sustainability

MDPI

Article

Establishing a Sustainable Sports Tourism Evaluation Framework with a Hybrid Multi-Criteria Decision-Making Model to Explore Potential Sports Tourism Attractions in Taiwan

Jen-Jen Yang [1], Huai-Wei Lo [2], Chen-Shen Chao [3], Chih-Chien Shen [4] and Chin-Cheng Yang [5,*]

1. Office of Physical Education General Education Center, Chaoyang University of Technology, 168, Jifeng E. Rd., Wufeng District, Taichung 41349, Taiwan; jjyang@cyut.edu.tw
2. Department of Industrial Engineering and Management, National Taipei University of Technology, 1, Sec. 3, Zhongxiao E. Rd., Taipei 10608, Taiwan; w110168888@gmail.com
3. Physical Education Center, Feng Chia University, 100, Wenhwa Rd., Seatwen, Taichung 40724, Taiwan; chaohc@fcuoa.fcu.edu.tw
4. Institute of Physical Education and Health, Yulin Normal University, 299 Jiaoyu Middle Rd., Guangxi Zhuang Autonomous Region, Yulin 537000, China; shen169168@gmail.com
5. Department of Leisure Services Management, Chaoyang University of Technology, 168, Jifeng E. Rd., Wufeng District, Taichung 41349, Taiwan

* Correspondence: yccheng@cyut.edu.tw

Received: 7 February 2020; Accepted: 20 February 2020; Published: 23 February 2020

check for updates

Abstract: In recent years, the awareness of sustainable tourism has risen around the world. Many tourism industries combine sports to attract more customers to facilitate the development of the economy and the promotion of local culture. However, it is an important task to establish a comprehensive tourism evaluation framework for sustainable sports tourism. This study proposes a Multi-Criteria Decision-Making (MCDM) model to discuss the above issues, using the Bayesian Best Worst Method (Bayesian BWM) to integrate multiple experts' judgments to generate the group optimal criteria weights. Next, the modified Visekriterijumska Optimizacija i Kompromisno Resenje (VIKOR) technique is combined with the concept of aspiration level to determine the performance of sports attractions and their priority ranks. In addition, this study adds a perspective of institutional sustainability to emphasize the importance of government support and local marketing. The effectiveness and robustness of the proposed model is demonstrated through potential sports tourism attractions in Taiwan. A sensitivity analysis and models comparison were also performed in this study. The results show that the proposed model is feasible for practical applications and that it effectively provides some management implications to support decision-makers in formulating improvement strategies.

Keywords: sustainable sports tourism; sports tourism; sustainable development; MCDM

1. Introduction

Since the 20th century, advancements in transportation and communication technology have promoted the development of tourism globalization. Although the vigorous development of tourism has brought many economic benefits and cultural exchanges, it has also negatively affected the environment, society, and traditional culture. Many adverse effects have led environmental groups and organizations in various countries to pay more attention to the protection and preservation of natural resources and cultural assets [1–3]. In recent years, various countries have realized that mass tourism will bring environmental pollution, garbage accumulation, and disruption of social order.

Therefore, sustainable development has been introduced into the tourism industry in order to devise more environmentally friendly tourism planning [4–8]. The concept of sustainable development is "the process by which people maintain environmental balance and harmony in resource development, investment direction, technological development, and institutional change while meeting human needs and future development, and the benefits they bring are in line with social expectations." [9]. Many studies have divided sustainability into three main dimensions: economic, social, and environmental. The three dimensions complement each other to construct a complete sustainability framework. The World Tourism Organization (UNWTO) and the United Nations Environment Program (UNEP) advocate that sustainable tourism must promote social and cultural prosperity, environmental protection responsibilities, and economic development [5].

However, there are many studies suggesting different sustainable tourism evaluation frameworks. For example, Gkoumas [6] proposed an evaluation model for sustainable tourism in the Mediterranean region. The study shows that culture, politics, and economy are the main factors affecting the region's sustainable development. It is emphasized that the tourism industry must establish a complete sustainability certification process, strengthen local governance, and improve operating technology in order to provide travelers with better services. Nunkoo et al. [10] pointed out that the support of government departments and nonprofit organizations can further promote sustainable tourism. In addition, the establishment of public trust and local governance are successful factors for the development of tourism policies. Hsu et al. [7] proposed an intercultural sustainable tourism attitude assessment scale to explore tourism quality of island environments. The study shows that people living on islands often want to develop fisheries into tourist attractions, but that this will also cause environmental damage and lead to a decline in food productivity. The authors believe that maintaining the stability of the ecosystem and the support of residents can develop tourism in the long run. Musavengane et al. [8] considered the risks of tourism areas in African countries, and listed their inclusion, safety, resilience, and environmental protection as important tourism assessment items. A review of these publications indicates that the current sustainable tourism assessments consider not only economic, social, and environmental dimensions, but also government regulations and relevant local management policies, which are also on the list of the necessary elements [11]. These studies have contributed to the issues related to sustainable tourism.

Sports tourism has gradually gained prominence in various countries, and major cities and local small towns have established specialized sports tourism agencies [12]. In response to the Taiwanese government's promotion of sports tourism, this study proposes a novel concept that incorporates sports elements into travel itineraries with sustainable development in mind. It fits the spirit of "sustainable sports tourism." The concept of sports tourism is derived from the research of Knop [13], who identified three types of sports tourism: (i) pure sports holidays, such as skiing in the mountains in winter and swimming by the sea in summer; (ii) travelling to a resort, where the site has sports facilities, such as fitness equipment, and an outdoor environment, such as extensive grassland; (iii) unorganized sports activities, allowing tourists to participate freely during the tourism process, such as beach volleyball, rock climbing, river tracing, etc. Sports tourism is a low-cost leisure activity, but it also can improve the physical and mental health of travelers. Many countries are paying more and more attention to sports tourism, creating many sports activities in scenic spots and resorts, including mountaineering, cycling, road running, river tracing, rock climbing, swimming, etc. [14]. The integration of sports and tourism requires considerable time, but government support and promotion can accelerate the process [15].

The four dimensions of sustainable sports tourism evaluation proposed in this study are economic sustainability, environmental sustainability, socio-cultural sustainability, and institutional sustainability. The following questions are examined based on the four perspectives: (i) What are the evaluation criteria under the four dimensions? (ii) How important are the criteria of the evaluation? (iii) How can we assess the performance of alternatives for sustainable sports tourism? (iv) How can it be improved? These problems are a typical multicriteria decision-making (MCDM) problem. The MCDM method has excellent evaluation performance in complex environments. It does not require the basic assumptions of traditional statistics, and only requires a small sample of expert interview data. The goal of MCDM is to integrate objective survey data with subjective expert judgments, and to provide effective management information to support decision-makers in formulating optimal strategies [16]. The procedures performed by MCDM include the determination of evaluation criteria, the calculation of criteria weights, and the integration of alternatives. Common weight calculation methods are the Analytic Hierarchy Process (AHP) [17], Analytic Network Process (ANP) [18], Best Worst Method (BWM) [19], and entropy [20]. The importance weights of criteria are necessary for evaluations, and they will significantly affect the outcome of alternatives performance integration. In addition, the weights of the criteria may let decision-makers know which factors must be considered and improved first [21]. Popular alternative performance integration methods include Technology for Order Preference by Similarity to an Ideal Solution (TOPSIS) [21], Visekriterijumska Optimizacija i Kompromisno Resenje (VIKOR) [22], ELECTRE [23], and the Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) [24]. MCDM has been widely used in evaluations and selections of various industries, such as green supplier evaluations and improvements [21], international airport operation management [25], building construction risk detection [26], and so on.

