Optimization of Tourism Industry Ecosystem Structure Upgrading based on Complex Network

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Abstract: Under the current background of global environmental change, the research on ecosystem structure upgrading has become one of the frontier and hot fields of sustainable scientific research. Taking the provincial administrative unit of China as the research scale, this paper carries out the research on the structural upgrading of the tourism industry ecosystem. On the basis of defining the connotation of the structural upgrading of the tourism industry ecosystem, aiming at the two interactive relationships between developers in the software ecosystem, this paper constructs different types of networks, studies the community detection methods of the software ecosystem, and constructs the evaluation index system and evaluation model of the structural upgrading of the tourism industry ecosystem, The entropy method is used to determine the index weight, and the weighted summation method is used to calculate the optimization index of China's provincial tourism industry ecosystem structure. The ArcGIS spatial analysis method and obstacle degree model are used to analyze the temporal and spatial evolution characteristics and obstacles of China's provincial tourism industry ecosystem structure upgrading, and the optimization strategy of China's tourism industry ecosystem structure upgrading is put forward.

1. Introduction

The relationship between man and earth is the core content of modern geography research, and it is also the key problem facing the current social and economic development. The relationship between man and earth is accompanied by the evolution of human development. In the evolution of human civilization, resources and environment, on the one hand, as input elements of human activities, have greatly promoted economic prosperity and social progress. On the other hand, as a space carrier of human activities, they bear the pressure of ecological environment brought by a

large number of human activities [1]. Scholars have put forward a series of complex concepts and their theoretical analysis frameworks, such as "human environment coupling system", "social ecosystem", "human economy natural system" and "vulnerability", "elasticity", "structural upgrading", "resilience" and "adaptability", which means that the connotation of sustainable development is constantly enriched and improved on the basis of the initial simple environmental protection, and gradually develops into a system involving economy, society Comprehensive concepts and strategies in many fields such as ecology [2-3].

Tourism has always been regarded as a "smoke-free industry" and "green industry". Affected by this leading concept, people often ignore the loss of resources and environment caused by tourism development while pursuing short-term social and economic benefits, blindly demanding from the natural environment, which seriously destroys the harmonious relationship between tourism development and its dependent environment [4]. How to promote the sustainable development of the tourism industry is a long-term practical issue for the development of China's tourism industry [5]. Ecology is the essential feature and important trend of the development of tourism industry. Applying the idea of circular economy and industrial ecology to the tourism industry and guiding the development of tourism industry with ecological principles is the entry point to solve the contradiction between tourism development and resources and environment, which is conducive to promoting the transformation and upgrading of tourism industry and ensuring the ecological safety of tourism industry [6]. Today, with the rapid development of social economy and the increasing contradiction between people and land, opportunities and challenges coexist in the development of tourism industry, which urgently needs transformation and upgrading [7]. Applying industrial ecology and system theory to the study of tourism industry, examining and reconstructing the tourism industry system from the perspective of natural ecosystem, not only enriches the theoretical system of industrial ecology, but also expands the research methods and contents of tourism industry, providing new ideas for the study of sustainable development of tourism industry; From the perspective of structural upgrading, this paper analyzes the characteristics of the tourism industry ecosystem, establishes an evaluation index system for the structural upgrading of the tourism industry ecosystem on the basis of clarifying the connotation of the structural upgrading of the tourism industry ecosystem, scientifically measures the structural upgrading of China's provincial tourism industry ecosystem, deeply reveals the operation law and mechanism of China's tourism industry ecosystem, and discusses the optimization strategy for the structural upgrading of the tourism industry ecosystem, It is of great significance to expand the application scope of structural upgrading theory and improve the research and analysis framework of tourism industry ecosystem [8-9].

This paper puts forward an ecological network structure upgrading and optimization method based on complex network, constructs different types of networks, and optimizes them according to the characteristics of the network. This paper attempts to build an evaluation index system for the structural upgrading of the tourism industry ecosystem, uses entropy method and weighted summation method to calculate the structural upgrading evaluation index of the tourism industry ecosystem and each subsystem, uses the obstacle degree model to identify the obstacle factors affecting the optimization and upgrading of China's provincial tourism industry ecosystem, and puts forward the optimization strategy for the structural upgrading of China's tourism industry ecosystem.

