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A Fuzzy Analytic Hierarchy Process-Based Analysis of the Dynamic Sustainable Management Index in Leisure Agriculture

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Abstract: Agricultural leisure is one of the development trends in modern society. However, in leisure agriculture management, managers must consider the dual characteristics of agricultural production technology and the leisure service industry. Therefore, managers often face various selection pressures during management decision-making. This study examined the following five evaluation aspects: organization and operation, leisure agricultural resources, environmental maintenance management, public facility maintenance management, and operational performance. Thereafter, according to the five evaluation aspects, 21 subprojects were further divided at the second level on the basis of different attributes. Fuzzy analytic hierarchy process (FAHP) was adopted to calculate the relative weights of various indicators, and the indicators were dynamically sorted according to their importance. Moreover, the study summarized the dynamic management indicators of leisure agriculture and contributed to research on leisure farming. The results show that managers' approach toward leisure agriculture management can be divided into three types: active, moderate, and conservative. The indicators in which the active managers attach importance when managing leisure agricultural enterprises are clearly different from those valued by moderate and conservative managers. Finding managers who are suitable for leisure agriculture management is of great significance to leisure agriculture enterprises. Appointing managers with appropriate attitudes who can continuously improve the efficiency of enterprises and create a competitive advantage can bring sustainable business value to these enterprises.

Keywords: fuzzy analytic hierarchy process; dynamic sustainable management index; leisure agriculture

1. Introduction

Agriculture is the most primitive and basic industries in the history of human civilization. Originally, it was only responsible for food production [1]. However, with social evolution and industrial upgradation, the agricultural industry currently combines production, processing, and related services, which led to the evolution of six-level industrialized leisure agriculture (or recreational agriculture), which is now the new model for agricultural management. Leisure agriculture is a creative industry that responds to the needs of the times. It applies agricultural resources to leisure and recreational activities to meet the needs of tourists and increase farmers' income, thereby enhancing agriculture industry's value. In short, agricultural management entails the localization of agricultural resources based on agricultural production activities and compatibility with natural ecological environments [2].

Agricultural leisure is one of the development trends of a modern society. Leisure agriculture management has four main principles and characteristics: agricultural management, natural ecological conservation, farmers' interests, and consumer demand-orientation [3]. The general characteristics of the service industry comprise intangibility, difference in service quality, simultaneity of production and consumption, and perishability of goods that cannot be stored. Moreover, leisure businesses have the characteristics of being capital-oriented and labor-intensive [4]. The market is influenced by significant environmental impacts, large demands of elasticity (people's livelihood necessities), predictable seasonality in demand, rigidity in supply (some goods cannot be temporarily supplied), inability to store products and provide immediate service, continuity of operation, and comprehensive functions concerning 10 characteristics, such as publicity and locality [5].

Thus, leisure agriculture has extremely diverse management characteristics, and the complexity of its management necessitates a scientific method that can provide managers with a reference for decision-making. Particularly, managers must consider the dual characteristics of agricultural production technology and leisure services. Therefore, managers often face different selection pressures during management decision-making. The current study used the fuzzy method to dynamically sort indicators according to their importance, summarize the dynamic management indicators of leisure agriculture, and provide a reference to facilitate leisure agriculture operators' decision-making.

2. Literature Review

2.1. Leisure Agriculture

Leisure agriculture entails the use of agriculture, farmers, and rural resources to combine production, life and ecology, and design experience activities [6]. It integrates primary, secondary, and tertiary industries; maximizes the overall effect of resources; develops an innovative agricultural enterprise management method; and drives rural sustainable development [7]. After decades of development, Taiwan's leisure agriculture industry is well received in the international tourism market and represents a successful example of transformation and innovation in Taiwan [8].

Relevant literature suggests that the management scope of leisure agriculture is all-encompassing, including industries such as the catering industry (food), hotel industry (accommodation), transportation and travel industry (tourism), activity and leisure industry (play), and accompanying gift industry (retail), which all broadly fall under leisure business [9]. In other words, the service scope of leisure business is to combine food, clothing, housing, transportation, education, entertainment, and even social practices, including assembly, health, shopping, and other functions. A series of service products that are linked together can be considered a part of the leisure business.

The leisure agriculture department falls within the broad scope of the service industry. In addition to having the characteristics of any general service industry; it also has short consumption experience, emotional purchasing, emphasis on service evidence, emphasis on reputation and image, diversified sales channels, interdependence of related businesses, and product susceptibility [10]. This industry adopts and pays attention to strategies such as off-season promotions [11].

The operating conditions are based on the resources available at the time of operation, and are considered from the externally available resources and the conditions they own. The operating conditions include four items: the operating entity, land attributes, resource characteristics, and professional functions [12]. The operating entity refers to the enterprise that is operating and the basic organization of the operation, which influences the decision-making model of business operation. Land attributes include the carrying capacity, cultivation capacity, nutritional capacity, and location of the farms [13]. Resource characteristics can be divided into natural resources, landscape resources, industrial resources, cultural resources, and human resources, and others [14]. Professional functions can be summarized as knowledge, ability, technology, and attitude [15]. Leisure agriculture introduces features that make tourists feel valuable and provides them with a value-for-money experience. Therefore, the development of leisure agriculture, in particular, requires a return to the origin of resources. The basic resources of leisure agriculture comprise agricultural resources and rural resources [16].

This study argues that the operating conditions must include organization operations, leisure agricultural resources, environmental maintenance management, public facilities maintenance management, operating performance, and others [16].

2.2. FAHP Method

In the traditional Analytic Hierarchy Process (AHP) method, the nine-point scale method is used to compare each level of the target options, and each pair represents the priority of the target options. The nine-point scale method was proposed by Saaty [17]. The preferences among options are rated as equal, slightly strong, strong, very strong and extremely strong. The values of these preferences are respectively 1, 3, 5, 7, 9 in comparison, and the ratio of comparison is a clear real value. However, the selection of target options is often subjective and imprecise, so the traditional AHP method cannot accurately determine the relative weight of target options.