This paper proposes a novel evaluation framework for sustainable sports tourism, combining Bayesian BWM [27] and modified VIKOR technique to evaluate the performance of sports tourism alternatives. First, according to study of the relevant literature, discussions were held with relevant government departments and private organizations of sports tourism to establish a complete evaluation criteria system. In particular, this study adds a perspective of institutional sustainability to optimize the system. Second, Bayesian BWM is used to obtain the importance weights of the criteria. This method is based on the concept of statistical distribution to strengthen the usability of original BWM and to more effectively integrate the judgments of multiple experts. Finally, the modified VIKOR technique is used to calculate the performance of each alternative, and then the priorities of the alternatives are ranked. In this study, the modified VIKOR improved the original VIKOR technique, introducing the concept of aspiration level into the calculation procedure of VIKOR, so as to avoid "choos(ing) a relatively good apple among the rotten apples". The traditional concept of "relative satisfaction" was replaced by "aspiration level" to meet the development trend of MCDM [28–30]. In the process of implementing VIKOR, we regard the aspiration level and the worst level as two alternatives. From this, we can know determine much improvement room that each alternative has from the aspiration level, so that more management information can be obtained in actual applications. This study takes a survey of potential sports tourism attractions in central Taiwan as an example. The research can help decision-makers to be more systematic in the decision-making processes and provide more reliable improvement implications for attractions.

The rest of this paper is organized as follows. Section 2 introduces the evaluation criteria for sustainable sports tourism. Section 3 describes the proposed hybrid model and the basic concepts of its method. Section 4 describes a real application to prove the feasibility and practicability of the proposed model. Section 5 summarizes the discussion of the whole article and provides future research directions.

2. Dimensions and Criteria of Sustainable Sports Tourism Evaluation

Sports tourism should emphasize the active participation of tourists in sports, not just attending and watching some sports events. Sports tourism is a way to expend physical energy and experience the culture and features of a place through sports. This approach will definitely deepen the memory of the attractions' culture [31], e.g., Hokkaido Skiing, the Mount Fuji Marathon, Bali Streaming, etc. As research on the introduction of sustainability in sports tourism has not yet been developed, this study worked with tourism-related government departments and private organizations (including tourism operators, sports organizations, research institutes) to establish the initial evaluation criteria for sustainable sports tourism based on the relevant academic literature. The relatively important criteria were then selected for the evaluation system to reflect the characteristics of sustainable sports tourism.

The main framework includes four dimensions, namely Economic Sustainability (D_1), Environmental Sustainability (D_2), Socio-cultural Sustainability (D_3), and Institutional Sustainability (D_4). Each of these dimensions can be divided into several criteria, and a total of 18 assessment criteria constitute the evaluation framework, as shown in Table 1. The proposed criteria for sustainable sports tourism in this study can test whether tourist attractions conform to sustainable sports development.

Table 1. Dimensions and criteria for sustainable sports tourism evaluation.

Dimensions	Criteria	References
Economic sustainability (D_1)	Local employment opportunities (C_{11})	Asmelash and Kumar [11], Liu et al. [32], Rashidi and Cullinane [33]
	Economic feasibility (C_{12})	Asmelash and Kumar [11], Rashidi and Cullinane [33], Zhang et al. [34]
	Promotion of local sports culture (C_{13})	Gkoumas [6], Pouder et al. [12], Cho et al. [14]
	Sports diversity (C_{14})	Gkoumas [6], Pouder et al. [12], Cho et al. [14]
Environmental sustainability (D_2)	Sports facility integrity (C_{21})	Asmelash and Kumar [11], Sun et al. [35]
	Biodiversity (C_{22})	Asmelash and Kumar [11], Sun et al. [35], Santarém et al. [36], Wu et al. [37],
	Waste recycling (C_{23})	Rashidi and Cullinane [33], Sun et al. [35]
	Low environmental pollution (C_{24})	Rashidi and Cullinane [33], Lou et al. [38]
Socio-cultural sustainability (D_3)	Social equity (C_{31})	Asmelash and Kumar [11], Rashidi and Cullinane [33], Trudeau [39]
	Tourist services (C_{32})	Gkoumas [6], Pouder et al. [12], Rashidi and Cullinane [33]
	Protection of residents' basic rights (C_{33})	Gkoumas [6], Nunkoo et al. [10], Asmelash and Kumar [11]
	Social Welfare (C_{34})	Rashidi and Cullinane [33], Guillen-Royo [40], Gillam and Charles [41]
	Enrichment of local features (C_{35})	Rashidi and Cullinane [33], Santarém et al. [36]
	Emergency response and rescue (C_{36})	Musavengane et al. [8], Rashidi and Cullinane [33]
Institutional sustainability (D_4)	Regional ordinance protection (C_{41})	Gkoumas [6], Rashidi and Cullinane [33]
	Policy promotion and marketing (C_{42})	Asmelash and Kumar [11], Rashidi and Cullinane [33]
	Sports tourism land planning (C_{43})	Asmelash and Kumar [11], Liu et al. [32]
	Local government involvement (C_{44})	Asmelash and Kumar [11], Wu et al. [37]

2.1. Economic Sustainability

Economic sustainability (D_1) is defined as the ability to create stable income for organizations and members at all levels of society without jeopardizing the economy and resources. In other words, economic growth is based on morality and conscience, and its economic activities do not affect the sustainable development of society and nature [42]. Economic sustainability is a necessary condition for the development of sports tourism to maintain the revenue of tourism attractions and local residents. Its criteria include local employment opportunities (C_{11}), economic feasibility (C_{12}), local cultural promotion (C_{13}), and sports diversity (C_{14}).

Local employment opportunity (C_{11}) aims at the development of sports tourism which can bring more employment opportunities for local residents. The government should promote equal employment opportunities, so employees can be men or women of all ages, and even disabled people. Economic feasibility (C_{12}) is the use of local natural resource conditions to construct profitable economic activities in which organizers are required to spend only a modest amount of time planning and incur few maintenance costs to create higher returns. The promotion of local sports culture (C_{13}) can attract more sports-loving travelers; for example, the seasonal flower season will attract mountain-going tourists who like to observe flowers and birds. The development of sports culture combined with tourism will increase the length of stay of tourists. Sports diversity (C_{14}) can attract more tourists of different ages to participate in scenic activities, and promote local prosperity and recreational diversity [6,11–14,32–34].

2.2. Environmental Sustainability

Environmental sustainability (D_2) is one of the most important factors for maintaining the stability of regional ecosystems. In addition to reducing carbon and waste, it also attaches importance to the recyclability of consumables, and to biodiversity. Sports tourism advocates the use of environmentally friendly tableware, and walking or the use of noncarbon-emitting vehicles (skateboards and bicycles) for transportation [11,15]. The environmental sustainability dimension consists of sports facility integrity (C_{21}), biodiversity (C_{22}), waste recycling (C_{23}), and low environmental pollution (C_{24}).

Sports facility integrity (C_{21}) assesses whether a given area is suitable for developing sports tourism activities while maintaining the current status as much as possible without destroying any of the natural environment and facilities. At the same time, the local biodiversity (C_{22}) is also one of the assessment items of the sports environment. A large number of species of animals and plants indicates that the ecological environment of the region is diverse. Waste recycling (C_{23}) and low environmental pollution (C_{24}) are the first environmental protection assessment items. The main appeal of the word "green" is to minimize environmental pollution and waste reduction as much as possible, and use recyclable materials to achieve the recycling of resources [11,33,35–38].