2. Overview of Relevant Concepts

2.1. Tourism Industry Ecosystem

In recent years, some domestic scholars have studied the tourism industry ecosystem from the perspective of the basic elements of the tourism industry by imitating the operation law of the natural ecosystem, and the special whole of the continuous exchange of energy and information between the tourism industry cluster, tourists and the tourism environment. Among them, the tourism industry cluster includes the functional departments of various tourism industry elements and their related industries [10]. This view focuses on discussing the ecological relationship within the tourism industry system, aiming to establish an internal resource recycling mode, so as to minimize the damage caused by tourism industry activities to the resources and environment. Other scholars put the tourism industry under a larger external environment and studied it. They believed that the tourism industry ecosystem is a concept of social economic natural composite ecosystem, involving tourism industry, social environment, natural ecological environment and other aspects [11]. The understanding of the concept of tourism industry ecosystem in this paper is more inclined to the latter, that is, to focus on the relationship between the tourism industry system and its dependent environmental system [12]. This paper believes that the tourism industry ecosystem is a special composite system formed by the interdependence and mutual restraint of tourism industry subsystem, social environment subsystem and ecological environment subsystem. In the tourism industry ecosystem, the tourism industry subsystem is the core, which is mainly composed of various tourism industry sector elements; Social environment subsystem is the foundation, including population, safety, transportation, science and technology, medical treatment and other social environment elements involved in the development of tourism industry; Ecological environment subsystem is the premise, including water resources, biological resources, land resources, air quality and other resource and environmental elements that the development of tourism industry depends on [13-14].

2.2. Industrial Ecology Theories

Industrial ecology is a new discipline formed on the basis of interdisciplinary and comprehensive development. It mainly studies the relationship between industrial development and resource environment from the perspective of resource and environmental constraints, with the purpose of realizing the benign interaction and coordinated development between industrial systems and their dependent environmental systems. Industrial ecology transforms the idea of sustainable development into concrete practice, providing theoretical support and practical path for solving the development contradiction between economy, society and environment [15-16].

2.3. Ecological Economics Theory

Ecological economics is developed under the background of environmental damage and resource shortage caused by the development of large-scale industrialization. Its purpose is to reduce the pollution and damage of economic development to the ecological environment. Compared with traditional economics, ecological economics rethinks the relationship between economic development and ecological environment, and believes that economic development should not take economic growth as a single measurement index, but also pay attention to the carrying capacity of natural ecological environment and environmental benefits in economic development [17-18].

3. Tourism Industry Ecosystem Evaluation Experiment

3.1. Data Standardization

To build the original index data matrix, first standardize the data, and the formula is as follows:
Positive evaluation indicators:

$$r_{ij} = (x_{ij} - \min x_j)/(\max x_j - \min x_j) \qquad (1)$$

Negative evaluation index:

$$r_{ij} = (\max x_j - x_{ij})/(\max x_j - \min x_j) \qquad (2)$$

Where, Xij represents the initial value of the jth index of the ith sample, M represents the number of samples, and N represents the number of evaluation indicators. Rij represents the standard value of index Xij, maxxj represents the maximum value of the j-th index; Minj represents the minimum value of the j-th index.

3.2. Weight Determination

This paper mainly uses the entropy method of objective weighting method to weight the indicators in the evaluation index system of tourism industry ecosystem structure upgrading, in order to reduce the deviation caused by subjective weighting. Entropy is used to measure and measure fuzziness in information theory. According to this property, the dispersion degree of each index can be judged by entropy. The higher the dispersion degree of the index, the greater the weight value. The specific calculation process of entropy method is as follows:
(1) Calculate the proportion of the i-th sample index value under the j-th index:

$$p_{ij} = \frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}}, (0 \le r_{ij} \le 1) \qquad (3)$$