In order to model the uncertainty of this human preference, the AHP method is combined with the pair comparison of fuzzy sets. The FAHP facilitates decision-making procedures with precise definitions. Buckley [18] is an early researcher of FAHP, who used the triangular membership function to represent pair fuzzy ratios to figure out the partial fuzzy priority through the method of least squares (later the geometric mean method). Singh and Sarkar [19] further revised the hierarchical analysis method of Saaty [17] by calculating the relative preference of each factor, and then using the fuzzy Delphi method to integrate group opinions. Hsu matched the ideal values with the actual evaluation values, calculated the performance value of each proposal, and performed the multiplication of the triangular fuzzy number in hierarchical cascade. As a result, a new fuzzy comprehensive evaluation method was developed to solve the nonlinear problem.

Kwong and Bai [20] combined the concept of triangular fuzzy numbers with the AHP-based operation of Saaty [17], and applied this algorithm to the program of quality function deployment. First, the semantic measurement of tourists' quality requirements for agricultural products was transformed into triangular fuzzy numbers, and these numbers were constructed into an AHP contrast matrix by means of pair comparison. The weights and relative importance of tourists' demands were calculated through FAHP. Then, an empirical study on the mountaineering bicycle industry was conducted, applying the FAHP method to the three-level quality function deployment framework. In doing so, a complete AHP mode was built featuring simple, easy-to-understand and easy-to-operate calculation process. Therefore, the FAHP method of Kwong and Bai [20] was used in this study to determine the relative preference and ranking of consumer experience value.

2.3. Dynamic Management Index

To be successful in a fiercely competitive market, enterprise management must have the right business positioning and an effective business strategy to give direction to enterprises through appropriate planning processes and effective incentivization systems. The index can be defined as "a measure that can summarize information related to a particular phenomenon or thing, or can reasonably replace that measure." [21]

The Management Index can be used to improve enterprise performance. Every successful enterprise has its own Management Index; however, when an enterprise faces a rapidly changing environment, its Management Index must also be innovative enough to respond to the impact environment and maintain its competitive advantage [22].

This study defined a dynamic Management Index by referring to a company's business operation process on the basis of internal data and data analysis, external environment forecast, timely adjustment of the company's business strategy, management methods, and business plans. The circular process of modification and supplementation, which can be used to measure specific phenomena or related information, can provide various criteria for management decision-making.

2.4. The Evolution of FAHP Theory

Some scholars use the AHP method to judge the importance of human perception attributes [23–27]. Within the AHP context, the decision maker cannot provide deterministic preferences but perception-based judgment intervals instead. This kind of uncertainty in preferences can be modeled using fuzzy set theory [23]. In fuzzy set terminology, the ratio supplied by the decision maker is a fuzzy number described by a membership function. Here, a membership function describes the degree and which elements in the judgment interval belong to the preference set. FAHP consists of derivation of the local priorities from these fuzzy preference ratios, which are subsequently aggregated to form the global priorities [24]. Because the preferences in AHP are essentially human judgments based on perception (this is especially true for intangibles), the fuzzy approach might allow a more accurate description of the decision-making process. The earliest work on FAHP appeared in Buckle [25], which compared fuzzy ratios described by triangular membership functions; Lootsma's logarithmic least square was used to derive local fuzzy priorities [26]. Later, using geometrical means, [27] determined fuzzy priorities of comparison ratios whose membership functions were trapezoidal.

Then, Godoy [28] applied row mean method to obtain priorities for comparison ratios that were fuzzy triangular numbers. All the aforementioned works compute fuzzy priorities based on arithmetic operations for fuzzy triangular (or trapezoidal) numbers [29].

To use fuzzy arithmetic operations, specific assumptions on the forms of membership functions are required. To date, there are only a limited number of membership-function forms that are computationally manageable [30]. Moreover, the accuracy of the final ranking is inevitably weakened by the series of approximations required during the computation procedure. However, the most important criticism on these works is their failure to address the issue of consistency [31]. There was no explicit articulation on what would constitute as an inconsistent comparison matrix within the FAHP context and, equally important, on how inconsistent information should be handled [32]. Lacking a mechanism to exclude inconsistent data, the fuzzy priorities so obtained were likely to be of a low quality [33].

In deterministic (referring to crisp in fuzzy terminology) AHP, Pandey and Litoriya [34] warned about the difficulties with inconsistent comparisons in the analysis. As part of the AHP procedure, a consistency check is required to identify an inconsistent matrix (with unacceptable deviations) [35]. For a comparison matrix that fails the consistency test, the decision-maker has to recalculate the ratios [36]. Unlike crisp AHP where the ratios are point estimates, the comparison ratios in FAHP are given in ranges of values [37]. The likelihood of having inconsistent ratios within the given ranges is therefore far greater [38]. Additionally, to expect the decision-maker to provide (or redo) comparisons such that the ranges include only consistent comparison ratios would be highly unrealistic, as it is a labor-intensive task [39]. The critical gap is thus not only needed for a consistency test to accept only consistent matrices, but also a mechanism to filter out inconsistent information within a consistent matrix [40].