2.3. Socio-Cultural Sustainability

Socio-cultural sustainability (D_3) expresses the importance of sustainable development for social activities and culture. Many industries are paying special attention to corporate social responsibility [11,30]. The significance of this dimension needs to be promoted in sports tourism, because many tourist attractions are operated and managed by nonprofit organizations. This study divides socio-cultural sustainability into six criteria: social fairness (C_{31}), tourist services (C_{32}), protection of residents' basic rights (C_{33}), social welfare (C_{34}), enrichment of local features (C_{35}) and emergency response and rescue (C_{36}).

Established sports tourist attractions should not be limited to targeting travelers, and travelers should not be treated differently due to their social status and household income. Facilities and buildings should provide barrier-free access for people with disabilities to maintain social equity (C_{31}). Tourist services (C_{32}) refers to the fact that regional operators should establish a complete sports tourism guide system and customer service center so that tourists can enjoy the services in the area quickly and happily. The protection of residents' basic rights (C_{33}) guarantees the residents' basic right to life, and educates the residents about the history and features of local cultural relics and cultures, so that residents can introduce their culture to tourists. Social welfare (C_{34}) is a preferential scheme that gives residents extra living subsidies and related facilities, while maintaining their lifestyle. The enrichment of local features (C_{35}) refers to keeping local culture and combining external, themed activities or commodities to enhance the richness of sports tourism. Emergency response and rescue (C_{36}) is an indispensable assessment item, and is a basic element of the safety of sports tourism [6,8,10–12,33,36,39–41].

2.4. Institutional Sustainability

According to the literature review described in Section 1, we can see that Institutional sustainability (D_4) is a new dimension of sustainability assessment. Government commitment and public trust are often based on the integrity of regulations and institutions. The key factor for the success of sports tourism promotion is policy support [6,7,11]. This study extends the concept of institutional sustainability proposed by Asmelash and Kumar [11] to formulate four criteria: regional ordinance protection (C_{41}), policy promotion and marketing (C_{42}), sports tourism land planning (C_{43}), and local government involvement (C_{44}).

Regional ordinance protection (C_{41}) includes the formulation of local regulatory measures and the management of knowledge and culture. The development rate of sports tourism depends on policy promotion and marketing (C_{42}). Seasonal or recurring events are held to maintain the stability of local visitor traffic to prevent tourism attractions from falling into an off-season/peak-season rotation. Sports tourism land planning (C_{43}) is the zoning of sites at attractions to develop a proper area protection and development plan. Local government involvement (C_{44}) refers to the fact that the local government organizes sports events from time to time, and subsidizes the resources required in activities, which can enhance residents and tourists' willingness to participate in sports tourism [6,11,32,33,37].

3. Proposed Hybrid MCDM Model

This section describes the evaluation method used and its calculation process, including the Bayesian BWM and modified VIKOR methods. An illustration of the proposed model and the calculation steps is displayed in Figure 1.

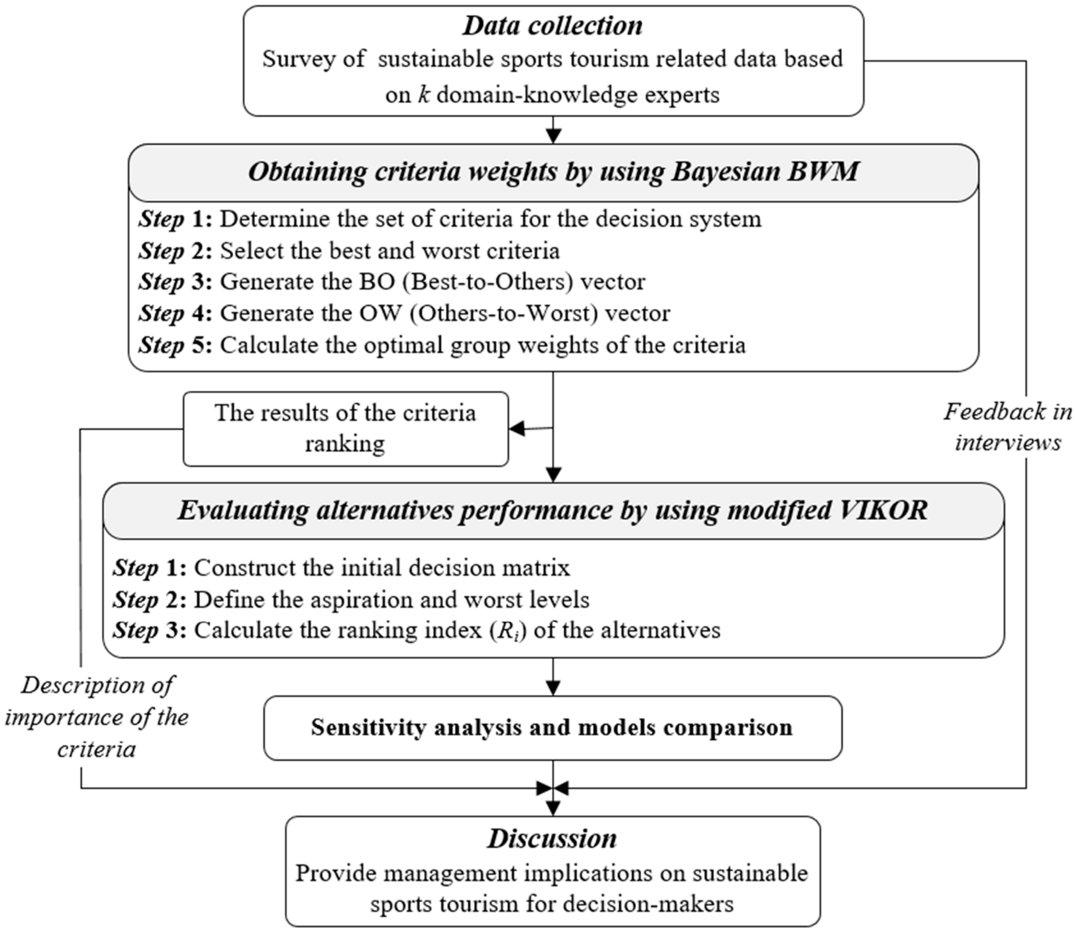

Figure 1. Proposed hybrid MCDM model.

3.1. Bayesian BWM Technique

BWM is a relatively new MCDM method proposed by Rezaei [19]. It improves the disadvantages of AHP. AHP needs to compare all n criteria in pairs, that is, n $(n - 1)/2$ pairwise comparisons. In contrast, BWM requires only $2n - 3$ pairwise comparisons. BWM has this advantage, and its consistent test is usually better than that of AHP. The execution steps of BWM are simple. The best and worst criteria are selected, and then the other criteria are compared with these two to form two groups of structured vectors. This structure helps decision-makers to provide more reliable results. In addition, the special structure of BWM forms two vectors containing only positive integers (A_B and A_W), thereby avoiding the basic distance problem of AHP in the form of fractions (such as 1/a).

Due to the different opinions provided by each expert in BWM, there are differences in the two pieces of vector information (the different best and worst criteria are selected). Therefore, it is not good to use the arithmetic mean to aggregate the opinions of multiple experts. Many studies have proposed different approaches for group decision making in BWM. However, no method has been proposed to determine the group weight based on the statistical probability distribution. The typical weight vector of the MCDM method is $w_j = (w_1, w_2, \ldots, w_n)$, and requires $\sum_{j=1}^{n} w_j = 1$ and $w_j \geq 0$. Each w_j is expressed as a weight of the corresponding criterion c_j. From the perspective of probability, the c_j can be regarded as a random event, and the w_j is its probability of occurrence. With mathematical derivations, $\sum_{j=1}^{n} w_j = 1$ and $w_j \geq 0$ are also like this based on the probability theory. Therefore, it is meaningful to construct probabilistic models from the perspective of decision science [27]. The detailed implementation steps and inference steps of Bayesian BWM are as follows:

Step 1. Determine the set of criteria for the decision system

Decision-makers or experts develop n criteria $\{c_1, c_2, \ldots, c_n\}$ used in the decision issues.

