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Research On The Construction Of An Evaluation Index System For The Sustainable Development Capability Of The Kiwifruit Industry Under The Background Of Rural Revitalization- Taking Boshan District As An Example

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Abstract:
Background*: Rural revitalization is not only integral to national planning but also crucial for enhancing people's livelihoods. Against the backdrop of the ongoing implementation of the rural revitalization strategy, the transformation and revitalization of the countryside have emerged as pivotal objectives for contemporary scholars. This research focused on constructing an evaluation index system for the sustainable development capability of the kiwifruit industry in Boshan. This effort holds both theoretical significance and practical importance, offering valuable guidance for the sustainable development of the Boshan kiwifruit industry and contributing to future rural revitalization endeavors.*
Materials and Methods*: In this study, the current status of the sustainable development of the Boshan kiwifruit industry was analysed using a questionnaire and descriptive analysis. Key factors influencing sustainable development were identified through this process. A comprehensive framework for evaluating the sustainable development capability of the Boshan kiwifruit industry was established. Key indicators were extracted from four dimensions: production technology (B1), market factors (B2), economic factors (B3), and environmental factors (B4). The hierarchical analysis method (AHP) and the Delphi method were employed to construct the evaluation index system. The results revealed that the weights in descending order were B2 > B3 > B1 > B4, underscoring the paramount importance of market factors and acknowledging the significance of economic factors in the sustainable development of the Boshan kiwifruit industry.*
Results*: By characterizing the sustainable development of the kiwifruit industry with extracted key indicators and actual data, an assessment of the sustainable development capability of the kiwifruit industry in the Boshan region was conducted. The findings can lead to insightful decisions and recommendations aimed at fostering the sustainable development of the kiwifruit industry in the Boshan region.*
Keywords*: Rural revitalization, Kiwifruit industry, Analytic hierarchy process, Sustainable Development*

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I. Troduction

The introduction of China's rural revitalization strategy heralds a new era, presenting both unprecedented opportunities and challenges for the country's agricultural sector. This comprehensive strategy aims to stimulate sustainable growth in rural economies, enhance the living standards of farmers, and foster balanced economic and social development across urban and rural landscapes. It encompasses a range of initiatives, including deepening rural reforms, bolstering infrastructure[1], and promoting industrial upgrades.

Within the framework of this ambitious strategy, the kiwifruit industry has garnered significant attention as a key avenue for agricultural structural adjustments and for augmenting farmers' incomes. As society and the economy continue to evolve, a distinctive hallmark of contemporary living is the upsurge in consumer preferences and heightened health consciousness. There has been palpable increase in people's concerns regarding food safety and health, leading to a growing demand for highly nutritious, environmentally friendly, and organic food options. Kiwifruit, with its abundant vitamin C content and various other nutrients, has gained prominence in the market against this backdrop [2]. The rural revitalization strategy explicitly advocates for the integration of scientific and technological innovations in agriculture to enhance production efficiency [3]. In this context, the development of specialty agriculture and the establishment of competitive agricultural industrial clusters and their associated systems are not only national strategic imperatives but also intrinsic requirements for regional economic development. Furthermore, these initiatives provide empirical

cases that contribute to the structural adjustment of the agricultural economy, enriching and expanding the theoretical framework of agricultural economics.

The analytic hierarchy process (AHP) is a quantitative analysis method used for multilevel complex decision-making problems. He et al. [4] constructed a decision-making model for the selection of regional strategic emerging industries, applied ARCGIS to study the spatial distribution of strategic emerging industries in Sichuan Province, and used the fuzzy comprehensive evaluation method (FCEM) and AHP to solve the priority problem of strategic emerging emerging industry. Additionally, Peng et al. [5] employed a combination of fuzzy mathematics and hierarchical analysis for land conflict risk assessment to effectively address social problems in the field of land exploration, specifically land conflicts, in order to cope with the challenges of uncertainty and inaccuracy. Karimi et al. [6] used hierarchical analysis and fuzzy hierarchical analysis to determine the optimal wastewater treatment process. Hierarchical analysis is one of the best ways to make decisions about complex criteria structures at different levels, while fuzzy hierarchical analysis is a comprehensive extension of the classical approach with ambiguity considerations for decision makers.