The issue of consistency in FAHP was first tackled by Buckle [25]. Departing from the fuzzy arithmetic approach, Singh et al. [41] derived fuzzy weights using an auxiliary programming formulation that described relative fuzzy ratios as constraints on the membership values of local priorities. Discussions about the feasible region of relative weights in terms of linear inequalities was previously provided by Behera et al. [42] and extended in Yucesan and Gul [43]. Requiring only quasi-concave and continuous fuzzy comparison ratios, Roy and Dutta [44] defined consistency in terms of the mean values of the fuzzy ratios (range of values with membership degree equal to one). Here, a fuzzy matrix was considered consistent if there existed a set of crisp relative weights within the feasible region defined by the ranges of mean values [45]. Kaya et al. [46] used a two-grade fuzzy synthetic decision-making system with use of AHP for evaluating the performance of grinding fluids reported. Five different pairs of algorithms were used in the first evaluation. Their reliability was ordered according to the principle of least squire method [47]. Here the first three algorithms were selected and used in the second-grade evaluation. However, it could not concurrently tackle the pairwise comparison involving triangular, general concave and concave [48]. Wang et al. [49] used AHP to elicit a corresponding priority vector interpreting the preferred information from the decision-makers, based on the pairwise comparison values of a set of objects. Since pairwise comparison values are the judgments obtained from an appropriate semantic scale, in practice the decision-makers usually give some or all pair-to-pair comparison values with an uncertainty degree rather than precise ratings [50]. By employing the property of goal programming (GP) to treat a fuzzy AHP problem, this study incorporates an absolute term linearization technique and a fuzzy rating expression into a GP-AHP model for solving group decision-making fuzzy AHP problems [51]. In contrast to current fuzzy AHP methods, the GP-AHP method developed herein can concurrently tackle the pairwise comparison involving triangular, general concave and concave–convex mixed fuzzy estimates under a group decision-making environment. However, deriving a crisp ranking from the global fuzzy weights is complicated [52]. Thus, the framework of feasible region of relative weights for QFD must be adopted [53]. They allowed the feasible region to include tolerance deviations of the fuzzy ratios, and define fuzzy consistency as the existence of relative weights within the region. Then using the extension principle, the filtered information is used to construct the local fuzzy weights and subsequently the global fuzzy weights [54]. Here, they devise a maximum-minimum set ranking method to derive a crisp ranking from the global fuzzy weights. However, it is difficult to reduce the failure rates in cases when any two members in fuzzy sets have close membership values.

Jain et al. [55] also described and extended Saaty's eigenvalue approach to fuzzy membership determination. A genetic algorithm-based procedure is adopted to minimize the failure rates in fuzzy membership determination using Saaty's eigenvalue approach. The proposed method is then extended to develop an aggregate fuzzy membership function using a multiple decision-maker environment [56]. He examined Saaty's eigenvalue approach for fuzzy membership function determination. It was shown that the traditional approach of fuzzy membership function determination, using the CDP concept for evaluating test problems, resulted in high failure rates when any two membership functions had very close values [51]. A GP-based optimization procedure was proposed here to reduce the failure rates when any two members in fuzzy sets have close membership values. However, identifying a meaningful indicator for measuring the level of group consistency is challenging through this method.

3. Research Method

This study adopts the FAHP developed by Kwong and Bai [20] to figure out the preference of each principle and subprinciple, based on which the importance ranking of each preference is calculated for susceptibility analysis.

3.1. Framework and Definition of Study

3.1.1. Framework

According to the literature review in Section 2, this study believes that the sustainable operation of leisure farms requires the coordination of various resources. Therefore, it is more appropriate to use FAHP to plan the sustainable operation of leisure farms. Because the hierarchical analysis method can analyze the weight of each project, and incorporate the projects of high importance into the future sustainable development indicators of planning leisure farms. Therefore, this study constructs a model for the sustainable management index of leisure farms. To modify the FAHP structure of the leisure farms, the final decision of the FAHP structure is shown in Figure 1. This study constructs five main criteria facets and 21 subcriteria evaluation projects.

3.1.2. Definition of Study

The classification and definition of the preliminary and subcriteria are shown in Table 1.

Table 1. Aspects and criteria for evaluating the integrated development of leisure agricultural operation.

Indicator Facet	Subindicator Facet	Description
C1 Farm operation	S1: Farm structure and division of labor implementation S2: Farm growth S3: Farm objectives S4: Self-improvement and enhancement function S5: Farm self-sufficiency	Refers to the organizational structure and projects that an farm must have when operating

Table 1. *Cont.*

Indicator Facet	Subindicator Facet	Description
C2 Leisure agricultural resources	S6: Inventory of local industry resources S7: Local industry resource utilization S8: Leisure Agriculture–Related Fields S9: Channel connection and inter-industry cooperation	The degree of cooperation between various resources and industries outside of leisure agriculture
C3 Environmental Maintenance Management	S10: Overall Farm environment creation S11: Use of environment S12: Maintenance of Farm environment	Refers to the environmental maintenance during leisure farm operations
C4 Maintenance and management of public facilities	S13: Utilization of public facilities S14: Maintenance and management of public facilities S15: Friendly facility environment	The establishment and maintenance of various facilities related to leisure farm operations
C5 Operational performance	S16: Visitors S17: Economic output value S18: Driving population to stay and return S19: Promotion of employment S20: Use of network situation S21: Special performance	Operational performance refers to the basis for the performance of leisure farm in operation

Source: Lin, C.-N. etc. (2020); this study.

