Analysis and evaluation on the progress of beautiful China strategy—taking shandong province as an example

Xinqi Ding*, Jing Xu, Chunli Lyu, Haisheng Li
Institute of Energy Conservation-Environmental Protection and Low Carbon Economy, Yantai Nanshan University, Yantai 265713, Shandong, China

ABSTRACT

The analysis and evaluation builds up beautiful Shandong evaluation index system with comprehensive method, including 28 indicators of the 4 subsystems—environmental, economic, innovative and social. Using the multi-level factor analysis method, the thesis analyzes the data collected from 2001 to 2013 and the results show that firstly, the evolution of beautiful Shandong strategy presents "wooden barrel effect"; secondly, social public service is an important component of the evolution of beautiful Shandong strategy; thirdly, innovation is the "bottleneck" restricting the evolution of beautiful Shandong strategy. Finally, based on the conclusion of factorial analysis, the thesis puts forward countermeasures and suggestions on speeding up the construction of beautiful Shandong.

Keywords: Beautiful Shandong, evaluation index system, multi-level factor analysis

1. INTRODUCTION

The Eighteenth National Congress of the Communist Party of China clearly points out the construction of a system for ecological civilization should be given a position of prominence and incorporated into every aspect and the whole process of economic, political, cultural, and social development, and thus to strive to build a beautiful China and to realize the sustainable development of the Chinese nation. This statement highlights the importance of implementing the strategy of beautiful China and also proposes new requirements for ecological civilization[1]. The newly issued *Integrated Reform Plan for Promoting Ecological Civilization* aims to build a beautiful China, to handle correctly the relationship between humankind and nature, and to solve serious ecological and environmental problems, to safeguard China's ecological security, to improve the environment, to ensure that resources are used more efficiently, and to step up efforts to promote the formation of a new pattern of modernization in which humankind develops in harmony with nature. It also emphasizes that ecological progress bears on the people's well-being and the nation's long-term strategy in the future. Faced with the current situation of tighter resource constraints, serious environmental pollution and ecological degradation, people should respect, protect, and stay in tune with nature; People should also give ecological civilization the position of prominence and incorporate it into every aspect and the whole process of economic, political, cultural, and social development; Meanwhile, they should strive to build a beautiful China and to realize the sustainable development of the Chinese nation.

2. LITERATURE REVIEW

A lot of scholars carry out a variety of research on building a beautiful China from different angles. Some scholars study connotation and realization, pointing out that beautiful China can be realized by the way of establishing the concept of ecological progress, strengthening the construction of institutions, intensifying protection of the environment, transformation of the pattern of economic development, following a new path of industrialization, strengthening scientific and technological support and strengthening the fundamental role which economic means play in environment protection and analyzes the value targets and value awareness of the beautiful China[2-4]. Some scholars consider beautiful China as a systematic project which must be carried out based on the actual situations of different locations and points out core tasks on the realization of beautiful Shandong: the transformation of the pattern of economic development, promotion of the new urbanization, setting up a system for ecological progress, inheritance and carrying forward the traditional culture, perfection of social security system, improvement of social governance[5,6].

To sum up, studies on beautiful China strategy are still theoretical, in which qualitative analysis from the macro level takes up the majority while quantitative evaluation is rarely adopted. This paper builds beautiful Shandong evaluation

*465150658@qq.com; phone 15064561353

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index system, targets on quantitative evaluation on the implementation and economic basis of beautiful Shandong strategy with multi-level factor analysis method and puts forward suggestions for existing problems.

3. COMPREHENSIVE EVALUATION ON THE IMPLEMENTATION OF BEAUTIFUL SHANDONG STRATEGY

3.1 Comprehensive evaluation index system

Beautiful China is the goal of the economic and ecological progress, referring to the beautiful picture in which green hills, blue sky and water and strong and wealthy country coexistence with each other. According to the basic connotation of beautiful China, combining with the distinctive situations of Shandong province and referring to relevant academic research results, this paper builds the evaluation index system of beautiful Shandong strategy (see in Table 1) using 28 indicators from 4 angles namely environmental, economic, innovative and social (see in Table 1).

Table 1. Evaluation index system of beautiful Shandong strategy.

