Evaluation of Rural Revitalization Based on AHP and Entropy Weight Method

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Abstract—The implementation effect of the rural revitalization strategy directly affects the rural living standards, becomes a key factor in building a well-off society in an all-round way, and is also a basic guarantee for winning the battle against poverty. This paper selects 14 second-class indexes from five aspects of thriving industry, ecological livability, civilized local custom, effective governance and affluent life, constructs an effective evaluation index system, evaluates and analyzes 25 representative administrative villages in various regions of Guangdong Province, and gives corresponding countermeasures.

Keywords-Rural Revitalization; AHP; Entropy weight method

1 INTRODUCTION

The report of the 20th National Congress of the Communist Party of China proposed to comprehensively promote rural revitalization, deepen rural reform, further implement the requirements of "industrial prosperity, ecological livability, rural civilization, effective governance, and rich life"; and continuously increase rural agricultural policy support and promote agricultural modernization. The implementation of the rural revitalization strategy is the fundamental policy to solve the "Three Rural" issue, win the battle against poverty, improve rural ecological civilization, increase farmers' income and ensure rural harmony and stability. Therefore, constructing an objective, scientific and effective rural revitalization evaluation index system is an important means to complete the strategic objectives and tasks of rural revitalization, which can make all elements organically combined, scientifically gathered and flowed. The scientific evaluation index system not only effectively measures the development degree of rural revitalization, but also provides reference for rural management in different regions. In addition, effective monitoring and evaluation can be carried out to find out the problems in the implementation of rural revitalization in time and put forward feasible countermeasures and suggestions.

2 RELATED LITERATURE REVIEW

The effectiveness of rural revitalization needs to be evaluated. The level of evaluation mechanism directly reflects the degree of rural development. It can grasp the development level of each region and is an important basis for a comprehensive understanding of the actual situation in rural areas [1]. At present, China's research on the content of rural revitalization

evaluation mainly focuses on two aspects: First, research on rural revitalization index system. In the construction of index system, Li Liqing & Li Mingxian (2007) mainly from the industrial development, living standards, spiritual civilization, village appearance, governance effectiveness five levels to build the relevant index system [2]. Guo Xiangyu et al. (2008) established three levels of index system from three aspects of new rural construction, modern agriculture and rural civilization [3]; wang et al. (2009) made a scientific evaluation of the level of rural development, the status quo of villagers' governance and the effectiveness of rural construction in major provinces of China [4]. Secondly, research on the method of rural revitalization evaluation. Tian Yaping et al. (2007) used fuzzy mathematics comprehensive evaluation method, in the form of expert scoring, combined with an analytic hierarchy process (AHP), to empower each evaluation index and calculate the results [5]. Han Xinyu & Yan Fengying (2019) selected the elements of industry, civilization and ecology as the evaluation index, and used the common factor extraction analysis method to construct a unique evaluation index system [6].

Based on the previous research results, this study uses the entropy weight method and the analytic hierarchy process (AHP) to evaluate the effectiveness of rural revitalization [7]. The specific research contents are as follows: First, Based on the above five evaluation indicators, a more detailed evaluation index of rural revitalization is constructed to more objectively reflect the effectiveness and construction status of rural revitalization. Secondly, Using the index system, field research and data collection, 25 administrative villages in Guangdong Province were evaluated and analyzed to verify the effectiveness and scientificity of the evaluation index system [8].

3 CONSTRUCTION OF EVALUATION INDEX SYSTEM OF RURAL REVITALIZATION

3.1 Principles of Index System Construction

The evaluation of the implementation effect of the rural revitalization strategy involves many aspects such as the agricultural economy, farmers' income, rural governance, spiritual civilization and ecological development. Additionally, China has a vast territory, unbalanced regional development, and large differences in resource endowment capabilities. Therefore, when formulating evaluation indicators, certain principles should be followed to strive for objectivity and authenticity.

3.1.1 Systemic principles

The rural revitalization strategy is a systematic project. Therefore, the selected evaluation indicators must reflect the function of the organic whole. The formulation of the index system must systematically reflect the basic connotation and requirements of rural construction. In other words, the constructed evaluation index system can fully reflect the current situation and development trend of rural development.

3.1.2 Scientific principles

When constructing the index system, we must first ensure the objective authenticity of the evaluation content. Simultaneously, it should also reflect the purpose of evaluation and the internal relationship between indicators, in line with the law of development of things.

3.1.3 Comparability principle

Due to the different resource endowments, production factors and economic development levels in different regions, the evaluation indicators should be different. The indicators should be consistent and independent of each other. Simultaneously, avoid duplication of content, so as not to be compared

3.1.4 Data availability principle

The availability of data should be ensured when selecting indicators. Data collection is simple and convenient, and sample data sources are reliable.

