$ in the above equations are the standardized form of the original variable, the standardized formula is as in Equation 7.

$$x_{ij}^* = \frac{x_{ij} - \overline{x_j}}{S_j} \qquad (7)$$

According to the functions above, we can get the factor score of the tourism sustainable development in Shanghai from 2003 to 2012, which is shown in Table 3.

Calculate the composite scores of the MFA model

According to Table 3, we can draw the explained variance contribution rate of each factor. Therefore, we can take the proportion explained variance contribution rate of each common factor accounted for the total variance contribution rate of five factors like the weight. Then the weight of each factor can be calculated automatically without circumventing assignment problem, and synthetical factor score can be worked out after a consolidated summary, as in Equation 8:

$$F = (28.109F_1 + 21.643F_2 + 19.063F_3 + 16.62F_4 + 9.551F_5) / 94.987 \qquad (8)$$

Synthetical factor score of Shanghai can be obtained by calculation and sorted as in Table 4.
In the end, we have the factors as follows:

X_1:The tourism industry development investment growth rate/GDP growth rate; X_2: Tourism industry investment revenue / fixed assets investment of the whole society; X_3: The tourism industry revenues/ fiscal revenues of provincial domain;

Table 4. Evaluation score and ranking of Shanghai city tourism sustainable development potential in 2003-2012.

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
The synthetical factor score	21.21	25.47	-42.58	-39.23	-32.56	-60.23	53.38	76.11	7.05	-8.63
Sorting	4	3	9	8	7	10	2	1	5	6

X_4: New Tourism industrial market development investment/tourism industry development investment; X_5: Tourism industry revenue/total investment of travel industry development; X_6: A load of total tourists/tourist bearing capacity; X_7: Environmental quality index; X_8: Per capita tourists travel consumption growth rate/ Per capita disposable income growth; X_9: Per capita disposable income growth rate; X_{10}: The growth rate of investment in the tourism industry development in the same year; X_{11}: The tourism industry revenue growth rate in the same year; X_{12}: Tourism infrastructure investment growth rate; X_{13}: Growth rate of tourism employees; X_{14}: Private capital investment/tourism industry development investment.

DISCUSSION

Through the above evaluation, we can find the sustainable development ability of the Shanghai tourism industry is on the decline for two consecutive years since 2011. As the way scholars used to analyze the regional tourism sustainability (Liu et al., 2018; Zha et al., 2019; Alfaro Navarro et al., 2020), we could use the factor score, evaluation score and ranking of a region to discuss the outcomes, proved to be mainly caused by the following reasons:

(1) The industry positioning is not clear. The urban tourism industry of Shanghai has been on a large scale, but the sustainability of the development direction is relatively weak.
(2) Insufficiency in tourism marketing. Shanghai, as a national metropolis, the range of tourism products marketing promotion is relatively narrow, mainly concentrated in short-range countries, while the marketing ability of Shanghai is weak in big tourism output countries. As a model of urban tourism, the tourism brand influence of Shanghai is weak.
(3) Insufficient fusion in the high-end industry. All the international high-end urban tourist cities ought to have international visibility and reputation, a good international image of the city and convenient tourist traffic system, perfect public service facilities, unique cultural elements and worldwide famous tourist attractions. While Shanghai is lacking cultural creativity and the integration ability of the tourism force, so is unable to form a mutually promote pattern of industry development.
(4) Obliterated regional tourism cooperation among the dense regions of tourism resources, Shanghai plays a leading role in the Yangtze River Delta region, beginning regional tourism resources cooperation mode long ago. However, affected by many factors such as system, mechanism and profit distribution, the cooperation pattern is not smooth, seriously influencing the sustainable development of the tourism industry in Shanghai.

CONCLUSION

From the result of the analysis and its discussion, we could have suggestions to promote tourism sustainable development

(1) Economy and culture have mutual promotion and reflection. Tourism is just one of the industries which are combinations of economic benefit and cultural undertakings. The development basis of the tourism industry includes not only the local natural environment resources but also the ability of its own culture and the humanities to attract tourists. A scenic spot can be eternally charming and enduring only when it is full of rich cultural connotations. For a country like China, which has a five-thousand-year-old culture, the importance of culture is prominent.
(2) Adjustment of tourism industrial development pattern. The tourism industry in China is in the transformation of the development of local resources from extensive development to intensive development. On the premise of the protection of natural and cultural tourism resources, we ought to improve the tourism development mode to realize the sustainable development of tourism. For instance, Shanghai, being the urban tourism center among the surrounding provinces, attracts tourists because of its convenient transportation and economic status. Moreover, it also cooperates with the surrounding provinces to make the establishment of the "Yangtze river delta" tourism cooperation mode characterized by resource sharing and profit allocation in proportion.
(3) Strengthen the policy guidance of tourism investment. For provinces with more developed tourism industry, investment policy should guide the investors to invest in modern tourism scenic landscape development and the construction of tourist reception facilities, to improve the quality of the tourism industry service level and industry quality. For other provinces, due to the poor infrastructure and tourism facilities, the policy guidelines should encourage and motivate to invest in the urban

infrastructure and public service facilities, to complete the hard environment of the tourism industry. However, because this kind of investment has a long return cycle, corresponding preferential policies should be given to attract investors.

(4) Strengthen the regulation of the industry. Tourism regulators ought to strengthen and improve the tourism administration and the administrative supervision, coordination and cooperation, to standardize the order and mechanism of the tourism market. To solve the regulation problems of some regions, the administrative supervision department should urge the tourism regulators to fulfill the function of supervision and administration, and improve the level of tourism administrative management. The regulators are also expected to strengthen the administration force of the tourism market order and accountability mechanism construction and solve the intense prominent problems reflected by masses of tourists and tourism enterprises. We should treat tourism standardization and information as the main working direction of regulation, and enhance the sustainable ability from the internal industry to realize the sustainable development of the provincial tourism industry.

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