(2) Calculate the entropy of index J:

$$e_j = -K \sum_{i=1}^{m} p_{ij} \ln p_{ij} \qquad (4)$$

(3) Calculate the difference coefficient of evaluation index J:

$$d_j = 1 - e_j \qquad (5)$$

(4) The weight of index J is:

$$u_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \qquad (6)$$

4. Analysis on the Upgrading and Optimization of Tourism Industry Ecosystem Structure

4.1. Analysis of Temporal Changes in the Upgrading of Tourism Industrial Structure

From the perspective of the change trend of the structural upgrading of the tourism industry subsystem, the overall level of the structural upgrading of China's tourism industry subsystem showed a fluctuating growth trend from 2010 to 2019. The average score of the structural upgrading of the national tourism industry subsystem increased from 10.7525 in 2010 to 11.7106 in 2019, with an average annual growth rate of 0.89%. From 2010 to 2014, the average score of the tourism industry subsystem structure upgrading showed a ladder like change trend of "relatively stable - rapid growth - relatively stable". Among them, the average value of the tourism industry subsystem structure upgrading in 2010-2012 and 2012-2013 was stable at about 10.7400 and 11.1700 respectively. From 2011 to 2012, the average value of the tourism industry subsystem structure upgrading increased from 10.7231 to 11.1802, with an annual growth rate of 4.26%. After 2014, the structural upgrading level of the tourism industry subsystem began to decline, and the decline rate accelerated from 2015 to 2016, with a decline rate of -10.76%. However, from 2016 to 2017, it rebounded rapidly with a growth rate of 13.13%, showing a "V" shaped change trend, and a "trough" in 2016. From 2017 to 2019, the average value of the structural upgrading of the tourism industry subsystem showed an inverted "V" trend of first rising and then declining. Among them, the average value of the structural upgrading of the tourism industry subsystem from 2017 to 2018 increased from 11.6941 to 11.8921, with an annual growth rate of 1.69%, and the average value of the structural upgrading of the tourism industry subsystem from 2018 to 2019 decreased from 11.8921 to 11.7106, with an annual decline rate of -1.53%.
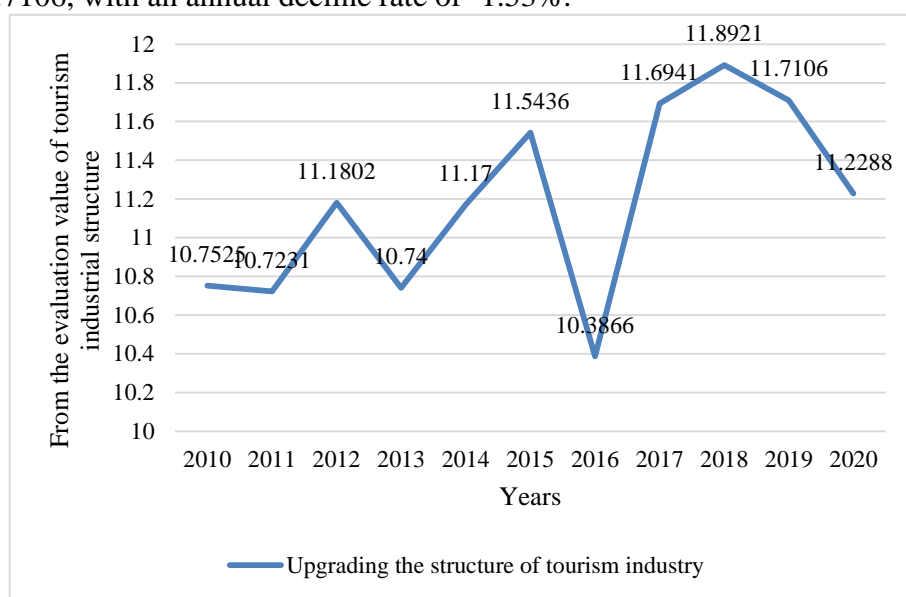

Figure 1. Change trend of tourism industry system structure optimization

4.2. Analysis on the Level Distribution of Tourism Industry System Structure Optimization

From table 1, the number of provinces at the high level of the tourism industry subsystem in 2010, 2014 and 2019 was 3, 3 and 4 respectively, with relatively stable changes in the number; The number of provinces at the higher level of the tourism industry subsystem is 4, 6 and 5, accounting