Therefore, this paper describes research on the construction of an index system for evaluating the sustainable development capacity of the kiwifruit industry in the Boshan region. The methodology involves analysing the current situation of sustainable kiwifruit industry development, analysing the influencing factors of sustainable kiwifruit industry development, constructing the content framework of the sustainable kiwifruit industry development system, extracting the key indexes of sustainable kiwifruit industry development, and using hierarchical analysis and the Delphi method to establish an evaluation index system for sustainable kiwifruit industry development ability. By combining the characterization of the Boshan region with the extracted key indexes and actual data, this study evaluated the sustainable development ability of the Boshan region kiwifruit industry and proposed corresponding decisions and suggestions.

II. Development of a mathematical model for kiwifruit evaluation systems

Hierarchical analysis

The analytic hierarchy process (AHP) is a decision-making methodology that systematically dissects the essential components of decision-making, such as objectives, guidelines, and scenarios, by translating them into technical terms. This process involves both qualitative and quantitative analyses [7-10]. The hierarchical analysis method (AHP) further dissects the problem into formal factors based on the nature of the problem and the overarching goal. It then aggregates and integrates these factors at different levels, considering their relevance and subordination, thereby forming a multilevel analytical structural model. This approach ultimately simplifies the problem from the highest level (comprising the overall goal) to the lowest level (encompassing decision-making options, measures, etc.), prioritizing the determination of relative importance or value rankings, as illustrated in Figure 1. To assign weights to these factors, this thesis adopts a two-by-two comparison method combined with experiential knowledge to rank the relative importance of each factor [9, 11].

Hierarchical analysis involves a systematic four-step process:

1. Association Analysis: Scrutinizing the interconnections between factors to create a recursive hierarchy for the system.
2. Two-by-Two Comparison: Conducting a meticulous two-by-two comparison of factors within the same level, assessing their relative importance concerning a criterion from the previous level. A judgment matrix is constructed based on these comparisons.
3. Relative Weight Calculation: The relative weights of the compared factors concerning the criterion, derived from the judgement matrix, are computed.
4. Synthetic Weight Calculation: Computation of synthetic weights for factors at each layer in relation to the system objectives, facilitating their ranking.

This systematic approach ensures a comprehensive hierarchical analysis, systematically evaluating the relative importance and impact of factors within the decision-making system.

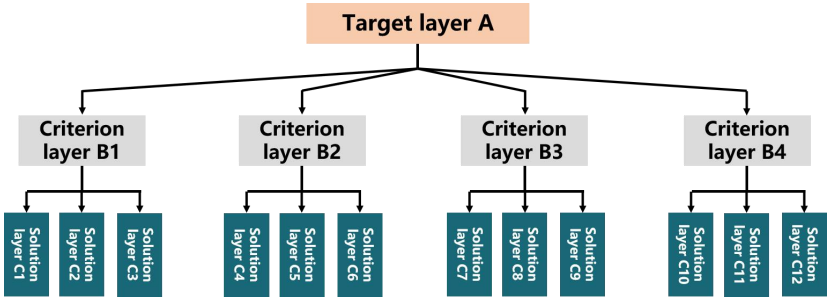

Figure 1. Hierarchical model

Delphi technique

The Delphi technique, which originated from the RAND Corporation in the United States around the 1950s, is an intuitive forecasting method that amalgamates the expertise of numerous professionals with subjective judgment. Widely applied in comprehensive evaluations across diverse fields, the Delphi method employs a correspondence survey format, relying on a systematic procedure of anonymously expressing opinions. Team members are prohibited from discussing with each other, maintaining vertical communication only with the investigator. Through multiple rounds of expert surveys on pertinent questionnaire issues, the Delphi method involves repeated solicitation, induction, modification, and technical processing, ultimately consolidating into a fundamental consensus of expert views as predictive results. It adheres to basic principles such as anonymity, round robin, control feedback, group response, and expert consensus, fostering consensus among experts and arriving at final prediction results [12].

The establishment of a hierarchical structure model involves categorizing decision-making objectives, factors, and indicator layers into the highest, middle, and lowest tiers based on their interrelationships. This leads to the creation of a hierarchical structure diagram. In the context of evaluating the sustainable development capacity of the kiwifruit industry in Boshan, the top-level decision-making target is the evaluation system. The impacts of various indicators on sustainable development capacity are then analysed across four aspects: production technology, market factors, economic factors, and environmental factors. Consequently, the intermediate layer comprises the influences of production technology, market factors, economic factors, and environmental factors on the sustainable development of the kiwifruit industry. The lowest level included various indicators affecting the sustainability of the kiwifruit industry in Boshan, classified under the respective intermediate layers, as depicted in Figure 2.