Step 2. Select the best and worst criteria

According to the n criteria developed in Step 1, select the best (i.e., most satisfied, preferred, or most important) and worst (i.e., least satisfied, disliked, or least important) criteria. The best and worst criteria chosen are the key factors affecting the results of the analysis.

Step 3. Take the best criterion as the benchmark, and perform pairwise comparison with other criteria to generate the BO (Best-to-Others) vector

Decision-makers assess the relative importance of the best and other criteria. The evaluation scale ranges from 1 to 9 (with a higher number on the scale indicating greater relative importance), and thus, the BO vector can be generated. Scale 1 indicates that it is equally important, while scale 9 is absolutely important and belongs to the highest level of scale. It is expressed as:

$$A_{Bj} = (a_{B1}, a_{B2}, \ldots, a_{Bn}) \tag{1}$$

where a_{Bj} indicates the importance of the best criterion B relative to the criterion j, and the comparison between the best criterion and itself must be 1, that is, $a_{BB} = 1$.

Step 4. The rest of the criteria are used as benchmarks, and pairwise comparisons with the worst criterion yield the OW (Others-to-Worst) vector.

Similar to Step 3, the expert evaluates the relative importance of the other criteria and the worst criterion to generate the OW vector:

$$A_{jW} = (a_{1W}, a_{2W}, \ldots, a_{nW})^T \tag{2}$$

where a_{jW} indicates the importance of the remaining criteria j relative to the worst criterion W, and the comparison between the worst criterion and itself must be 1, that is, $a_{WW} = 1$.

Step 5. Calculate the optimal group weights of the criteria

The input values A_B and A_W of the original BWM can be constructed as a probability model of multinomial distribution. Since the contents of both vectors are positive integers, the probability mass density function of a multinomial distribution of A_W is

$$P(A_W|w) = \frac{\left(\sum_{j=1}^{n} a_{jW}\right)!}{\prod_{j=1}^{n} a_{jW}!} \prod_{j=1}^{n} w_j^{a_{jW}} \tag{3}$$

where w is the probability distribution. According to the multinomial distribution, the probability of event j is proportional to the number of experiments.

$$w_j \propto \frac{a_{jW}}{\sum_{j=1}^{n} a_{jW}}, \ \forall j = 1, 2, \ldots, n \tag{4}$$

Similarly, the worst criterion c_W can be written as

$$w_W \propto \frac{a_{WW}}{\sum_{j=1}^{n} a_{jW}} = \frac{1}{\sum_{j=1}^{n} a_{jW}} \tag{5}$$

Integration of Equations (4) and (5) can be obtained as follows,

$$\frac{w_j}{w_W} \propto a_{jW},\ \forall j = 1, 2, \ldots, n \tag{6}$$

This is the same concept as original BWM, which is converted into a set of optimized weights based on the values evaluated by experts. In addition, A_B is modeled using multinomial distribution. However, the generation concepts of A_B and A_W are different. The former is the best criterion, B, compared with other criteria, j. The larger the evaluation value, the smaller the weight of the criterion j being compared; for criterion W, the larger the evaluation value, the greater the weight of the criterion j. Therefore, the conversion of the assessment content of A_B into weights should be an inverse function.

$$A_B \sim multinomial\left(\frac{1}{w}\right) \tag{7}$$

which can be written as

$$\frac{1}{w_j} \propto \frac{a_{Bj}}{\sum_{j=1}^{n} a_{Bj}},\ \forall j = 1, 2, \ldots, n \tag{8}$$

Similarly, the best criterion c_B can be written as

$$\frac{1}{w_B} \propto \frac{a_{BB}}{\sum_{j=1}^{n} a_{Bj}} = \frac{1}{\sum_{j=1}^{n} a_{Bj}} \Rightarrow \frac{w_B}{w_j} \propto a_{Bj},\ \forall j = 1, 2, \ldots, n \tag{9}$$

We can use statistical inference to find the best weight value w_j. MCDM requires each weight to be greater than or equal to 0, and the total weight must be equal to 1. Therefore, the model is constructed using Dirichlet Probability Distribution (Forbes et al., 2011). The function is

$$Dir(w|\alpha) = \frac{1}{B(\alpha)} \prod_{j=1}^{n} w_j^{\alpha_j - 1} \tag{10}$$

where α is the vector parameter, and w satisfies the constraints required by MCDM.

Bayesian BWM is a way of estimating approximate parameters through Bayesian, instead of using a statistical maximum likelihood method. First, the Dirichlet probability distribution model is used as the prior distribution of the weight vector, where α is set to 1, because this parameter does not affect the prior probability. Then, based on the w parameter assigned by Dirichlet to perform Bayesian estimation, the posterior distribution model is

$$\mu_j = \frac{\alpha_{post,t_j} - 1}{\sum_{j=1}^{n} \alpha_{post,t_j} - n} = \frac{1 + a_{jW} - 1}{\sum_{j=1}^{n} \left(a_{jW} + 1\right) - n} = \frac{a_{jW}}{\sum_{j=1}^{n} a_{jW}} \tag{11}$$

where $\alpha_{post} = \alpha + A_W = 1 + A_W$ and $A_W = \left(a_{jW}\right) = (a_{1W}, a_{2W}, \ldots, a_{nW})$.

The posterior distribution model will provide an accurate maximum likelihood estimator. So far, only A_w has been considered to estimate the weight. But for BWM, both the A_B and A_W vectors must be considered simultaneously, and the integration of the survey data of multiple experts is needed. Bayesian BWM solves the two problems mentioned above. Its steps are as follows:

Step 5.1. Construction of joint probability distribution for group decision making

Suppose there are k experts, k = 1, 2, ... , K; the evaluation criterion $c_j = c_1, c_2, \ldots, c_n$; and the individual optimal weight after each expert is evaluated is w^k, then the group weight after integration is w^{agg}. ${A_B}^{1:K}$ indicates the vector that all experts evaluate the best criterion compared to other criteria. The same ${A_W}^{1:K}$ indicates the vector that all experts evaluate other criteria compared to the worst criterion. The two vectors are required information to construct a joint probability distribution. The joint probability distribution of group decision is

$$P\left(w^{agg}, w^{1:K} \middle| A_B^{1:K}, A_W^{1:K}\right) \tag{12}$$

The calculation of each individual variable can use the following probability rules (marginal probability function concept).

$$P(x) = \sum\nolimits_y P(x, y) \tag{13}$$

where x and y are arbitrary random variables.