for 12.9%, 19.4% and 16.1% of the total number of provinces, respectively, showing an inverted "V" trend of first increasing and then decreasing; The number of provinces at the middle level of the tourism industry subsystem is 12, 9 and 8 respectively, accounting for 38.7%, 29.0% and 25.8% of the total number of provinces, showing a continuous downward trend; The number of provinces at the lower level of the tourism industry subsystem is 7, 7 and 10 respectively, showing a trend of stability in the early stage and growth in the later stage; The number of provinces at the low level of the tourism industry subsystem is 5, 6 and 4 respectively, which has the same trend as the number of provinces at the high level of the tourism industry subsystem, that is, it shows an inverted "V" trend of increasing first and then decreasing. On the whole, the level of tourism industry subsystem in the provinces at the middle and lower levels has been weakening, and many provinces have "fallen down", making the gap between tourism industry subsystems among provinces continue to increase.

Table 1. Analysis on the distribution of tourism industrial structure upgrading

	2010	2015	2020
high-level	3	3	4
Higher level	4	6	5
Medium level	12	9	8
Lower level	7	7	10
low-level	5	6	4

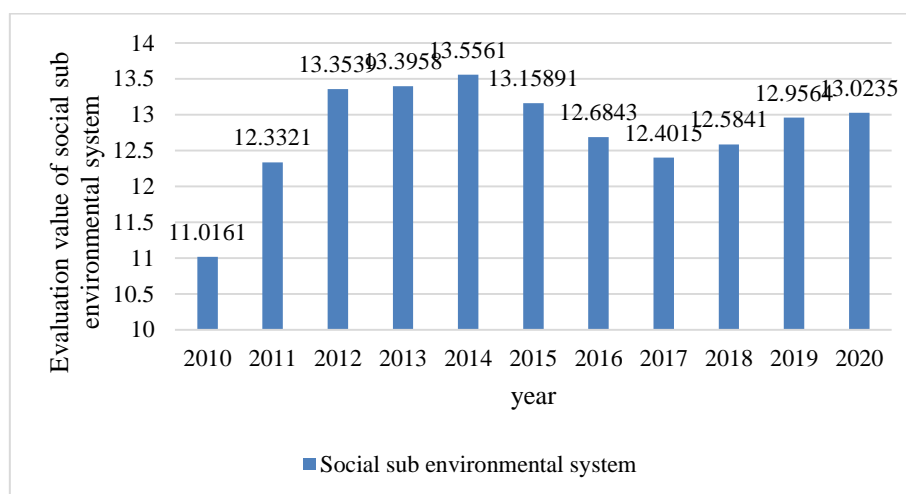## 4.3. Analysis of Space-time Evolution of Social Environment System

Figure 2. Evaluation value of social environment system

It can be seen from Figure 2 that the overall development trend is fluctuating growth. The average score of the national social environment subsystem increased from 11.0161 in 2010 to 12.9564 in 2019, with an average annual growth rate of 1.76%. From 2010 to 2012, the average value of the social environment subsystem showed a rapid growth trend, from 11.0161 in 2010 to 13.3539 in 2012, with an average annual growth rate of 7.07%. After 2012, the growth rate began to slow down, and the average value of the social environment subsystem from 2012 to 2014 increased slowly between 13.3539 and 13.5561. From 2014 to 2017, the average level of China's social environment subsystem showed a trend of rapid decline. The average value of the social

environment subsystem fell from 13.5561 in 2014 to 12.4015 in 2017, with an average annual decline rate of -2.13%. After 2017, the average value of the social environment subsystem began to rise, and the growth rate continued to accelerate.

4.4. Analysis of Grade Distribution of Structural Optimization of Social Environment System

Table 2. Hierarchical distribution of social environment subsystem

	2010	2015	2020
High-level	2	2	2
Higher level	8	11	6
Medium level	11	8	11
Lower level	9	9	8
Low-level	1	1	4

From the perspective of grade distribution, the number of provinces at the high level of the social environment subsystem in 2010, 2014 and 2019 has always been 2, and the number changes are relatively stable; The number of provinces at the higher level of the social environment subsystem is 8, 11 and 6, accounting for 25.8%, 35.5% and 19.4% of the total number of provinces, respectively, showing an inverted "V" trend of first increasing and then decreasing; The number of provinces at the middle level of the social environment subsystem is 11, 8 and 11 respectively, showing a "V" shaped change trend of first decreasing and then increasing; The number of provinces at the lower level of the social environment subsystem is 9, 9 and 8 respectively, and the number change is relatively stable; The number of provinces at the low level of the social environment subsystem is 1, 1 and 4 respectively, showing a trend of stability in the early stage and growth in the late stage. On the whole, the horizontal hierarchical structure of China's social environment subsystem presents an "olive" structure with a small number of provinces at both ends and a large number of provinces at the middle level.