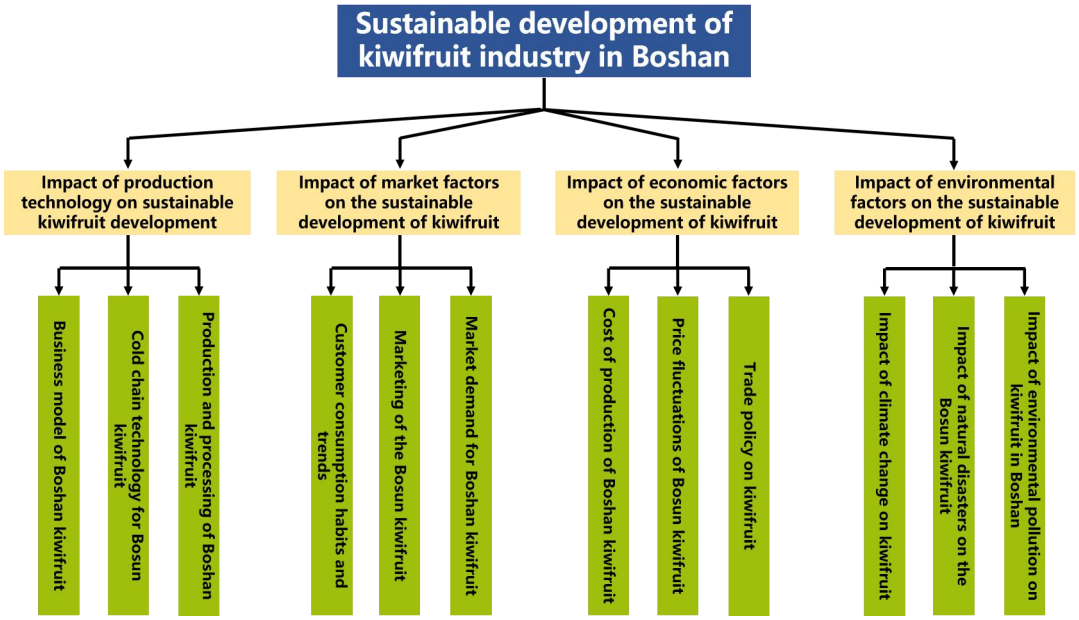

Figure 2. Hierarchical Modelling Diagram

Construction of judgement matrices

When evaluating various factors at each level, purely qualitative results are often met with skepticism by others. To address this issue,, Saty et al. propose a consistent matrix approach that allows for a comprehensive comparison of all factors rather than their mere aggregation. Using relative scales, however, poses challenges in comparing factors across different properties with a high degree of accuracy. In the comparison process, pairs assess the options and gauge their importance levels, denoted as a_{ij}, which represents the result of comparing the importance of element i and element j [13]. Table 1 provides a list of nine importance levels and corresponding recommendations suggested by Saty.

Determining weights between factors at each level can be challenging if the results are solely qualitative. In response, Saaty et al. advocate for the consistency matrix method. Instead of comparing all factors together, they recommend a pairwise comparison approach with a relative scale, minimizing the difficulty of comparing factors with diverse natures. For instance, under a specific criterion, programs are compared pairwise, and their importance levels are rated accordingly. The resultant matrix from these two-by-two comparisons is termed a judgment matrix. The judgement matrix possesses certain properties:

$$a_{ij} = \frac{1}{a_{ji}}$$

The scaling method for the judgement matrix aij is as follows:

Table 1: Scale of proportions

Factor i over factor j	Quantitative value
Equally important	1
Low Priority	3
Neutral Significance	5
Moderate Importance	7
High Priority	9
Median of two adjacent judgments	2，4，6，8

a_{ij} is the result of the importance comparison of element i to element j. Table 1 lists the nine importance levels given by Saaty and their assigned values.