Step 5.2. Bayesian hierarchy model development and calculation

The optimal weight of each expert w^k depends on the two sets of vectors, A_B and A_W, and the group optimal weight w^{agg} depends on the optimal weight of each expert, w^k. The calculation logic of the Bayesian hierarchy model is based on an iterative method, which means that the vector values A_B and A_W after each expert evaluation will generate w^k, and the new optimal group weight w^{agg} will be continuously updated after new evaluation data is added. Based on the above concepts, there is conditional independence between variables. Considering the independence between different variables, the joint probability of the Bayesian model is:

$$P\left(w^{agg}, w^{1:K} \middle| A_B^{1:K}, A_W^{1:K}\right) \propto P\left(A_B^{1:K}, A_W^{1:K} \middle| w^{agg}, w^{1:K}\right) P\left(w^{agg}, w^{1:K}\right) \tag{14}$$

Equation (14) can be further presented as follows

$$P\left(A_B^{1:K}, A_W^{1:K} \middle| w^{agg}, w^{1:K}\right) P\left(w^{agg}, w^{1:K}\right) = P\left(w^{agg}\right) \prod_{k=1}^{K} P\left(A_W^k \middle| w^k\right) P\left(A_B^k \middle| w^k\right) P\left(w^k \middle| w^{agg}\right) \tag{15}$$

According to Equation (15), we need to specify the distribution of each element, and we can find the corresponding probability. According to the inference process of Equations (3)–(9), $A_B^k \middle| w^k$ and $A_W^k \middle| w^k$ can be defined as

$$\begin{gathered} A_B^k \middle| w^k \ \sim multinomial\left(\tfrac{1}{w^k}\right),\ \forall_k = 1, 2, \ldots, K;\ A_W^k \middle| w^k \ \sim multinomial\left(w^k\right), \\ \forall_k = 1, 2, \ldots, K \end{gathered} \tag{16}$$

and w^k under w^{agg} condition can be constructed as Dirichlet distribution.

$$w^k \middle| w^{agg} \ \sim Dir\left(\gamma \times w^{agg}\right),\ \forall_k = 1, 2, \ldots, K \tag{17}$$

where w^{agg} is the average value of the distribution and γ is a non-negative parameter.

According to Equation (17), it can be known that the weight w^k of each expert will approximate w^{agg} to the average value of probability distribution, and the degree of approximation is determined by the parameters. This method is a common operation method of the Bayesian model [43]. It is reasonable for the distribution of the parameter γ to obey the gamma distribution, because it has a non-negative limit.

$$\gamma \sim gamma(a, b) \tag{18}$$

where a and b are the shape and scale parameters of the gamma distribution.

Finally, the group optimal weight w^{agg} obeys the Dirichlet distribution, and α the parameter is set to 1.

$$w^{agg} \sim Dir(\alpha) \tag{19}$$

After the construction of probability distribution of all parameters is completed, the Markov-chain Monte Carlo (MCMC) technique is used to calculate the posterior distribution [44]. Therefore, the group optimal weight w^{agg} can be obtained according to the aforementioned calculation process, which only needs each expert to provide BO and OW vectors.

Step 5.3. Ranking confidence test

Suppose there is a set of criteria c_j being evaluated, two of which are c_i and c_j. We must understand whether the ranking results of the group weights are consistent with the evaluation of all experts. Therefore, the concept of Credal Ranking is used to examine its confidence. Then, the probability that c_i is better than c_j will be

$$P\left(c_i > c_j\right) = \int I\left(w_i^{agg} > w_j^{agg}\right) P\left(w^{agg}\right) \tag{20}$$

where $P(w^{agg})$ is the posterior probability of w^{agg}, I is a conditional parameter, and can only be calculated when $\left(w_i^{agg} > w_j^{agg}\right)$ is held; otherwise it is 0. The confidence is calculated by the number of samples Q obtained by MCMC.

$$P\left(c_i > c_j\right) = \frac{1}{Q}\sum_{q=1}^{Q} I\left(w_i^{agg_q} > w_j^{agg_q}\right);\ P\left(c_j > c_i\right) = \frac{1}{Q}\sum_{q=1}^{Q} I\left(w_j^{agg_q} > w_i^{agg_q}\right) \tag{21}$$

where w^{agg_q} represents q w^{agg}'s from MCMC samples. When $P\left(c_i > c_j\right) > 0.5$, it means that criterion i is more important than criterion j, and the probability presented is the confidence. Furthermore, the total probability is 1, $P\left(c_i > c_j\right) + P\left(c_j > c_i\right) = 1$.

3.2. Modified VIKOR Method

The VIKOR method was developed to solve multicriteria decision problems in complex systems [45]. This method determines the performance and ranking of alternatives based on criteria weights and the evaluation of the alternatives. After each alternative is scored according to each criterion, the eclectic ranking of alternatives can be defined by the closest degree compared to the ideal solution. The VIKOR method defines the parameters through L_p-*metric*, including S_i (group benefit), Q_i (individual regret) and R_i (ranking index). Assume that the evaluation value of alternative A_i obtained under the criterion c_j is f_{ij}, where i = 1, 2,.., m; j = 1, 2,.., n, then the L_p-*metric* is shown in Equation (22):

$$L_p^v = \left\{ \sum_{j=1}^{n} \left[w_j\left(\left|f_j^* - f_{ij}\right|\right) / \left(\left|f_j^* - f_j^-\right|\right) \right]^v \right\}^{\frac{1}{v}},\ 1 \le v \le \infty \tag{22}$$

In order to overcome the shortcomings of VIKOR setting the current best solution as the benchmark solution during operation, this study adds the concept of aspiration level to VIKOR's calculation, and regards aspiration and worst levels as alternatives. In this way, the gap between each alternative and the aspiration level can be identified, as can the most effective management implications. The detailed VIKOR operation steps are explained as follows:

Step 1. Construct the initial decision matrix

Each expert k obtains the evaluation values of all alternatives according to the linguistic variables (Very poor: 1, Poor: 2, Fair: 3, Good: 4, and Very good: 5) and their corresponding evaluation scales.

This article uses the arithmetic mean to aggregate the evaluation values of all experts to obtain the initial decision matrix, which is expressed as

$$\boldsymbol{F} = \left[f_{ij}\right]_{m\times n} = \begin{bmatrix} f_{11} & f_{12} & \cdots & f_{1j} & \cdots & f_{1n} \\ f_{21} & f_{22} & \cdots & f_{2j} & \cdots & f_{2n} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ f_{i1} & f_{i2} & \cdots & f_{ij} & \cdots & f_{in} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ f_{m1} & f_{m2} & \cdots & f_{mj} & \cdots & f_{mn} \end{bmatrix}, i = 1, 2, \ldots, m, j = 1, 2, \ldots, n. \tag{23}$$

where $f_{ij} = \frac{1}{p}\sum\limits_{k=1}^{p} f_{ijk}$, $k = 1, 2, \ldots, p$.

Step 2. Define the aspiration and worst levels

The regular VIKOR normalization method is to take the best performance value in the alternative as the denominator. The best and worst performance values are

$$f_i^* = \max_j\left\{f_{ij}\right\} \tag{24}$$

$$f_i^- = \min_j\left\{f_{ij}\right\} \tag{25}$$

This article introduces the concept of aspiration level into this step. The modified formula is

$$f_i^* = f^{aspire} = 5 \tag{26}$$

$$f_i^- = f^{worst} = 1 \tag{27}$$

Among them, $f^{asprie} = 5$ (the highest level of evaluation scale) and $f^{worst} = 1$ (the lowest level of evaluation scale).

Step 3. Calculate S_i, Q_i and R_i

The ranking of VIKOR is based on the S_i and Q_i to construct the R_i, where the weight w_j is defined according to the calculation result of Bayesian BWM, and α is a preference function, usually set to 0.5. It can be seen when R_i is smaller, the gap between the alternative and the aspiration level becomes smaller. Conversely, when R_i is larger, it means that the gap between the alternative and the aspiration level becomes larger.

$$L_i^{v=1} = S_i = \sum_{j=1}^{n}\left[w_j\left(\left|f_j^{aspire} - f_{ij}\right|\right)/\left(\left|f_j^{aspire} - f_j^{worst}\right|\right)\right] \tag{28}$$

$$L_i^{v=\infty} = Q_i = \max_j\left\{w_j\left(\left|f_j^{aspire} - f_{ij}\right|\right)/\left(\left|f_j^{aspire} - f_j^{worst}\right|\right)\right\} \tag{29}$$

$$R_i = \alpha(S_i - S^*)/(S^- - S^*) + (1-\alpha)(Q_i - Q^*)/(Q^- - Q^*) \tag{30}$$

where $S^* = \min\limits_i\{S_i\}$, $S^- = \max\limits_i\{S_i\}$, $Q^* = \min\limits_i\{Q_i\}$, $Q^- = \max\limits_i\{Q_i\}$.