First class indicator	Second class indicator	Third class indicator	Index attribute	Definition
Index system of beautiful Shandong strategy	Environmental subsystem	Per capita park green area	Positive	X_1
		Green coverage rate	Positive	X_2
		Sewage centralized treatment ate	Positive	X_3
		Urban garbage treatment rate	Positive	X_4
		Comprehensive utilization rate of industrial solid waste	Positive	X_5
		Total industrial discharges	Inverse	X_6
		Chemical oxygen demand emissions	Inverse	X_7
		Ammonia nitrogen emissions	Inverse	X_8
		Sulfur dioxide emissions	Inverse	X_9
		Soot emissions	Inverse	X_{10}
	Economical subsystem	Per capita GDP	Positive	X_{11}
		The tertiary industry as a proportion of the GDP	Positive	X_{12}
		Public financing income	Positive	X_{13}
		Loan amount of financial institutions	Positive	X_{14}
		Per capita consumption expenditure	Positive	X_{15}
		FDI	Positive	X_{16}
	Innovative subsystem	R&D expenditure for enterprises at national scale	Positive	X_{17}
		R&D expenditure	Positive	X_{18}
		Patent applications	Positive	X_{19}
		Patent accreditation	Positive	X_{20}
		Output for high-tech industries at national scale	Positive	X_{21}

First class indicator	Second class indicator	Third class indicator	Index attribute	Definition
	Social subsystem	Enrollment institutes in colleges and universities	Positive	X_{22}
		Book collections in public libraries	Positive	X_{23}
		Sickbed for per thousand people	Positive	X_{24}
		Doctor for per thousand people	Positive	X_{25}
		Per capita urban road space	Positive	X_{26}
		Standard operating cars quantity	Positive	X_{27}
		Per capita living space for rural residents	Positive	X_{28}

3.2 Data-processing and analysis

(1) Data-processing

According to the four subsystems and definitions of the 28 index variables designated in the evaluation index system, data from 2001 to 2013 in Shandong province are collected. The Statistical Yearbook of Shandong Province and Shandong statistical information network are the two sources of the data. Moreover, the relevant indexes are all statistically collected directly or indirectly and the collected data are reliable.

Through analysis of the nature of the index variables, it is found that five index variables are reverse index and the rest 23are positive indicators. So the reverse index with the primary data are regarded as communalities, namely its reciprocal substitute. Because the designed evaluation index system has a wide range and the 28 index variables have different units with no unified metrics, there will be deviation if factorial analysis is adopted. Therefore, this paper uses the standardization of Z transformation with standardization of data processing.

(2) Analysis Method

In the factorial analysis method, the important role the index itself play in the synthesis is neglected. Because the results are influenced by the balance of correlation degree between the original indexes, multi-level factor analysis is adopted in the process of comprehensive evaluation. Multi-level factor analysis is developed on the basis of factor analysis which is used to solve matters of comprehensive evaluation based on multi-layer index. Take second-class index as an example, the first task to do is to evaluate each second-class index separately with factorial analysis method and to distinguish the advantage according to the factorial score; then information of all first-class indexes are empowered and merged with factorial analysis method and thus to get the final comprehensive evaluation[7].

The advantages of multi-level factor analysis lie in that it eliminates influences of the balance of correlation degree between the original indexes. It can not only make an overall judgment on the implementation of beautiful Shandong strategy, but also makes a comparison of the progress of each subsystem, which can clearly show the problems existing in the development process and its role in the process of strategy implementation.

3.3 The process of factor analysis

Using SPSS27.0 software and factorial analysis, this thesis respectively analyzes the environmental, economic, innovative and social-the 4 subsystems and takes common factors whose cumulative contribution rate reached over 85%.

First of all, this thesis makes factorial analysis of the environmental subsystem:

(1) Data correlation inspection and applicability of factorial analysis

Using factorial analysis to standardize the original data from X1 to X10 and coefficient matrix between each index variable is obtained. The analysis finds that there is a correlation between index variables from X1 to X10, and the common factorial extracted using factorial analysis method; this group of data is for KMO inspection and Bartlett sphericity test and the results are shown in Table 2:

Table 2. KMO and Bartlett test.

Test	Indicator		Data
KMO test	Enough samples for Kaiser-Meyer-Olkin test		.577
Bartlett test	Bartlett sphericity	Similar to chi-square test	201.714
		df	45
		Sig.	.000

It can be seen from Table 2 that KMO value is 0.577 > 0.5, which is within an acceptable range. Approximate chi-square is 201.714, the significance level is 0.00 in the case of 45degrees of freedom and thus these data are suitable for factorial analysis.

