Evaluation of Urban Sustainable Development and the Influencing Factors: Considering the Citizen Perception

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ABSTRACT

This paper constructed the evaluating indicator system for urban sustainable development (USD) based on People Oriented and carried out the case study. Based on citizens' cognition of urban green growth, this paper selects network analysis method to establish evaluation model, combines subjective demand and objective weight to conduct measurement research, and determines the elements of the system and their relationship. Seventeen cities in Shandong Province are chosen as the sample with the data in 2014-2018, this paper analyzes the characters of the green growth of different cities and find out the affecting factors during the period. The results indicate that: From the perspective of the overall structure, the green environment shows a downward trend, and the green living standard is significantly improved. The USD of cities shows volatility in the sample period. Economic development, industrial structure and foreign trade have a certain impact on the USD index. The sustainable development evaluation system combined with citizen perception has strong rationality and feasibility, which enriches the structure, function, elements and spatial level of urban sustainable development.

Keywords: Urban sustainable development, citizen perception, entropy weight network analytic hierarchy process

1. INTRODUCTION

With the great achievements of urbanization since China's reform and opening up, the traditional way of development at the expense of resources and environment shall be reformed urgently [1], and urban sustainable development (USD) becomes the important target and breakthrough point in the post-urbanization period [2]. Under the guidance of the development philosophy of "people-oriented", how to build an urban environment that meets the people's demands for a better life is an important issue to be solved urgently. For the current evaluation of USD, scholars mainly pay attention to the concept of sustainable development, the overall framework and the specific implementation path [3]. USD shall consider the integration of environment, economy and society, and it contains social justice and environmental ethics [4]. Quantitative research mainly focuses on the measurement of USD, and evaluation factors of the index system design include energy and CO_2 emissions, land use and construction, transportation, garbage disposal, water resources, health, air quality, environmental management and other aspects. The similar indexes also include WAVES of the World Bank (Wealth Accounting and Evaluation of Ecosystem Services) [5], Green Growth Indicators put forward by OECD etc. At present, the research framework of USD theory and empirical aspects

has been relatively complete, and the views and methods of research are still improving [6]. However, there are rare researches to combine urban development and the demands of "people". How to integrate the current theoretical system to build an all-around and all-dimensional logical framework that can truly reflect the multiple goals and appeals of sustainable development and build a set of adaptive method system is worth exploring in depth. This paper plans to select Analytic Network Process, ANP to conduct index system analysis. From the public's understanding and perception of USD as a starting point, the USD index system is constructed through ANP method to measure the sustainable development level of all cities in Shandong province from 2014 to 2018, explore the level of USD, and provide theoretical and methodological support for promoting inter-regional USD.

2. INDEX SYSTEM AND METHODS

2.1. The Index System for USD

USD contains the public's basic understanding on green. The index system adopts the people-oriented research paradigm to emphasize the participants' basic understanding on USD, and 32 indicators were chose to evaluate the USD (see Table 1).

Table 1 Evaluation Index System of USD

First class	Second class	Third class
Green environment	Environmental pollution; Urban greening; Air quality; Pollution control	Dust emission per capita*, Sewage discharge per capita*; Proportion of green area in built-up areas; Park green area per capita; Urban Air Quality Index (AQI); Comprehensive utilization rate of industrial solid waste; Proportion of environmental expenditure
Green society	Urbanization; Income level; Employment level; Living expenses	Population urbanization rate; Urban disposable income per capita, Net income of rural residents per capita; Urban unemployment rate*; Engel coefficient for urban residents*, Engel coefficient for rural residents *
Green economy	Economic vitality; Economic benefit; Economic structure	GDP, Annual GDP growth rate; Number of registered famous brands per thousand people, Number of standard applications per thousand people; Proportion of tertiary industry, Export per capita
Green population	Population quality; Education level; Income level; Medical conditions	Natural population growth rate*; Number of middle and high schools with thousand people; Disposal income per capita; Average life expectancy at birth; Number of beds per thousand
Green production	Land investment; Capital investment; Output per capita	Urban construction land area per capita*; R&D fund investment per capita, Fixed asset investment per capita; GDP per capita
Green life	Energy conservation; Traffic conditions; Housing conditions	Domestic water consumption per capita*; Road area per capita; Housing security expenditure per capita, Completed housing area per capita