VIKOR is a useful soft calculation tool in multicriteria decision analysis. Especially if experts do not know or are not sure how to express their preferences, this compromise solution can be used to obtain more scientific results because VIKOR provides the concept of maximum "group benefit" and minimum "individual regret".

4. Empirical Example

This section introduces some well-known scenic spots in central Taiwan as a case study to demonstrate the effectiveness and practicality of the proposed hybrid model. First, we discuss the background of the case and the potential alternatives. Then, the Bayesian BWM method is used to obtain the optimal group weights, and the modified VIKOR technique is used to calculate the performance and ranking of the alternatives.

4.1. Problem Description

Since the development of sustainable sports tourism, Taiwan's domestic tourism industry and the Tourism Bureau have faced strong market challenges. Initially, some tourist attractions tried to reduce ticket prices to attract more customers, but they soon realized that this was an unsuccessful strategy. If low-cost sports can be added to tourist itineraries, it will not only promote the physical and mental health of travelers, but will also increase the time spent by tourists at attractions to promote local culture. In central Taiwan, the government is actively promoting sports tourism policies to attract more foreign tourists. Therefore, this study takes four well-known sports tourist attractions in central Taiwan as examples. These attractions have corresponding promotion sports programs and local cultural features. We show the four potential locations as A_1, A_2, A_3, and A_4; their locations are described in Table 2.

Table 2. Introduction of potential sustainable sports tourist attractions.

Alternative	Description of Local Features	Sports Items
A_1	A_1 is located in Nantou County. Its biggest feature is that it has a vast lake with an altitude of 736 m, an area of 7.93 square kilometers, and a maximum water depth of 27 m. It is very rich in natural ecology. Starting in 1983, swimming competitions have been taking place here, and the whole route is about 3000 m. In addition, a circular bicycle path is established around the lake to allow tourists to ride bicycles to enjoy the lake and the mountain.	Swimming, cycling, and hiking.
A_2	A_2 is located in the center of Taichung City, and it is the most complete green park in Taichung. The site has many perfect public buildings, museums, art galleries, etc., forming a network of green urban space architecture. The site has developed many popular sports, and the crowds on weekdays are not much different from the holidays.	Walking, frisbee, kite, rock climbing, parent-child group recreation activities, etc.
A_3	Located in the North District of Taichung City, A_3 is Taiwan's first dedicated bicycle path converted from an abandoned railway. There are various trees and flowers on both sides of the bicycle path, and business districts are formed around the attraction. Driven by the local government's tourism policies, many flower fairs are held at this attraction, bringing sports tourism to the local industry.	Cycling, hiking, and horse riding.
A_4	A_4 is located in the East District of Taichung City and is one of the most famous mountain-climbing areas in the Central Region. The area has 12 well-planned hiking trails, and many tourism itineraries are developed in conjunction with hot spring operators. In particular, the local ecological protection is quite complete, with more than 30 deciduous tree species covered with golden leaves on both sides of the hiking trails.	Hot spring, and mountain climbing.

According to the proposed evaluation model, the development performance of four potential sports tourist attractions was then discussed. In order to conduct a comprehensive evaluation, nine experts were invited to form a decision-making group, including senior managers of practitioners, professors in the field of tourism, and government representatives related to tourism. The nine experts had more than 10 years of working experience in tourism-related departments and industries. This study considers the importance of nine experts to be equal. The following analysis process is performed in accordance with the sustainability criteria proposed in Section 2.

4.2. Obtaining Criteria Weights by Using Bayesian BWM

The advantages of Bayesian BWM and its calculation process are detailed in Section 3.1. First, each expert was required to select the best and the worst dimensions/criteria in the proposed evaluation framework. Next, the evaluation scales (1 to 9) were used to obtain the BO and OW vectors of each expert. Because the proposed evaluation framework is a hierarchical structure, there are five BWM questionnaires in total, including the dimension part and the criteria under four dimensions. Taking the dimension part as an example, Tables 3 and 4 can be obtained through the professional feedback of nine experts. For example, in Table 3, the first expert thought that D_4 was the most important dimension. Therefore, the BO vector formed by comparing D_4 with other dimensions was $A_{Bj,1}$ = (3, 3, 2, 1). Similarly, D_2 was selected as the least important dimension, and the OW vector was $A_{jW,1}$ = (1, 1, 2, 3), as shown in Table 4. All experts did the same, and information from the expert groups could be obtained. All BWM questionnaires underwent a consistency ratio (CR) test to review the logic and reliability of the expert responses. The average CR value was 0.016, indicating a high level of consistency [19].

Table 3. The best dimension and BO vectors.

Expert	Best	D_1	D_2	D_3	D_4
No. 1	D_4	3	3	2	1
No. 2	D_4	3	5	2	1
No. 3	D_4	5	3	2	1
No. 4	D_1	1	4	3	2
No. 5	D_1	1	2	3	5
No. 6	D_1	1	2	2	3
No. 7	D_4	3	5	2	1
No. 8	D_4	3	4	2	1
No. 9	D_4	3	3	2	1

Table 4. The worst dimension and OW vectors.

Expert	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9
Worst	D_2	D_2	D_1	D_2	D_4	D_4	D_2	D_2	D_2
D_1	1	2	1	4	5	3	2	2	1
D_2	1	1	2	1	3	2	1	1	1
D_3	2	3	3	2	2	2	3	2	2
D_4	3	5	5	2	1	1	5	4	3

Unlike the original BWM, we do not need to individually calculate the BWM questionnaire data of the nine experts. The Bayesian BWM used the statistical probability model to estimate the optimal criterion weight of the group. Through the solution process of Equations (1)–(19), we determined the optimal group weights of the dimensions and criteria. The calculation software used in this study to perform Bayesian BWM was the application provided by Mohammadi and Rezaei [27]. In order to check whether the optimal group weights were obtained and their rankings were reliable, a ranking confidence test was performed. Taking dimensions as an example, the ranking confidence matrix was established according to Equations (20) and (21), as shown in Table 5. For example, D_1 is more important than D_2 with a confidence level of 0.906, and the average ranking confidence is 0.875, indicating that the ranking of the dimension has a high degree of confidence. In addition, Bayesian BWM also provides individual weights for each expert; the higher the experts' judgment consensus, the smaller the gap between the generated individual weights, as shown in Figure 2.

Table 5. The ranking confidences of the dimensions.