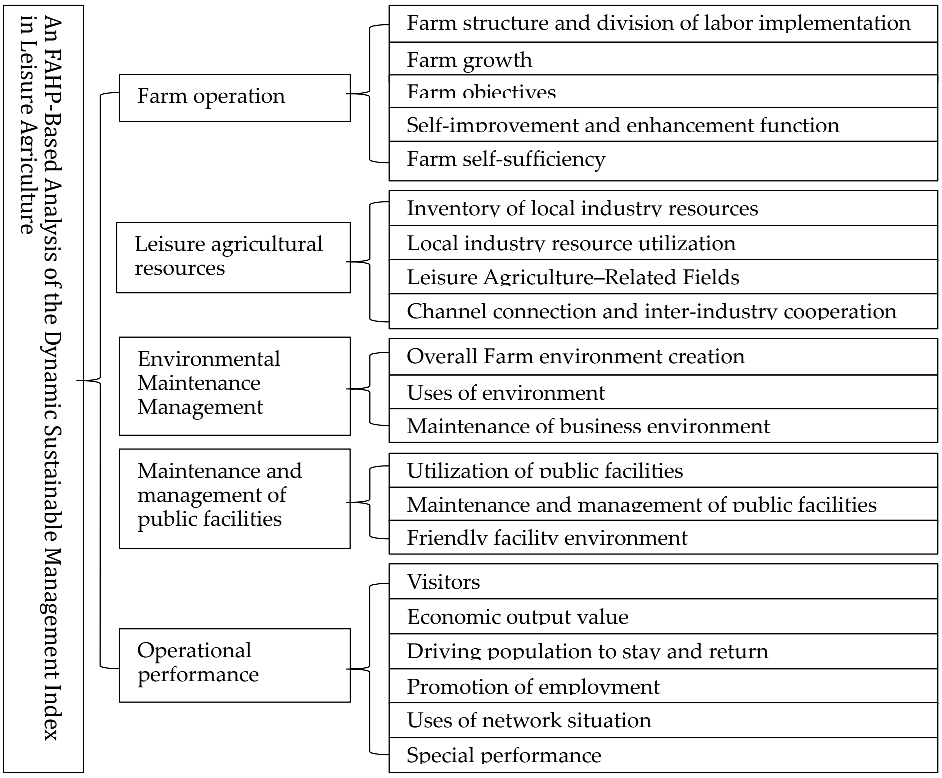

Figure 1. The Framework of leisure farm management indicators. Source: This study.

3.2. *Samples and Surveys*

In this study, the questionnaires of experts in leisure farms were distributed by mail, in-person interviews, and e-mail to collect the opinions of experts. In this study, the questionnaire survey was conducted by experts, and the questionnaire was first sent out in person and mailed. Those who did not reply to the questionnaire within seven days received the first collection by telephone or SMS to remind them that they had not yet responded to the questionnaire. If there was no reply after 14 days, the second collection will be carried out. When designing the questionnaire for the FAHP structure of the sustainable operation indicators of leisure farms, we should understand and analyze the factors that affect the sustainable operation of leisure farms as much as possible, i.e., the factors that affect the sustainable operation of leisure farms in the question. At the same time, the ultimate goal of the question was determined.

The questions on this research questionnaire targeted the managers of five leisure farms in Taiwan. The five leisure farms are the Flying Cow Ranch, Dongshi Forest Farm, Hualu Leisure Farm, Fairy Lake

Leisure Farm, and Shangrila Leisure Farm. The expert information of the questionnaire experts, such as age, length of work, gender, education, title, etc., are detailed in Table 2. A total of 5 questionnaires were distributed in the initial test, and 5 questionnaires were recovered. There were five valid responses, and the recovery rate was 100%. Five questionnaires were issued in the retest, and five questionnaires were recovered. There were five copies of valid questionnaires, and the recovery rate was 100%. In this study, two tests were conducted through the initial test and the retest.

Table 2. The expert information of the questionnaire experts.

Region	Farms	Title	Working Years
Northern	Flying Cow Ranch	Special Assistant to the Chairman	15
Central	Dongshi Forest Farm	Commissioner	9
	Hualu Leisure Farm	General manager	18
Southern	Fairy Lake Leisure Farm	Manager	25
Eastern	Shangrila Leisure Farm	Manager	12

Source: This study.

After establishing the management index of the sustainable management index of the leisure farm, the FAHP quantitative questionnaire for the pairwise comparison between the standards was be issued by mail. The respondents of the AHP questionnaire targeted the managers of 21 leisure farms in Taiwan. The 21 questionnaires surveyed leisure farms are distributed in the north, middle, south and east of Taiwan. Among them, there are 5 leisure farms in the north, 5 leisure farms in the middle, 5 leisure farms in the south, and 6 leisure farms in the east. The expert information of the questionnaire experts, such as region of Taiwan, working experience (working years), professional title, etc., are shown in Table 3. Twenty-one questionnaires were distributed, and 21 questionnaires were recovered. Among them, 21 copies of valid questionnaire were received, and the recovery rate was 100%. Finally, MATLAB software was used as an asset analysis tool.

Table 3. The expert information of the questionnaire experts.

Region	Farms	Title	Working Years
Northern	Flying Cow Ranch	Special Assistant to the Chairman	15
	Green World Leisure Farm	Manger	6
	Jiudou Village Leisure Farm	General manager	24
	Jinyong Tourism Farm	General manager	20
	Futianyuan Leisure Farm	Manager	5
Central	Dongshi Forest Farm	Commissioner	9
	Hualu Leisure Farm	General manager	18
	Taiyi Educational Leisure Farm	Manager	10
	Lavender Forest Leisure Farm	Manager	10
	Mogu Tribe Leisure Farm	Manager	10
Southern	Fairy Lake Leisure Farm	Manager	25
	Tsou Ma Lai Farm	Commissioner	10
	Dakeng Leisure Farm	Manager	15
	Angel Garden Leisure Farm	General manager	10
	Fuwan Leisure Farm	Chairman	21
Eastern	Shangrila Leisure Farm	Manager	12
	Toucheng Leisure Farm	Manager	5
	Lichuan Fishing Leisure Farm	Chairman	10
	Xinguang Zhaofeng Leisure Farm	Manager	6
	Chulu Ranch	Manager	2
	Toyugi Leisure Farm	Manager	3

Source: This study.