Note: The index marked with * is the reverse index

2.2. Entropy-Weight and Analytic Hierarchy Process Model (ANP)

2.2.1. The network structure of USD index based on ANP model

Network hierarchy model is a kind of non-independent hierarchical structure and a multi-criteria decision model that can solve internal dependency and feedback effect. In order to simplify the calculation process, this paper adopts SD software (Super Decisions) launched by Rozann W.Satty and William Adams to conduct programmed operation of ANP calculation process. A total of 500 questionnaires were distributed in Shandong province and 457 valid questionnaires were recovered. The research group mainly focused on random sampling population from 18 to 70 years old. The Saaty 1-9 scale was adopted in the questionnaire for comparison. On the premise of passing the consistency test, the geometric mean method was used to integrate the score and transform people's overall understanding of sustainable development into relevant index weight.

2.2.2. The USD index

This paper adopts the entropy weight method to calculate the relative weight of index factors. In order to vertically compare the indexes between different years, this paper improves the entropy weight method by adding the time variable, so as to improve the vertical comparability of evaluation results.

The overall level of USD can be reflected by constructing USD index GI. GI is the linear evaluation result formed by integrating the weights of the secondary indexes determined by the network hierarchy model and the factor weights determined by the entropy weight method. The comprehensive index weight can be expressed as:

$$w_j = \frac{w_{aJ} * w_{fj}}{\sum_{j=1}^{m} w_{aJ} * w_{fj}}$$, among which, w_{aJ} is the weight

corresponding to the index, and the further USD index can be calculated through the following formula:

$GI = x'_{\theta ij} * w_j * 100$. GI is between 0 and 100, and the higher the index, the better the level of USD; on the contrary, the lower the index, the worse the level of USD.

3. OVERVIEW OF THE RESEARCH AREA AND DATA PROCESSING

This paper takes 17 prefecture-level cities in Shandong Province as the basic evaluation units, and the relevant data sources include Statistical Yearbook of Shandong Province, China City Statistical Yearbook, Statistical Yearbook of Urban Construction in China, as well as almanac data of all cities in Shandong Province. In the process of data collection, the principle of comparability shall be strictly observed, and the statistical caliber of indexes used in different cities shall be as consistent as possible, so as to facilitate the horizontal comparison and analysis between cities. In case of partial absence in the previous data, scientific rules shall be adopted to process the missing value after analysis. The principle of comparability is emphasized in the calculation process of the index, so as to guarantee the consistency and continuity of indexes, improve the credibility of the evaluation results and the consistency of conclusion.

4. RESEARCH RESULTS

4.1. Analysis of Overall Structural Characteristics of USD in Shandong Province

The comprehensive calculation results of the Entropy-Weight and Analytic Hierarchy Process Model are shown in Table 2. From 2014 to 2018, the level of USD in Shandong Province still has a large room for improvement, and the overall level of GI shows the trend of first rising and then falling, which indicates that there is a certain fluctuation of USD during the "12th Five-Year Plan" period. The maximum comprehensive value of sustainable development is 28.54 in 2012 and the minimum value is 24.10 in 2014, but the fluctuation range is not large, and the overall performance is relatively uniform. The

sustainable development in the first three years is relatively good, and the level of sustainable development in the last two years is relatively low. From the factors to USD, the contribution rate of environment, economy, population and life is high, while the contribution rate of production and life is low. From the vertical development of all indexes, the indexes of green environment, green economy and green population in USD continue to keep a downward trend, which indicates that transforming the economic growth model at the expense of the environment is still the key issue of USD; green society, green production and green life continue to improve, which indicates that as people pay more and more attention to environmental pollution, the contributions of micro individuals to USD by means of energy conservation, emission reduction, and education make up for the adverse impact of macro development to some extent.