	D_1	D_2	D_3	D_4
D_1	-	0.906	0	0
D_2	0	-	0	0
D_3	0.645	0.952	-	0
D_4	0.913	0.995	0.841	-

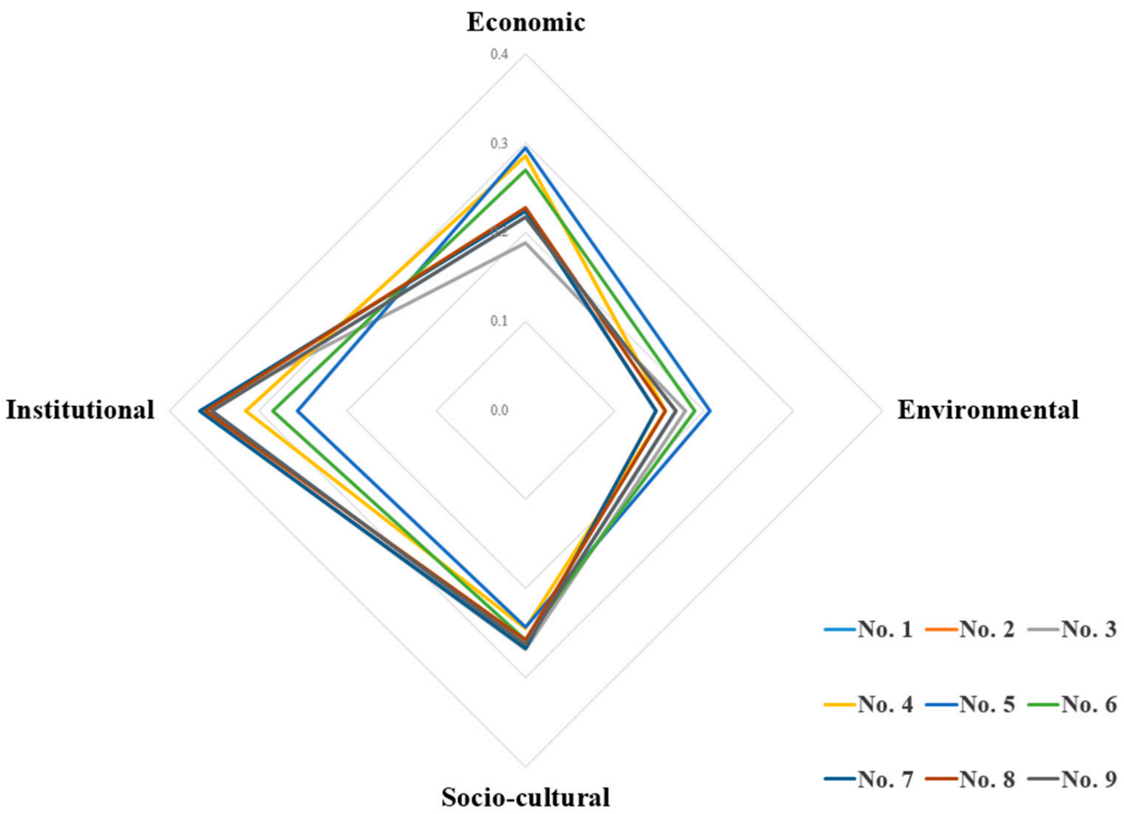

Figure 2. Consensus on the importance of dimensions evaluated by nine experts.

Table 6 lists the optimal group weights for the nine expert integrations. In terms of dimensions, institutional sustainability (D_4) is the most important factor in the development of sustainable sports tourism, emphasizing that governance and policies are more important than others. As shown in the overall evaluation results, it can be seen that the top five rankings are local government involvement (C_{44}), policy promotion and marketing (C_{42}), local employment opportunities (C_{11}), economic feasibility (C_{12}), and the enrichment of local features (C_{35}). Next, the modified VIKOR was applied to aggregate the values and criterion weights of each alternative.

Table 6. Weights of dimensions and criteria.

Dimension	Local Weight	Rank	Criteria	Local Weight	Rank	Global Weight	Rank
D_1	0.237	3	C_{11}	0.340	1	0.081	3
			C_{12}	0.318	2	0.075	4
			C_{13}	0.161	4	0.038	13
			C_{14}	0.181	3	0.043	10
D_2	0.170	4	C_{21}	0.338	1	0.058	6
			C_{22}	0.155	4	0.026	18
			C_{23}	0.211	3	0.036	15
			C_{24}	0.295	2	0.050	7
D_3	0.260	2	C_{31}	0.122	5	0.032	16
			C_{32}	0.174	2	0.045	8
			C_{33}	0.118	6	0.031	17
			C_{34}	0.155	3	0.040	12
			C_{35}	0.287	1	0.075	5
			C_{36}	0.144	4	0.038	14
D_4	0.332	1	C_{41}	0.128	4	0.042	11
			C_{42}	0.357	2	0.119	2
			C_{43}	0.132	3	0.044	9
			C_{44}	0.383	1	0.127	1

4.3. Evaluating Alternatives Performance by Using Modified VIKOR

Assessing the development of sustainable sports tourism is both complex and difficult. An optimal compromise must be found among multiple constraints. VIKOR is one of the most effective methods to solve this kind of problem. It provides a lot of information with management value, and can support decision-makers in developing improvement strategies [29,45]. In this study, the modified VIKOR method was used to calculate the performance of each alternative, and the concept of aspiration level was introduced into the method to avoid considering only the preference solution of the existing scheme.

Nine experts evaluated the performance of four potential sustainable sports tourism locations based on the linguistic variables. An initial decision matrix (Equation (23)) was obtained by integrating the information from nine expert surveys using an arithmetic mean, as shown in Table 7. This study introduced the concept of aspiration level into VIKOR to improve the adaptability of practical applications. Therefore, the highest and lowest evaluation scales are 5 and 1 (Aspiration level and Worst level). The weight calculation result of the Bayesian BWM is a part of VIKOR's input information. We used Equations (26)–(30) to obtain the S_i, Q_i, and R_i, as shown in Table 8. In practice, governments, businesses, and organizations should formulate management goals through continuous improvement to move towards the aspiration level. According to the analysis results of Modified VIKOR using S_i, Q_i, and R_i, the priority ranking of the alternatives was $A_4 > A_1 > A_2 > A_3$. A_4 is the attraction with the best performance in terms of developing sustainable sports tourism among the alternatives ($S_4 = 0.098$, $Q_4 = 0.01$, $R_4 = 0.09$), indicating the smallest gap (0.09) from the aspiration level. Further discussions and management implications are presented in Section 5.

Table 7. Initial decision matrix.

	C_{11}	C_{12}	C_{13}	C_{14}	C_{21}	C_{21}	C_{23}	C_{24}	C_{25}	C_{26}	C_{31}	C_{32}	C_{33}	C_{34}	C_{41}	C_{42}	C_{43}	C_{44}
A_1	4.44	4.22	4.33	4.11	4.78	4.67	4.11	4.67	4.33	5.00	4.33	4.44	4.67	4.56	4.22	4.78	4.33	5.00
A_2	4.00	4.00	4.33	3.78	4.22	5.00	4.11	4.89	4.11	4.33	3.67	4.11	4.00	4.33	4.33	4.44	4.33	4.67
A_3	3.33	3.78	4.33	5.00	4.11	3.33	4.11	4.78	4.22	3.78	3.22	3.22	3.89	4.67	4.00	4.11	4.33	4.78
A_4	4.56	4.44	4.22	4.33	4.67	4.33	4.11	4.67	4.78	4.78	4.22	4.11	4.67	4.78	4.22	4.89	4.67	5.00
AL	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
WL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 8. The results of the modified VIKOR.

	S_i	Rank	Q_i	Rank	R_i	Rank
A_1	0.108	2	0.015	2	0.112	2
A_2	0.179	3	0.020	3	0.169	3
A_3	0.224	4	0.034	4	0.244	4
A_4	0.098	1	0.010	1	0.090	1
AL	0.000		0.000		0.000	
WL	1.000		0.127		1.000	

5. Discussions and Conclusions

In the contemporary literature on sustainable tourism management, most of the research focuses on economics, society, and the environment, and few studies have considered the necessity of institutions [6,7,11]. However, due to the rise of national sports awareness, many tourism practitioners have incorporated sports events into their travel itineraries [46]. Therefore, the sustainable sports tourism evaluation framework proposed in this study is forward-looking. The proposed research method is a novel hybrid MCDM model which can be transformed into a scientific quantitative analysis based on qualitative surveys by experts. In addition, the proposed model does not require statistical assumptions, and the linguistic variables are extracted into values with management implications by a soft computing method.