(2) The calculation of eigenvalues and determination of common factor

The eigenvalues of the coefficient matrix R, contribution rate and cumulative contribution rate, are calculated, as is shown in Table 3. Because the typical representative variables of solution to initial factor is not obvious, it is not convenient to analyze the practical problems, the eigenvalues of the initial value need to be rotated, so that they can better explain practical problems. Based on the principle "eigenvalues should be greater than 1", the first three factors are selected as common factor, respectively for f_{11}, f_{12}, f_{13}; and accumulation contribution rate of the three common factors reaches 96.495%, which can fully explain the original variables to insure less information loss and ideal effect for factorial analysis.

Table 3. Explanatory total variance.

Elements	Initial eigenvalues			Quadratic sum extraction loaded			Rotation sum loaded		
	Summation	Variance %	Accumulation %	Summation	Variance %	Summation %	Summation	Variance %	Summation %
1	5.377	53.769	53.769	5.377	53.769	53.769	4.663	46.625	46.625
2	2.980	29.796	83.565	2.980	29.796	83.565	3.072	30.723	77.348
3	1.293	12.930	96.495	1.293	12.930	96.495	1.915	19.147	96.495
4	.168	1.681	98.176						
5	.084	.836	99.012						
6	.065	.652	99.664						
7	.022	.217	99.882						
8	.008	.075	99.957						
9	.004	.038	99.994						
10	.001	.006	100.000						

Note: Extraction method: principal component analysis.

(3) Factorial loading matrix

To apply orthogonal rotation to factorial loading matrix by the method of Varimax to give the factor named explanatory. The rotated factorial loading matrix are shown in Table 4:

Table 4. Rotating Component Matrix.

Variables	Component		
	1	2	3
Zscore (X1)	.944	-.144	.159
Zscore (X2)	.943	-.118	.294
Zscore (X6)	-.921	.169	-.320
Zscore (X3)	.917	-.122	.330
Zscore (X5)	.913	.317	-.156
Zscore (X7)	-.148	.979	-.121
Zscore (X8)	-.264	.959	-.032
Zscore (X10)	.246	.926	.255
Zscore (X9)	.127	.277	.925
Zscore (X4)	.439	-.287	.795

As can be seen from the rotating loading matrix, per capita park green area (X1), green coverage rate (X2), sewage centralized treatment rate (X3), comprehensive utilization rate of industrial solid waste (X5), waste emissions (X6) have high load on common factor f_{11}, which reflect information on these indicators; chemical oxygen demand emissions (X7), ammonia nitrogen emissions (X8), soot emissions (X10) have high load on common factor f_{11}; The g garbage treatment rate (X4), sulfur dioxide emissions (X9) have high load on common factor f_{13}; Therefore, the three extracted factors can basically reflect the information of all indicators.

(4) Factorial score calculation

Regression method is used to estimate the factorial score in order to get the factorial score coefficient, as is shown in Table 5:

Table 5. Component score coefficient matrix.

Variables	Component		
	1	2	3
Zscore(*X1*)	.228	-.013	-.089
Zscore(*X2*)	.201	-.007	.002
Zscore(*X3*)	.186	-.009	.032
Zscore(*X4*)	-.055	-.089	.452
Zscore(*X5*)	.304	.143	-.303
Zscore(*X6*)	-.187	.025	-.025
Zscore(*X7*)	.022	.320	-.065
Zscore(*X8*)	-.031	.308	.020
Zscore(*X9*)	-.149	.083	.598
Zscore(*X10*)	.052	.312	.108

The factor score function is concluded from Table 5:

f_{11}=0.228*ZX1*+0.201*ZX2*+0.186*ZX3*-0.055*ZX4*+0.304*ZX5*-0.187*ZX6*+0.022*ZX7*-0.031*ZX8*-0.149*ZX9*+0.052*ZX10*

f_{12}=-0.013*ZX1*-0.007*ZX2*-0.009*ZX3*-0.089*ZX4*+0.143*ZX5*+0.025*ZX6*+0.32*ZX7*+0.308*ZX8*+0.083*ZX9*+0.312*ZX10*

f_{13}=-0.089*ZX1*+0.002*ZX2*+0.032*ZX3*+0.452*ZX4*-0.303*ZX5*-0.025*ZX6*-0.065*ZX7*+0.02*ZX8*+0.598*ZX9*+0.108*ZX10*

where *ZX* stands for corresponding variable X taking its standard value.