3.2 Construction of Index System of Rural Revitalization

On the basis of referring to the existing literature and research results, when constructing the evaluation system of rural revitalization, the article refers to the content of "the opinions of the Central Committee of the Communist Party of China and the State Council on the implementation of the rural revitalization strategy," "the index system of the national construction of a well-off society" and the existing research results of the rural construction index system. Simultaneously, combined with the current reality of rural construction, the evaluation system of rural revitalization is constructed from the aspects of economy, culture, governance and environment, as shown in table 1[9-10].

Table 1 Evaluation Index System of Rural Revitalization

General Objective	First Grade Indexes	Second Index	Required Value (%)
Index System of Rural Revitalization Development Level (A)	Industrial Prosperity (**B₁**)	Industrial Structure (C_1)	≥75
		Industrial Characteristics (C_2)	≥85
		Informatization Level (C_3)	≥74
		Industrial Benefits (C_4)	≥89
	Ecological livable (**B₂**)	Green Index (C_5)	≥88
		Garbage Disposal Rate (C_6)	≥98
		Social Security (C_7)	≥87
	Rural Civilization (**B₃**)	Cultural Education (C_8)	≥99
		Cultural Inheritance (C_9)	≥83
	Effective Governance (**B₄**)	Primary Organization (C_{10})	≥95
		Level of Villager Autonomy (C_{11})	≥97
		Poverty Alleviation Index (C_{12})	≥76
	Be Well-off (**B₅**)	Per capita Income (C_{13})	≥90
		Quality of Life (C_{14})	≥92

4 MODEL CONSTRUCTION

4.1 Using AHP Analytic Hierarchy Process to Determine Weight

According to the evaluation index system constructed in this paper. Firstly, a four-level hierarchical structure model is constructed, and the top layer is the target layer rural revitalization index; followed by the criterion layer, including 5 secondary indicators; again for the sub-criteria layer, contains 14 three indicators. For each level, this paper constructs a judgment matrix and adopts the nine-scale method proposed by Saaty (Thomas L., 1988), which is compared and judged by experts. After the collection, analysis and collation of research and public data, the 9-scale method created by Saaty was used to establish a judgment matrix after evaluation by experts, managers and related service personnel [11]. The sum product method is used to calculate the eigenvalues and eigenvectors of the matrix, and the weight coefficients of each level of indicators are derived. Finally, the calculated results have passed the consistency test, and the comparative analysis of the evaluation indicators shows that it meets the consistency requirements of the model.

4.2 Determining Weight by Entropy Method

The entropy method is a scientific quantitative evaluation method. Its main feature is that there are few subjective intervention factors. The basic idea is to determine the weight according to the degree of variability of the evaluation index. For example, the smaller the information entropy E_j of an index, the greater the variation value of the index, the more information it covers, the greater the weight, and vice versa. First of all, it is necessary to standardize or normalize the data positively and negatively [12]. Then, the entropy and redundancy of each indicator need to be calculated. The principle and steps of entropy weight method are as follows:

4.2.1 Data standardization

The data of each index are standardized. Assume that k indicators X_1, X_2, $\cdots X_k$ are given, where, $X_i = \{X_1, X_2, \cdots X_n\}$, assume that the standardized values of each indicator data are Y_1, Y_1, Y_1, then,

$$Y_{ij} = \frac{X_{ij} - \min(X_i)}{\max(X_i) - \min(X_i)}$$

4.2.2 Information entropy of each index

According to the connotation of information entropy, the information entropy of data $E_i = -\ln(n)^{-1} \sum_{i=1}^{n} p_{ij} \ln p_{ij}$, quorum:

$$p_{ij} = \left. Y_{ij} \middle/ \sum_{i=1}^{n} Y_{ij} \right.$$

If $p_{ij} = 0$, the definition is:

$$\lim_{p_{ij} \to 0} p_{ij} \ln p_{ij} = 0$$

4.2.3   Calculate information entropy weight

According to the relevant mathematical theorems [13], combined with the results obtained from the derivation process, the information entropy of each index is $E_1, E_2, \cdots E_k$, it can be seen that the final index weight are:

$$W_i = \frac{1 - E_i}{k - \sum E_i} (i = 1,2,\cdots,k)$$

4.3   The combination of AHP and entropy weight method

The analytic hierarchy process focuses on subjective assignment, while the entropy weight method is more dependent on objective facts. Both have advantages and disadvantages. In their respective evaluation areas, different applications, the two methods have achieved good evaluation results. Therefore, to reduce the subjective deviation of expert judgment, reduce the defects of data incompleteness, and reduce data errors, this study uses the method of equal weight-weighted average to add the subjective and objective weights and integrate them with each other to achieve the purpose of eliminating deviations. Finally, the comprehensive evaluation weight is obtained. In a word, using the path of combining analytic hierarchy process and entropy weight method to balance the subjective and objective data, the final mean is used as the comprehensive weight to calculate the results of index weighting at all levels, as shown in Table 2. The rural revitalization evaluation model used in the article is as follows [14-15]:

$$Q = \sum W_i Y_i$$

Among them, Q is rural revitalization, W is comprehensive weight, and Y is the standardized value of the sample data of item i in the four-level index.

Table 2 Evaluation index system weight

General Objective	First Grade Indexes	AHP Weight	Entropy Method Weight	Compre-hensive Weight	Second index	AHP Weight	Entropy Method Weight	Comprehensive Weight
Index System of Rural Revitalization Development Level (A)	Industrial Prosperity (B1)	0.2560	0.3248	0.2904	Industrial Structure (C1)	0.1257	0.1768	0.1512
					Industrial Characteristics (C2)	0.0859	0.0965	0.0912
					Information Level (C3)	0.0243	0.0383	0.0313
					Industrial Benefits (C4)	0.0201	0.0132	0.0167
	Ecological livable (B2)	0.4321	0.3832	0.4076	Green Index (C5)	0.6393	0.2278	0.4335
					Garbage Disposal Rate (C6)	0.2737	0.1163	0.1950
					Social Security (C7)	0.0869	0.0391	0.0630
	Rural Civilization (B3)	0.1017	0.1002	0.1010	Cultural education (C8)	0.0833	0.0845	0.0839
					Cultural City Heritage (C9)	0.0184	0.0157	0.0171
	Effective Governance (B4)	0.0986	0.0665	0.0825	Party Organization (C10)	0.0562	0.0478	0.0520
					Level of Villager Autonomy (C11)	0.0235	0.0087	0.0161
					Poverty Alleviation Index (C12)	0.0189	0.0100	0.0145
	Be Well-off (B5)	0.1116	0.1253	0.1185	Income (C13)	0.0867	0.0962	0.0915
					Quality of Life (C14)	0.0249	0.0291	0.0270

5 AUTHENTIC PROOF ANALYSIS

5.1 Data Sources

The data of this study are mainly from the data published by the government, which are "China Rural Statistical Yearbook 2019-2021", "Statistical Bulletin of National Economic and Social Development of Guangdong Province 2019-2021" and the statistical data of Guangdong Province in recent years. In view of the default of some indicators, the statistical mean is used instead.

Based on the research results of The Guangdong Rural Construction Research Group, this study selected 25 representative villages as the sample of this study, following the principle of systematicness and comparability on the basis of social research practice for 3 years. According to the above evaluation index system, a questionnaire was developed, and a dynamic interview survey was conducted on the selected sample individuals during 2019-2021. The obtained survey data were standardized and substituted into the above model operation to obtain the corresponding results. The distribution of the study samples is as follows: the eastern region of Guangdong accounted for 23.71%, the western region of Guangdong accounted for 26.46%, the northern region of Guangdong accounted for 29.98%, and the Pearl River Delta (nine cities) accounted for 19.85%. The sample basically covers the eastern, western, northern and central regions of Guangdong Province, as well as poor, medium and rich regions. According to the principle of a typical area study, the above samples are very representative.

5.2 Analysis of Empirical Evaluation Results

Based on 25 typical administrative villages, this study conducted a three-year investigation and research, and conducted 75 village-level statistics and evaluation studies; according to the annual evaluation results of 25 sample villages, in strict accordance with the above-mentioned comprehensive indicators and the corresponding secondary indicators were ranked. According to the results of annual data analysis, the comprehensive score of 25 villages in 2019 was 67.32, the comprehensive score of 25 sample villages in 2020 was 75.76, the comprehensive score of 25 villages in 2021 was 79.35. Observing from the time trend, the effect of rural revitalization is very significant, and the score has increased year by year.

From the analysis of the results, it can be seen that the villages with better implementation of rural revitalization have the following characteristics: the party building work has performed well, improved the governance level of grassroots organizations, and continuously introduced new measures to create agricultural industrial parks as the starting point. Speed up the circulation efficiency of agricultural products; at the same time, under the leadership of grassroots organizations with active economic thinking, the design of rural tourism boutique routes has broadened the income sources of farmers and laid a solid economic foundation for the construction of ecologically livable beautiful villages. In the villages with low comprehensive score of rural revitalization, most of the industries are in the exploratory stage, the path of increasing farmers' income is narrow, and it is in the primary development stage. In

terms of villagers' autonomy and cultural education, the scores of relevant indicators are generally low.