3.3. Fuzzy Pair Comparison

3.3.1. Triangular Fuzzy Number

The set of membership functions, which is a normalized and convex complete set of real numbers with segmental continuity, is called fuzzy number. The fuzzy number used in this study is $\widetilde{1}$ to $\widetilde{9}$, and its relative intensity is defined as $\widetilde{1}$ equivalent, $\widetilde{3}$ slightly strong, $\widetilde{5}$ strong, $\widetilde{7}$ very strong, and $\widetilde{9}$ extremely strong. The fuzzy set F = (x, F (x)), x R, R: −< x <+. F (x) is a continuous band with fuzzy triangle number $\widetilde{M}$ = (a, b, c), where a ≤ b ≤ c, and its membership function is defined as follows:

$$m_{\widetilde{M}}(x) = \begin{cases} 0\ x < a \\ \frac{x-a}{b-a}\ a \le x \le b \\ \frac{c-x}{c-b}\ b \le x \le c \\ 0\ x < c \end{cases} \quad (1)$$

Suppose that the confidence interval is, the triangular fuzzy number is defined as follows:

$$\forall_{\partial} \in [0,1]$$
$$\widetilde{M}_{\partial} = \left[a^{\partial}, c^{\partial}\right] = [(b-a)\partial + \alpha, -(c-b)\partial + c]$$

The five triangular fuzzy numbers adopted in this study are $\widetilde{1}$ to $\widetilde{9}$. The function is shown as Figure 2:

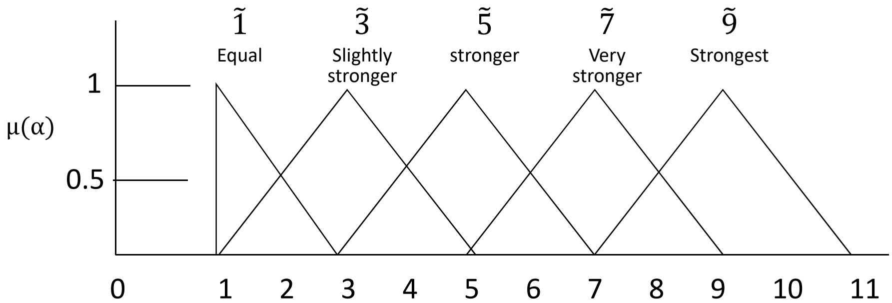

Figure 2. Triangular fuzzy number function. Source: Buckley (1986).

If the number of samples is not one and there are m samples, the triangular function number is $\widetilde{M}_{ij} = \left(a_{ij}, b_{ij}, c_{ij}\right)$. If i is the performance evaluation unit, j is the judgment principle, the calculation of triangular fuzzy numbers is shown as Formula (2):

$$a_{ij} = \left(\sum_{k=1}^{m} a_{ij}^{k}\right)/m$$
$$b_{ij} = \left(\sum_{k=1}^{m} b_{ij}^{k}\right)/m \quad (2)$$
$$c_{ij} = \left(\sum_{k=1}^{m} c_{ij}^{k}\right)/m$$

3.3.2. Algebra Calculation

According to the nature and expansion principle of triangular fuzzy numbers, it was supposed that there were two triangular fuzzy numbers; the algebra calculation is as follows:

$$\begin{gathered}\forall_{mL}, m_R, n_L, n_R \in R^+, \widetilde{M}_\partial = \left[m_L^\partial, m_R^\partial\right]\\ \widetilde{N}_\partial = \left[n_L^\partial, n_R^\partial\right], \partial \in [0,1]\\ \widetilde{M} \oplus \widetilde{N} = \left[m_L^\partial + n_L^\partial, m_R^\partial + n_R^\partial\right]\\ \widetilde{M} \ominus \widetilde{N} = \left[m_L^\partial - n_L^\partial, m_R^\partial n_R^\partial\right]\\ \widetilde{M} \otimes \widetilde{N} = \left[m_L^\partial n_L^\partial, m_R^\partial - n_R^\partial\right]\\ \widetilde{M} \oslash \widetilde{N} = \left[m_L^\partial / n_L^\partial, m_R^\partial / n_R^\partial\right]\end{gathered} \tag{3}$$

3.4. FAHP Algorithm

The triangular fuzzy number AHP method adopted in this study can effectively improve the calculation method of fuzzy vectors in the interval by calculating the fraction of the discriminant matrix. The algorithm can be divided into the following steps:

Step 1. Establish a hierarchical analysis framework and define comparative performance values. Establish a hierarchical framework of consumer experience value, and then calculate Equation (2) according to the algebraic operation of Equation (3) to obtain triangular fuzzy numbers.

Step 2. Establish a fuzzy pair comparison matrix. Use the average value of triangular fuzzy numbers, and establish a fuzzy discriminant matrix, which is defined as follows:

$$\widetilde{A} = \begin{bmatrix} 1 & \widetilde{\alpha}_{12} & \widetilde{\alpha}_{13} & \cdots & \widetilde{\alpha}_{1(n-1)} & \widetilde{\alpha}_{1n} \\ \widetilde{\alpha}_{21} & 1 & \widetilde{\alpha}_{23} & \cdots & \widetilde{\alpha}_{2(n-1)} & \widetilde{\alpha}_{2n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \cdots & \vdots & \vdots \\ \widetilde{\alpha}_{(n-1)1} & \widetilde{\alpha}_{(n-1)2} & \widetilde{\alpha}_{(n-1)3} & \cdots & 1 & \widetilde{\alpha}_{(n-1)n} \\ \widetilde{\alpha}_{n1} & \widetilde{\alpha}_{n2} & \widetilde{\alpha}_{n3} & \cdots & \widetilde{\alpha}_{n(n-1)} & 1 \end{bmatrix} \tag{4}$$

Step 3. Calculates the fuzzy eigenvalue. Assuming that ~ is a fuzzy number, the formula for solving fuzzy eigenvalues is as follows:

$$\widetilde{A}_{\widetilde{x}} = \widetilde{l}_{\widetilde{x}} \tag{5}$$

where A is an n x n fuzzy matrix composed of the non-zero fuzzy vectors of $\widetilde{\alpha}_{\widetilde{u}}$, $\tilde{x}$, and $n \times 1$, and the fuzzy number $\widetilde{x}_i$. The fuzzy multiplication and addition are shown, and the interval algorithm and αα-cut must be used. Equation (5) is equal to:

$$\left[a_{i1l}^\partial x_{1l}^\partial, a_{i1u}^\partial x_{1u}^\partial\right] \oplus \cdots \oplus \left[a_{inl}^\partial x_{nl}^\partial, a_{inu}^\partial x_{nu}^\partial\right] = \left[k_{il}^\partial, k_{iu}^\partial\right]$$

where

$$\begin{gathered}\widetilde{\alpha}_{ij}^\partial = \left|\alpha_{ijl}^\partial, \alpha_{iju}^\partial\right| \widetilde{x}_i^\partial = \left[x_{il}^\partial, x_{iu}^\partial\right] \widetilde{l}^\partial = \left[l^\partial{}_l, l^\partial{}_u\right]\\ 0 \leq \alpha \leq 1\end{gathered} \tag{6}$$

where i and j, i = 1, 2, ... , n; j = 1, 2, ... , n.