Weight (Table 3): the corresponding eigenvalues of each common factor account for the overall proportion of extracted common factor; calculation formula for comprehensive factorial score of environmental subsystem is concluded:

$$F = \sum_{i=}^{m} \lambda_i \quad pf_i$$

In the formula, *F*1 stands for comprehensive factorial score for the environmental subsystem; λ_i stands for corresponding eigenvalue of common factor f_{1i}; *P* stands for the sum of all eigenvalue for factors; f_{1i} stands for extracted common factor for environmental subsystem (i=1, 2, …, m). Based on the factorial score function and comprehensive factorial score of environmental subsystem formula, comprehensive factorial eigenvalues in environmental subsystem from 2010 to 2022 can be calculated.

Similarly, with SPSS27.0 software, using the same steps and method used in environmental subsystem, factorial analysis is made for economic (F2), innovative (F3) and social subsystems (F4) respectively to obtain comprehensive factorial score (F) for corresponding subsystem from 2010 to 2022, as is shown in Table 6.

Table 6. Comprehensive Factorial score for corresponding subsystem from 2010 to 2022 and comprehensive score for evaluation system.

Time	F1	F2	F3	F4	F
2010	-1.30173	-1.05864	-1.01165	-1.61085	-1.32316
2011	-1.05547	-0.86451	-0.96389	-1.12123	-1.05899
2012	-0.67232	-0.78013	-0.91217	-1.00986	-0.9365
2013	-0.22573	-0.56307	-0.8363	-0.66934	-0.6858
2014	-0.1537	-0.23023	-0.67683	-0.37353	-0.43824
2015	-0.0374	-0.37215	-0.52162	-0.35422	-0.39839
2016	0.52523	-0.30334	-0.27879	-0.10664	-0.14474
2017	0.619153	-0.1525	-0.03705	0.179278	0.086454
2018	1.023013	0.048431	0.172262	0.367842	0.320931
2019	1.147046	0.507165	0.536321	0.63088	0.664048
2020	-0.08097	0.923687	0.982275	0.959944	0.888879
2021	0.046026	1.261082	1.546222	1.381038	1.327542
2022	0.166852	1.584204	2.001226	1.726694	1.697974

3.4 Comprehensive score for beautiful Shandong evaluation index system

On the basis of factorial analysis to second-class indexes, factorial analysis on factorial score for each subsystem (*F1*, *F2*, *F3, F4*) is made again to get the comprehensive factorial score function for evaluation index system.

$$F=0.118F1+0.241F2+0.345F3+0.351F4$$

Comprehensive scores are shown in Table 6. As shown in Figure 1, dynamic analysis is carried out on data in Table 6 to objectively reflect the dynamic evolution rules of beautiful Shandong.

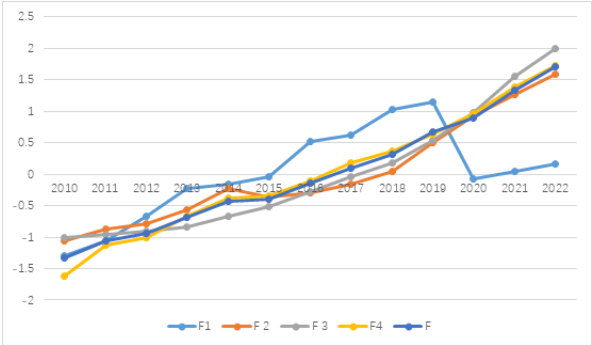

Figure 1. Dynamic evolution rules of beautiful Shandong.

3.5 Comprehensive evaluation on the implementation of beautiful Shandong strategy

The evaluation result shows that in recent years, the overall effect of beautiful Shandong construction is positive, with factorial score turns into a positive number since 2016:

(1) The implementation and evolution of beautiful Shandong strategy presents "wooden barrel effect".

From 2010 to 2016, the four subsystems in the implementation of beautiful Shandong strategy lost their balance with obvious short slab, especially in 2020, the factorial score of environmental subsystem collapsed suddenly. Analysis on the original data finds that ammonia nitrogen emissions of sulfur dioxide and fuel dust explosion increase in 2020, which obviously show that "wooden barrel effect" phenomenon exist in the evolution of beautiful Shandong strategy[8]. Therefore, during the 13th Five Year Plan period, strengthening air pollution and water pollution control needs to take the lead in the implementation of beautiful Shandong strategy.

(2) Social public service is an important part of beautiful Shandong strategy.

From Figure 1, it can be found that comprehensive score for beautiful Shandong strategy is strikingly similar to the score of social subsystem, with the two curves close to overlap. Although the similarity of the two curves is probably a coincidence, it reveals that beautiful Chinese strategy aims to improve people's livelihood, people's quality of life and people's well-being.