5.3 Analysis of the Implementation Effect of the Rural Revitalization Strategy

Through in-depth investigation of villages in various regions of Guangdong Province, based on the latest evaluation results in 2021, the sample villages are grouped and compared according to the length of implementation time, and the implementation results are obtained. According to the length of implementation time, 9 villages within half a year of implementation have an average score of 63.72; six villages have been implemented for about one year, with an average score of 67.61, and seven villages have been implemented for about two years. The average score was 80.43; the average score of sample villages which have been implemented for 3 years is 86.59.

In 2021, the average score of rural revitalization effectiveness of 25 villages will be 79.35. The industrial prosperity score was 13.58, reaching 75.55% of the target value; the ecological livability score was 19.09, reaching 70.66% of the target value; the score of rural civilization was 14.75, reaching 77.48% of the target value. The effective governance score was 12.84, reaching 86.29% of the target value. The wealth of life score was 15.78, reaching 73.44% of the target value. In the evaluation of the effectiveness of rural revitalization in 2021, the top three are Daya Village in Meizhou City, Zili Village in Jiangmen City, and Datang Village in Sanshui City. Daya Village in Meizhou City, relying on the park, actively cultivates agricultural industrial parks, and achieves an output value of 5.3 billion yuan. Around the characteristic agricultural product of 'Meizhou pomelo', it vigorously develops the rural e-commerce industry, builds a new agricultural product circulation system; and increases farmer' income. The comprehensive tourism construction carried out by Zili Village in Jiangmen City has created ecological livable beautiful villages, designated Kaiping Diaolou Overseas Chinese Hometown Boutique Line, and was named the first "Top Ten Beautiful Village Boutique Lines in Guangdong". Datang Village in Sanshui City pioneered the "government, bank and insurance" agricultural loan cooperation mechanism in China.During 2021, a total of 826 loans of "government, bank and insurance" were issued, totaling 228 million yuan. It effectively solves the financial bottleneck of farmers, promotes the entrepreneurial enthusiasm of individual farmers, and greatly broadens the income space.

6 AUTHENTIC PROOF ANALYSIS

6.1 Conclusion

The rural revitalization strategic plan involves many aspects such as industry, ecology, culture, rural governance and living standards. Comprehensive evaluation methods can objectively measure the implementation effect of rural revitalization. This study constructs a quality evaluation system for rural revitalization and development; and uses an evaluation model based on the combination of AHP entropy weight method to conduct in-depth research on 25 representative administrative villages of different types selected from the whole region of Guangdong Province for three consecutive years. The survey data obtained through empirical analysis and statistical tests show that the evaluation system constructed in this paper can objectively evaluate and reflect the effectiveness of rural revitalization. Therefore, it is

recommended to further promote the application in other regions and even nationwide. Simultaneously, this study also draws the following conclusions: the longer the implementation of the rural revitalization plan, the more obvious the effect of rural revitalization. Using this evaluation index system, the level of rural revitalization and development that is difficult to measure is transformed into quantifiable and observable indicators. Therefore, by evaluating and monitoring the development of rural revitalization, timely discovering problems and summarizing good experience, the development direction of rural construction in the future is further clarified.

6.2 Suggestions

Through the analysis of the level of rural revitalization and development in Guangdong Province, in response to the government's call for rural revitalization, to solve the problem of rural industrialization and civilization, based on practical considerations, put forward relevant recommendations for consideration:

6.2.1 Focus on systemic

The implementation of rural revitalization is a huge project, which is systematic and not achieved overnight. It does not require the realization of various indicators in the short term. It should follow the principle of being both comprehensive and comparable to gradually achieve common prosperity. For example, in the early stages of development of rural areas, although the implementation of the results are not significant, but also must maintain the continuity of policy. Unswervingly, adhere to the implementation, to achieve the purpose of comprehensive rural revitalization.

6.2.2 Organizational building

Strengthen the construction of rural party organizations, be good at discovering problems, improve political positions, identify entry points for rural governance, making good use of government policies, activating funds for rural revitalization industries, and developing efficient solutions; at the same time, we should focus on the fight against poverty and further strengthen the improvement of rural living environment and the construction of public health system.

6.2.3 Relying on scientific

Relying on a professional research team to establish a rural revitalization evaluation team, using scientific measurement methods, according to the actual situation of different villages classified implementation, to provide accurate quantitative management measures, build a scientific system of evaluation database, to draw reasonable suggestions.

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