4.5. Spatiotemporal Evolution Analysis of Ecological Environment Subsystem
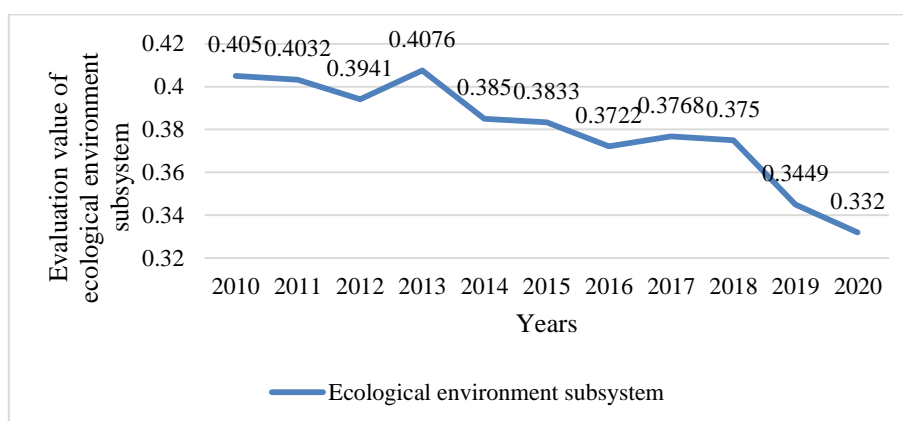

Figure 3. Change trend of ecological environment subsystem

From the perspective of the change trend of the ecological environment subsystem, the average level of China's ecological environment subsystem showed a fluctuating downward trend from 2010 to 2019. The average value of the ecological environment subsystem decreased from 0.4050 in 2010

to 0.3449 in 2019, with an average annual decline rate of 1.48%. From 2010 to 2013, the average value of the ecological environment subsystem showed a "V" shape change trend of first decreasing and then increasing, and formed a "trough" in 2012. After 2013, the average value of the ecological environment subsystem began to decline rapidly, so it appeared a "peak" in 2013. From 2013 to 2016, the average value of the ecological environment subsystem continued to decline, with the fastest decline from 0.4076 to 0.3850 in 2013-2014, with an annual decline rate of -5.55%. The decline rates in 2014-2015 and 2015-2016 were -0.51% and -2.82% respectively. From 2016 to 2018, the average level of China's ecological environment subsystem was relatively stable, and the average value of the ecological environment subsystem fluctuated between 0.3722 and 0.3768. From 2018 to 2019, the average level of China's ecological environment subsystem fell rapidly, and the average value of the ecological environment subsystem fell from 0.3750 to 0.3449, with an annual decline rate of -8.03%.

5. Conclusion

This paper takes the provincial administrative unit of China as the research scale, introduces the industrial ecosystem into the research of tourism field, and carries out the research of tourism industrial ecosystem. Firstly, on the basis of defining the connotation and characteristics of the tourism industry ecosystem, the tourism industry ecosystem evaluation index system is constructed. Secondly, the entropy method is used to assign the index weight, and the weighted sum method is used to calculate the China provincial tourism industry ecosystem index. ArcGIS spatial analysis method and obstacle degree model are used to analyze the spatial-temporal evolution characteristics and obstacle factors of China's tourism industry ecosystem, Finally, it puts forward the optimization path of China's tourism industry ecosystem: adhere to the priority orientation of people's livelihood, and increase financial investment; Strengthen traffic safety management and optimize the travel environment; Expand the increment of employment and entrepreneurship, and improve the income level of residents; Strengthen the prevention and control of environmental pollution and promote the construction of ecological civilization; Strengthen disaster risk prevention and control and reduce potential environmental safety hazards; Increase the proportion of environmental protection expenditure and increase environmental protection investment.

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Data Availability

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Conflict of Interest

The author states that this article has no conflict of interest.

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