The degree of importance can be estimated by μ, the optimistic index of the discriminant matrix. The higher the value of μ is, the higher the degree of optimism. The linear function group of this optimistic indicator is defined as:

$$\widetilde{\alpha}_{ij}^\partial = m a_{iju}^\partial + (1-m)\alpha_{ijl}^\partial,\ \forall_m \in [0,1] \tag{7}$$

when α is a fixed value, insert the optimistic indicator μ to calculate the importance of each factor.

$$\widetilde{A} = \begin{bmatrix} 1 & \widetilde{\alpha}_{12}^{\partial} & \cdots & \widetilde{\alpha}_{1n}^{\partial} \\ \widetilde{\alpha}_{21}^{\partial} & 1 & \cdots & \widetilde{\alpha}_{2n}^{\partial} \\ \vdots & \vdots & \ddots & \vdots \\ \widetilde{\alpha}_{n1}^{\partial} & \widetilde{\alpha}_{n2}^{\partial} & \cdots & 1 \end{bmatrix} \quad (8)$$

Step 4. According to the hierarchical relationship between principles and subprinciples, the preference importance of consumer experience value is calculated with α of different values.

Step 5. Susceptibility analysis and discussion.

4. Case Analysis

This survey targeted managers of leisure farms in northern, central, southern, and eastern Taiwan to collect data for a hierarchical analysis questionnaire survey to obtain the ranking of various aspects and evaluation indicators. The questionnaires were distributed from 10–30 November 2018. A total of 21 questionnaires were distributed, and 21 questionnaires were recovered. Hence, the questionnaire recovery rate was 100%. The average work experience of managers was 11.7 years (Table 3). The survey was conducted through emails, communication, and filling software. The analysis was conducted through the following steps:

Step 1. Five evaluation aspects of FAHP algorithm as explained in Section 3.2 were formulated, namely organization and operation, leisure agricultural resources, environmental maintenance management, public facility maintenance management, and operational performance. Thereafter, according to the five evaluation aspects, 21 subprojects were further divided at the second level according to different attributes; thus, the third level of the hierarchical structure was established. The 21 subprojects were classified into five subprojects under the structure of organizational operation, four subprojects under the structure of leisure agricultural resources, and three subprojects under the structure of environmental maintenance management and public facilities maintenance management. Moreover, three and six subprojects were classified into the face and operational performance face, respectively. This three-level structure comprised the research framework required for this research.

A hierarchical analysis framework to define comparative performance values was established. This study uses the manager experience value hierarchical framework proposed by this study to Charla Mathwick et al. [57] to classify consumer experience perception value into four principles and eight subprinciples with 17 attributes, and adopts a four-level hierarchical framework, as shown in Appendix A. The triangular fuzzy number $\left(\widetilde{1}, \widetilde{3}, \widetilde{5}, \widetilde{7}, \widetilde{9}\right)$ is defined as equivalent, slightly strong, strong, very strong, and extremely strong, and Equation (2) was used to calculate the triangular fuzzy number.

Step 2. After consolidating the opinions of relevant scholars through a literature review and providing a theoretical basis, this paper constructs the Delphi method index questionnaire data, covering a total of five aspects and 21 evaluation indicators. The questionnaire was issued in November 2019 and was used to assess the production of leisure agriculture-related fields. Questionnaires were administered to five experts, scholars, and officials, and five responses were received. Hence, the recovery rate was 100%. The average work experience of the experts was 20.6 years.

Step 3. After performing the screening using the Delphi method, five major evaluation aspects and 21 evaluation criteria passed the test. Therefore, all the evaluation aspects and evaluation criteria were retained, and the hierarchical architecture diagram remained unchanged.

Step 4. Establish a fuzzy pair comparison matrix.

$$S_1 : FCM_1 = \begin{matrix} CR_1 \\ CR_2 \\ CR_3 \end{matrix} \begin{bmatrix} (1.00, 1.00, 1.00) & (0.20, 0.33, 1.00) & (0.33, 0.99, 1.01) \\ (1.00, 3.02, 4.99) & (1.00, 1.00, 1.00) & (0.98, 1.01, 2.99) \\ (1.00, 1.00, 1.00) & (0.33, 0.99, 1.02) & (1.00, 1.00, 1.00) \end{bmatrix} \quad (9)$$

Use Equation (9) to establish a fuzzy comparison matrix (FCM), such as:

Step 5. Calculate the fuzzy eigenvalue.