Based on the table above, in conjunction with the use of the Delphi method, the constructed model is organized, summarized, and statistically weighted. Subsequently, the experts' scoring results are processed using the geometric mean method to obtain the final scores for various categories of indicators [9]. The formula for the Ho average method is:

III. Case Studies

Data collection

To faithfully capture the current state of sustainable development in the kiwifruit industry, survey locations were primarily chosen from kiwifruit-producing towns in Boshan District, Zibo city, Shandong Province, China. The survey employed a questionnaire distribution method, covering information related to the household head's family, the head's land ownership, kiwifruit cultivation practices, cultivation operations, production inputs, sales, and relevant policies. A total of 240 questionnaires were distributed among kiwifruit farmers in the Boshan area, yielding 217 valid responses. This resulted in a high validity rate of 90.42%. The comprehensive data gathered from these surveys provide a robust foundation for accurately assessing the dynamics of the sustainable development of the kiwifruit industry in the region.

Analysis of results

Upon integrating the evaluation system with the actual questionnaire responses, it becomes evident that the sustainable development capacity of the Boshan kiwifruit industry is influenced by diverse factors. Market factors exert the most significant impact, with a dominant weighting of 0.3770. This study underscores that shifts in the market and evolving demands play a decisive role in shaping the trajectory of the kiwifruit industry's development. Subsequently, economic factors follow closely with a weight of 0.3611, underscoring the pivotal role of economic considerations, financial support, and related aspects in ensuring sustainability. The weight of production technology is 0.1741, indicating that advancements in production technology positively contribute to the industry's sustainable development. Although environmental factors carry a comparatively lower weight at 0.0878, their influence on industry sustainability is still noteworthy. The statistical results are visually presented in Figure 3, providing a comprehensive overview of the various impacts of these factors on the sustainable development of the kiwifruit industry in Boshan.

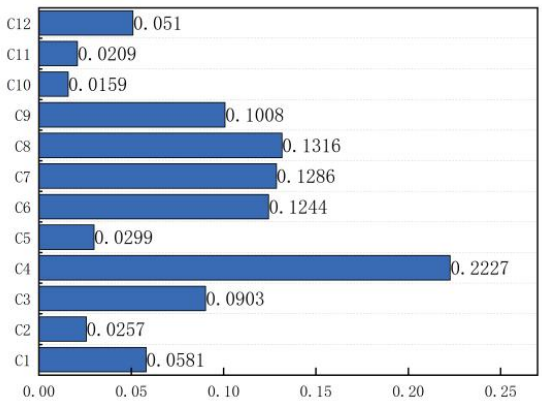

Figure 3. Analysis of the weights of the indicators of the kiwifruit industry's sustainable development capacity evaluation system

The aforementioned weighting analyses offer valuable insights for industrial decision-making, underscoring the significance of market and economic factors in shaping strategic directions. By prioritizing marketing efforts, refining product positioning, and adjusting economic policies, the Boshan kiwifruit industry can effectively navigate external changes and bolster sustainable development. Simultaneously, the prompt adoption of advanced production technology has emerged as a pivotal driver of industry advancement. While environmental factors carry a lower weight, they warrant sufficient attention in the industry's development to prevent irreversible damage to the environment. These weightings provide the Boshan kiwifruit industry with a comprehensive framework for developing a sustainable strategy, fostering the long-term prosperity of the industry as a whole.

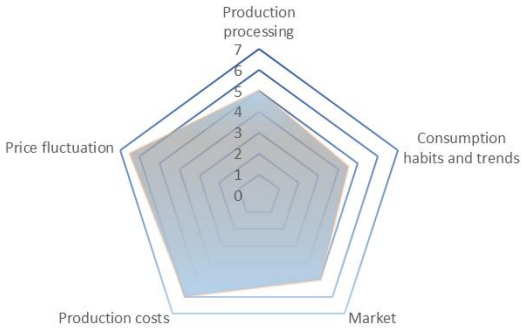

Figure 4. Radar chart on the sustainability of the kiwifruit industry

IV. Conclusion

This study focused on evaluating the sustainable development capacity of the kiwifruit industry in Boshan against the backdrop of rural revitalization. The research objective involves constructing a corresponding evaluation index system, conducting a standardized assessment of various influencing factors on kiwifruit industry development in Boshan, and conducting an in-depth analysis of its sustainable development. The main conclusions of the study are as follows:

The current state of the sustainable development of the kiwifruit industry in Boshan was analysed using a questionnaire research method and descriptive analysis. This study explored the key factors affecting the sustainable development of the kiwifruit industry in Boshan. By establishing a general framework for the evaluation system of the sustainable development capability of the kiwifruit industry in Boshan, key indicators were extracted from four aspects, including production technology (B1), market factors (B2), economic factors (B3), and environmental factors (B4). An evaluation index system for the sustainable development capability of the kiwifruit industry was constructed using the hierarchical analysis method and the Delphi method. The evaluation results indicated that the weights were B2 > B3 > B1 > B4, highlighting the importance of the market factor in the sustainable development of the kiwifruit industry in Boshan, while the influence of economic factors cannot be overlooked.