(3) Innovation is "bottleneck" which restricts the evolution of beautiful Shandong strategy.

From 2010 to 2022, on the one hand, factorial score of innovative subsystem is lower than that of the other three subsystems; on the other hand, it is also significantly lower than the comprehensive score of beautiful Shandong strategy. Both atmospheric pollution control in environmental subsystem and "restructure the economy and promote development" in economic subsystem all need the support of technology innovation. That the innovative subsystem is relatively backward becomes "bottleneck" restricting the evolution of beautiful Shandong strategy.

4. SUGGESTIONS TO SPEED UP THE EVOLUTION OF BEAUTIFUL SHANDONG STRATEGY

(1) To handle properly the relationship between harmonious development between environment protection and economy

What needs to do first is to clarify the role environment protection plays in economic growth, to place environment protection in a higher position even under the pressure of downward trend of economic growth and to adhere to "development in protection and protection in development" principle[9]. Secondly, people need to grasp the key, the methods and strength of environment protection, to find proper direction; meanwhile, the work force should not only adhere to the principle of giving environment protection priority, but also give full play to the role environment protection plays in optimization of economy, thus to support the boosting and upgrading of economic transformation and obtain win-win development between economic growth and environment protection. Different from situations in Guangdong and Jiangsu, second industry has a higher proportion in the economic structure in Shandong province. Thus, the insurance of economic growth needs to be solved urgently in the process of reducing energy consumption and insure energy conservation and emissions reduction.

(2) To develop energy conservation, environmental protection industry and strengthen innovative ability of green technology[10]

Science and technology are the first productive force, while innovative ability of green technology is a necessary condition for green technology to become the first productivity. During the process of constructing beautiful Shandong, the innovative ability of green technology needs to be promoted. First, we need to strengthen research in green technology for manufacturing industry, to promote the ecological design of industrial products, to carry out substitution of the poisonous and harmful material and to speed up the research and application of source control technology; Second, we need to focus on establishing centralized and open research and development system for green technology. Through the establishment of research platform with flexible policy and preferential treatment, a group of high-level research and development institutions and talents are gathered. Moreover, combined with the weak link of green technology in Shandong province, we need to carry out centralized research and to make key breakthrough, reaching international standards. Third, we need to explore innovation model of the green industry chain. Within the regional environmental bearing capacity, we need to achieve industry collaboration and to establish green industry chain innovation engineering characterized by resource recycling and efficient utilization.

(3) To promote afforestation

Compared with grass and flowers, forest can adsorb more carbon dioxide and dust. It has very high ecological value with the function of windbreak and sand-fixation. It is understood that forest coverage rate in the developed countries is generally over 70%, while in Shandong province it is less than 30%. Therefore, the government should make full use of Greening Expo to carry forward ecological culture, and to integrate greening and beautifying into the whole process of economic construction and into all aspects of social life. The government also needs to accelerate forestation in towns and villages, roads, schools, factories and regions on the basis of natural conditions like mountains, springs, lakes, and rivers, through the marketing operation, contracting management and professional construction, to build green cities and green villages, to create a green living space, and thus to build our green homes.

(4) To improve the public service capacity

The prior duties for governments at all levels are to deepen reform of the administrative system, to transform government function and to provide citizens with equal public services. Education, health care and social security are the focuses of current public service: firstly, on the basis of compulsory education, government needs to promote higher education and vocational education to meet the needs of residents and social enterprises; secondly, government needs to improve medical insurance system, hospital management system and medicine production and circulation system to solve the "doctor-seeking and high cost of medication" problem[11]; thirdly, governments needs to adhere to "wide coverage, protect the basic, multi-level and sustainable" policy, to accelerate the establishment of social security system with urban and rural integration, diversification, management refinement and social security equalization, and to promote social security work to the track of sharing and scientific development. The government needs to improve the fiscal expenditure structure, to increase the proportion rate public service field taking up in financial input, and to improve public service capacity. In addition, the following tasks should also be included: to improve the green credit mechanism, to encourage and guide financial institutions to offer support for circular economy, low-carbon economy, environmental protection and pollution control and emission reduction renovation project.

To sum up, through a variety of measures, Shandong province is moving forward towards the target of "blue sky, clear water and fresh air, peaceful life of citizens, prosperous of economy and sound public order", so as to benefit the future generations continuously.

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