The fuzzy number defined in Equation (1) was used, as was Equation (7) and Equation (5) to calculate the eigenvalue vector of each matrix, such as:

$\alpha = 0.5$, $\mu = 0.5$:

$$S_1 : FCM_1^{0.5} = \begin{bmatrix} 1.00 & 0.60 & 0.85 \\ 1.71 & 1.00 & 1.21 \\ 1.21 & 0.88 & 1.00 \end{bmatrix}$$

Its vector is:

$$S_1 = W_{CR_1}\ W_{CR_2} W_{CR_3} = [0.26\ 0.41\ 0.33]$$

Step 6. Calculate the preference value of each factor

Following Step 5: The eigenvectors of each matrix were computed and the relative importance preference of the whole was obtained by computing the product of the eigenvectors according to the hierarchical relationship between the principle and subprinciple. For example, when $TW_{CR_1} = W_{C_1} \times W_{S_1} \times W_{CR_1}$, $\alpha = 0.5$, $\mu = 0.5$, the importance preference of each factor was calculated and integrated in Table 1. Table 1 shows that when $\alpha = 0.5$, $\mu = 0.5$, consumers pay more attention to art in the principle of experiential value, followed by service excellence and return on investment of tourists; in the subprinciple of experiential value, consumers pay more attention to visual attraction and service enthusiasm; and in the relative importance of preference, they pay more attention to personnel service, time-saving and leisure farm environment. (shown as Table 4).

Table 4. Relative importance of the manager experience value preference of recreational agriculture. ($\alpha = 0.5$, $\mu = 0.5$).

Criterion	Weight	Subcriteria	Weight	Total Weight
C1 Business operation	0.39953	S1: Enterprise structure and division of labor implementation	0.29623	0.118353
		S2: Business growth	0.09255	0.036977
		S3: Business objectives	0.17926	0.07162
		S4: Self-improvement and enhancement function	0.20788	0.083054
		S5: Enterprise self-sufficiency	0.22409	0.089531
C2 Leisure agricultural resources	0.20887	S6: Inventory of local industry resources	0.213823	0.044661
		S7: Local industry resource utilization	0.274575	0.05735
		S8: Leisure Agriculture–Related Fields	0.224256	0.04684
		S9: Channel connection and inter-industry cooperation	0.287346	0.060018
C3 Environmental Maintenance Management	0.13149	S10: Overall business environment creation	0.430296	0.05658
		S11: Use of environment	0.203544	0.026764
		S12: Maintenance of business environment	0.36616	0.048146
C4 Maintenance and management of public facilities	0.09789	S13: Utilization of public facilities	0.244312	0.023916
		S14: Maintenance and management of public facilities	0.33890	0.033175
		S15: Friendly facility environment	0.416788	0.040799

Table 4. *Cont.*

Criterion	Weight	Subcriteria	Weight	Total Weight
C5 Operational performance	0.16222	S16: Visitors	0.08295	0.013456
		S17: Economic output value	0.25433	0.041257
		S18: Driving population to stay and return	0.22762	0.036925
		S19: Promotion of employment	0.21181	0.03436
		S20: Use of network situation	0.08940	0.014502
		S21: Special performance	0.13388	0.021718

Source: This study.

Step 7. Susceptibility analysis

Different α values and the MATLAB Package was used, and μ = 0.05, 0.5, 0.95 was put in Equation (7) to analyze the relative importance susceptibility of manager dynamic management index, and the results are shown in Appendix A.

5. Conclusions and Suggestions

5.1. Conclusions

The quantity of μ, the indicator to determine the optimism of management recreational agriculture, will affect the manager preference ranking. This study puts μ = 0.05, 0.5, 0.95 in Equation for susceptibility analysis (i.e., managers' attitude toward management is conservative, normal and positive), and uses MATLAB software to calculate the preference value of α from 0 to 1, and obtain the results of Figure 1. The horizontal axis of the graph is the least accurate region (α = 0) to the most accurate region (α = 1), and the relative importance of the preference of S1 to S16 is obtained. Some points in the figure of Appendix A are worth noticing:

1. The most important aspects of active management attitude toward leisure agriculture entail the following: S9: channel connection and cooperation between different industries, S8: leisure agriculture-related fields, S7: use of local industrial resources, S4: self; five items such as improvement and function enhancement, and S20: internet usage situation. Active managers' management attitude toward leisure agriculture is biased toward the integration of marketing and local resources. They attach importance to the improvement of self-management capabilities. Therefore, managers' attitudes toward leisure agriculture tend to be active, and the indicators they value tend to be related to the market. The positive management attitude of this type can improve enterprises' competitive advantage in the market for the operation of leisure agriculture. Management attitude is more meaningful in management practice.
2. The most important aspects of moderate managers' management attitudes toward leisure agriculture entail the following: S1: enterprise structure and implementation of division of labor, S5: enterprise self-sufficiency, S4: self-improvement and function enhancement, S3: enterprise operation goals, S9: channel connection and inter-industry cooperation, and other five items. These items focus on strengthening and improving the company's operating capacity and survival goals, improving the company's operating competitiveness, and then expanding external marketing channels. Therefore, managers' attitudes toward leisure agriculture usually tend to be moderate. Moreover, the management indicators they value mainly strengthen the competitiveness of the enterprise. In practice, the management performance of enterprises has the most important consideration by managers.
3. Conservative managers and moderate managers have almost the same attitude toward leisure agriculture. However, they differ in order due to the following: S5: enterprise self-sufficiency, S1: enterprise structure and division of labor implementation, S2: enterprise growth situation, S3: business operation target and S9: channel connection and inter-industry cooperation. The conservative focus is placed on the survival of the company, and the internal business

performance indicators of the company tend to be used. Therefore, managers who tend to have conservative management attitudes toward leisure agriculture value management indicators that focus on strengthening the survival of the enterprise. Moreover, in practice, implementing the enterprise's management system is the most important consideration.

4. Leisure farms should pay attention to the internal operation and the integrity and fluency of critical processes, and attention to the efficiency of resource use and the resource base of agriculture. This has a relationship with the establishment of the competitive advantages of corporate operations. Therefore, leisure farms should pay attention to the implementation of corporate structure and division of labor. In the maintenance of the operating environment, attention should be paid to the overall environmental creation.