Based on the evaluation model of the sustainable development of the kiwifruit industry in Boshan and a comprehensive analysis of industry characteristics and actual data, it was found that the unbalanced distribution of market demand, production cost instability, and the urgent need for improved management necessitate comprehensive and targeted industry adjustments. To address the current challenges and promote the sustainable development of the kiwifruit industry in Boshan, the following strategies are proposed: 1. Optimizing the marketing strategy, increasing brand publicity in areas with insufficient market demand, and improving customer awareness and acceptance of kiwifruit. Encouraging cooperation within and outside the industry, enhancing specialization, and elevating farmers' production levels through technical support and training. The focus should be on resolving uneven production costs, improving production efficiency through scientific and technological means, and reducing transport losses. The government provides guidance for farmers to actively participate in industry development through supportive policies, such as loan support and policy subsidies. For future research, it is recommended to delve more deeply into the factors behind market demand, including the psychological and social aspects of customers' purchasing decisions. Overall, through comprehensive improvements and innovations, the Boshan kiwifruit industry is anticipated to achieve enhanced sustainable development.

V. References

[1] Chen H, Wang Z. Research on the construction of village classification evaluation index system under the background of rural revitalization[C]. IOP Conference Series: Materials Science and Engineering. 2019, 592(1): 012115.

[2] Wang H, Wang X, Sarkar A, et al. Evaluating the impacts of smallholder farmer's participation in modern agricultural value chain tactics for facilitating poverty alleviation—A case study of kiwifruit industry in shaanxi, china[J]. Agriculture, 2021, 11(5): 462.

[3] Chen M, Zhou Y, Huang X, et al. The integration of new-type urbanization and rural revitalization strategies in China: Origin, reality and future trends[J]. Land, 2021, 10(2): 207.
[4] He K, Zhu N. Strategic emerging industry layout based on analytic hierarchy process and fuzzy comprehensive evaluation: A case study of Sichuan province[J]. PloS one, 2022, 17(3): e0264578.
[5] Peng G, Han L, Liu Z, et al. An application of fuzzy analytic hierarchy process in risk evaluation model[J]. Frontiers in Psychology, 2021, 12: 715003.
[6] Karimi A R, Mehrdadi N, Hashemian S J, et al. Selection of wastewater treatment process based on the analytical hierarchy process and fuzzy analytical hierarchy process methods[J]. International Journal of Environmental Science & Technology, 2011, 8: 267-280.
[7] Ara A, Zohora F T, Nurul N, et al. Optimal site selection for solar plant using analytical hierarchy process (AHP): A case study in Bangladesh[J]. Environmental Progress & Sustainable Energy, 2024, 43(2): e14272.
[8] Li L, Ma X M, Guo W. Evaluation model of cable insulation life based on improved fuzzy analytic hierarchy process[J]. Mathematical Problems in Engineering, 2021: 1-11.
[9] Han Y, Wang Z, Lu X, et al. Application of AHP to road selection [J]. ISPRS International Journal of Geo-Information, 2020, 9(2): 86.
[10] Darko A, Chan A P C, Ameyaw E E, et al. Review of application of analytic hierarchy process (AHP) in construction[J]. International journal of construction management, 2019, 19(5): 436-452.
[11] Coffey L, Claudio D. In defense of group fuzzy AHP: A comparison of group fuzzy AHP and group AHP with confidence intervals[J]. Expert Systems with Applications, 2021, 178: 114970.
[12] Niederberger M, Köberich S, DeWiss Network. Coming to consensus: the Delphi technique[J]. European Journal of Cardiovascular Nursing 2021, 20(7): 692-695.
[13] Li F, Phoon K K, Du X, et al. Improved AHP method and its application in risk identification[J]. Journal of Construction Engineering and Management, 2013, 139(3): 312-320.