4.2. Analysis of Affecting Factors of USD in Shandong Province

In order to further explore and analyze the factors affecting USD in Shandong Province, the research uses the frequency statistics method to select the factors that affect USD, and select the indexes with higher frequency of use, including population gross, GDP per capital, the ratio of output value of tertiary industry to GDP, the ratio of fiscal revenue to GDP and the ratio of total import and export to GDP as the affecting factors.
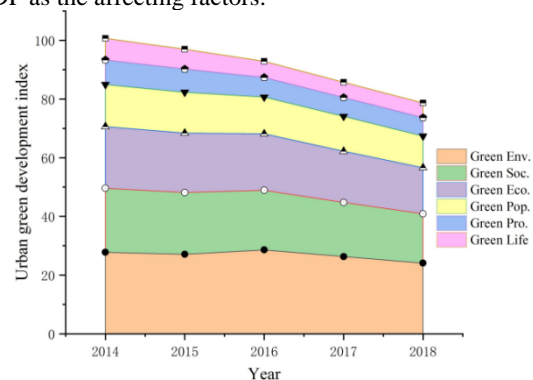

Figure 1 The Overall Index of USD in Shandong Province

Table 2 Panel Data Estimation Results of the Influence of Various Factors on USD

Variable	Coefficient	Std. Error	t-Statistic	Prob.
a Total population	0.481	1.258	0.382	0.704
b Per capita GDP***	9.965	1.881	5.297	0.000
c Tertiary industry proportion**	7.127	3.063	2.327	0.023
d Fiscal revenue as a proportion of GDP	4.242	3.375	1.257	0.213
e Urbanization rate	-6.024	3.793	-1.588	0.116
f The proportion of total exports to GDP***	2.730	0.930	2.934	0.004

Note: *, **, and *** mean passing the test at the significance levels of 10%, 5%, and 1%, respectively.

According to the research results (see Figure 1), GDP per capital promotes USD. GDP per capital has a significant impact on USD, which indicates that the improvement of GDP per capital can effectively improve the USD level. With the higher degree of economic development, the higher degree of economic development, conducive to promoting USD, which is consistent with the conclusion that the environmental Kuznets curve presents an inverted U-shape. The ratio of total import and export to GDP has a significant impact on USD mainly because that China's foreign trade at the expense of the environment has brought serious carbon leakage and resource environment deficit for a long term, which has caused trade friction in the world. With the higher proportion of total exports, domestic manufacturers are forced to improve the environment and technology, so as to avoid falling into the trap of "environmental comparative advantage". Therefore, the improvement of foreign trade level is conducive to USD. The ratio of the tertiary industry directly reflects the overall economic development level of a region, which reflects the stage of economic development of the region, so it has a significant impact on USD.

5. CONCLUSIONS

The results of this paper mainly include the following: (1) The index system and weight of USD was built in accordance with the citizen's demands, ANP method was used to quantify citizens' demands for sustainable development, put forward the core of sustainable development is people-oriented. This research framework integrates expert decision making and citizen perception, reflects the nature of sustainable development, and enriches the theoretical system of urban green evaluation. (2) The spatial panel entropy weight method was used to conduct the comprehensive measurement on USD of 17 prefecture-level cities in Shandong Province. From the time dimension, the sustainable development of Shandong showed certain fluctuation in recent 5 years, which reached the maximum value in 2012 and the minimum value in 2014. The fluctuation range of change is not big, which shows the characteristic of homogenization. (3) The spatial panel regression model was used to explore the key affecting factors of USD, and GDP per capital, the ratio of the tertiary industry and the ratio of total exports to GDP have a significant positive effect on USD. Therefore, it is the key to promote the overall sustainable development of Shandong Province to ensure the sustained and stable economic growth, optimize the industrial structure and increase the ratio of the tertiary industry.

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