5.2. Research Contribution

This study uses AHP to find out the relative importance of dynamic management index in recreational agriculture, and to obtain the ranking value of dynamic management index. To sum up, this study makes two contributions:

1. Applying the FAHP algorithm proposed by Kwong and Bai [20] to evaluate the relative importance of manager dynamic management index, which is easy to understand and use, and is close to the real management of managers' value. Using this method to strengthen the preference value of high relative importance can support managers' intentions of management; hence, this method benefits the formulation of management strategies.
2. In susceptibility analysis, we found that the ranking of the management value preferences of managers vary with different management tendencies. Manager or strategy-makers should pay attention to the performance of managers and changes in their attitudes toward increasing the competitive advantage of enterprises.

5.3. Management Significance

The priority for recreational agriculture farms is to create the art and service excellence for consumers in their recreation journeys, aiming at improving the return on investment of tourists. To this end, the quality of managers and strategy-makers and the enterprises' competitive advantage in the domain of recreational agriculture are important.

1. In terms of managers, recreational agriculture managers should strengthen training in order to enhance the professional competence and quality of management skills, while managerial tendencies must be more aligned with a positive attitude with the right choice, enterprise architecture and professional and clear explanation of travel market.
2. With regard to strategy-makers, finding managers who are suitable to the role of managing leisure agriculture is very important for leisure agriculture enterprises. Managers with different business tendencies place different degrees of emphasis on enterprise management. Different strategic combinations are utilized for the shaping of enterprise organizations, resource allocation, personnel assignment, and market judgment—all of which affects the overall competitiveness of leisure agricultural enterprises. Therefore, the choice of managers with different business preferences is the most important consideration for decision-makers.
3. With regard to enterprise competitiveness, the business of leisure farms is different from other general leisure businesses because the farms involve the production of agricultural products. However, companies are still competing in the leisure business in a broad sense; hence, managers must thoroughly analyze environmental changes and the resource advantages of the company. Appointing managers with appropriate attitudes, continuously improving the company's operating efficiency, and creating a competitive advantage for the company can bring sustainable business value to the company.

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Appendix A. Analysis of the Relative Importance of Experience Value Preference

Different α values and the MATLAB Package was used, and μ = 0.05, 0.5, 0.95 was put in Equation (7) to analyze the relative importance susceptibility of manager dynamic management index.

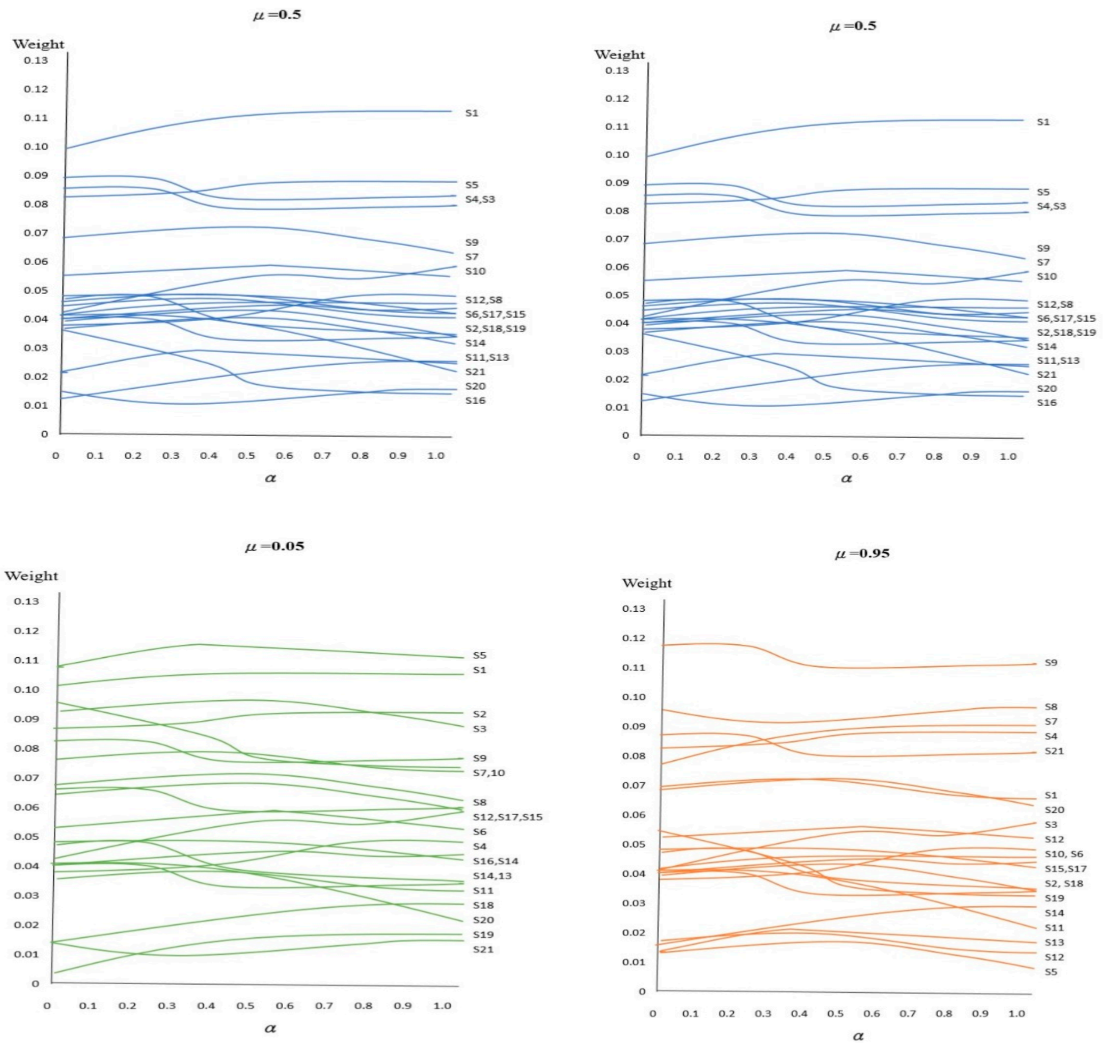

Figure A1. The Manager Dynamic Management Index of Relative Importance Susceptibility.

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