In terms of criteria weight calculations, according to the results of Bayesian BWM, institutional sustainability (D_4) is the most important dimension for the development of sustainable sports tourism. This result echoes the research of Asmelash and Kumar [11], whose research points out that national policies and local government support can promote the development of the tourism industry, including legislation of environmental protection, exposure of marketing media, and the development of tourism maps. In terms of the overall evaluation criteria, local government involvement (C_{44}), policy promotion and marketing (C_{42}), and local employment opportunities (C_{11}) are the three most important factors in the evaluation system. Practitioners and governments should target them to enhance the development performance of tourist attractions. In addition, the Modified VIKOR provides a gap between alternatives and aspiration levels to understand how much improvement needs to be made to reach the benchmark. Table 9 shows the calculated results and their differences between the modified VIKOR and the original VIKOR. Although the alternative ranking results of the two methods are the same, the management implications implied are different. In the modified VIKOR, R_4 is 0.09, which indicates that there is still room for improvement of 0.09 units from the aspiration level. Even though the performance of A_4 in all alternatives is the best, it still needs continuous improvement to pursue perfection. On the other hand, in the original VIKOR, R_4 is 0, which means that this alternative does not need any improvement. Therefore, the MCDM model used in this study can provide more management implications and relevant information to decision-makers.

Table 9. Comparisons of the Modified VIKOR and the Original VIKOR.

	Modified VIKOR		Original VIKOR	
	R_i	Rank	R_i	Rank
A_1	0.112	2	0.054	2
A_2	0.169	3	0.855	3
A_3	0.244	4	0.946	4
A_4	0.090	1	0	1
AL	0.000			
WL	1.000			

In order to check the robustness and reliability of the proposed model, we used a sensitivity analysis to detect whether changes in the weights of the criteria significantly affected the ranking results of alternatives. The results of this study showed that D_4 had the highest dimension weight, so the weight of D_4 was adjusted from 0.1 to 0.9, which was then performed a total of 9 times by the modified VIKOR. Table 10 shows the ranking results after conducting the sensitivity analysis nine times. It can be seen that the weight change of D_4 will not affect the modified VIKOR analysis results. In addition, this study was compared with other MCDM methods, including Simple Additive Weighting (SAW), TOPSIS, PROMETHEE, and Weighted Aggregated Sum Product Assessment (WASPAS). The alternative ranking obtained by these methods was consistent with the method proposed in this study.

Table 10. Ranking results for nine sensitivity analysis runs.

	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9
A_1	2	2	2	2	2	2	2	2	2
A_2	3	3	3	3	3	3	3	3	3
A_3	4	4	4	4	4	4	4	4	4
A_4	1	1	1	1	1	1	1	1	1

This study has successfully explored four dimensions of sustainable sports tourism development, i.e., the establishment of evaluation criteria, the measurement of the importance of evaluation criteria, the integration of the performance of alternatives, and the formulation of management policies and improvement strategies. Awareness of sustainability has been growing in various industries, especially in the development of sustainable tourism. In Taiwan, the Sports Administration actively promotes the integration of sports events in tourism planning, which facilitates the development of the tourism industry and the promotion of Taiwanese culture. If the tourism industry can enhance the diversified promotion of culture and folklore sports (such as Taekwondo, Chinese martial arts, gymnastics, etc.), it can effectively shape the country's sports image [47–49]. Based on the results of the study, several management implications are proposed: (i) The integration of sports events into tourism activities can foster the continued participation of citizens and the habit of sports. (ii) The government should encourage the combination of the sports service industry and the tourism industry to provide innovative and high-quality tourism services. (iii) In self-help tourism, people should be encouraged to incorporate sports elements into the travel itinerary planning, and then increase the proportion of sports consumption to increase the output value of the sports service industry.

In summary, the model proposed in this study has five main features and contributions:

(i) Development of a complete sustainable sports tourism evaluation framework Past studies have developed many sustainable tourism indicators, but few have proposed a sustainable evaluation framework for sports combined with tourism. This study integrates the sports elements promoted by various countries into tourist itineraries, which not only enable people to deeply experience the environment of the attractions, but also help with their physical and mental health.

(ii) Adding institutional sustainability as an evaluation dimension The promotion of sustainable sports tourism must be supported by governments and protected by relevant laws and regulations. Therefore, this study adds institutional sustainability to strengthen the evaluation model.

(iii) The innovativeness of combining Bayesian BWM and modified VIKOR technology The original BWM has successfully overcome the shortcomings of AHP, including significantly reducing the number of pairwise comparisons of questionnaires and obtaining better, more consistent results. Bayesian BWM has further optimized the original BWM and used the concept of statistical distribution to integrate multiple expert opinions to obtain more reliable group weights. The concept of aspiration level was added to improve the applicability of VIKOR in practice, and thus, to obtain more improvement information and management implications.

(iv) A case study on the potential tourist attractions in central Taiwan Under the policies of the Tourism Bureau and the Sports Administration in Taiwan aiming to promote sports tourism, this study used four attractions in central Taiwan that are suitable for the development of sports tourism as alternatives. The evaluation results of this study can provide the basis for the government and the tourism industry to promote sustainable sports tourism.

(v) Reproducibility and expansion of the proposed evaluation framework The evaluation criteria and methods proposed by this research are not limited to the use of scenic spots in central Taiwan, and thus, can be used to analyze sports tourism evaluation in other regions based on this model. In addition, other countries can increase their evaluation criteria to meet local tourism needs based on their cultural background and other considerations.

Although this study provides a novel framework for sustainable sports tourism evaluation, there are still some limitations that should be addressed. For example, the interdependence and influence of evaluation criteria have not been explored. In the future, Decision Making Trial and Evaluation Laboratory (DEMATEL) can be combined to optimize the evaluation model. In addition, future work will carry out a developmental strategy that combines urban development and sports tourism, hoping to provide more sports environments to the public. Finally, it is noted that sports that represent Chinese culture are also included in the tourism industry.

Author Contributions: J.-J.Y. collected the data and wrote the paper. H.-W.L. designed the research. C.-S.C. and C.-C.S. administrated the project and verified the model. C.-C.Y. co-wrote and revised the paper. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest: All authors declare that they have no conflict of interests.

References

1. López-Bonilla, J.M.; Bonilla, L.M.L. Environmental orientation in tourism: The RTEO scale. *Curr. Issues Tour.* **2012**, *15*, 591–596. [CrossRef]
2. López-Bonilla, J.M.; Reyes-Rodríguez, M.D.C.; Bonilla, L.M.L.; Bonilla, L. Interactions and Relationships between Personal Factors in Pro-Environmental Golf Tourist Behaviour: A Gender Analysis. *Sustainability* **2019**, *12*, 332. [CrossRef]
3. Lee, T.H.; Jan, F.-H. Can community-based tourism contribute to sustainable development? Evidence from residents' perceptions of the sustainability. *Tour. Manag.* **2019**, *70*, 368–380. [CrossRef]
4. Bonilla, L.M.L.; López-Bonilla, J.M. From the new environmental paradigm to the brief ecological paradigm: A revised scale in golf tourism. *Anatolia* **2015**, *27*, 227–236. [CrossRef]
5. Hall, C.M. A typology of governance and its implications for tourism policy analysis. *J. Sustain. Tour.* **2011**, *19*, 437–457. [CrossRef]
6. Gkoumas, A. Evaluating a standard for sustainable tourism through the lenses of local industry. *Heliyon* **2019**, *5*, 02707. [CrossRef] [PubMed]
7. Hsu, C.-Y.; Chen, M.-Y.; Nyaupane, G.P.; Lin, S.-H. Measuring sustainable tourism attitude scale (SUS-TAS) in an Eastern island context. *Tour. Manag. Perspect.* **2020**, *33*, 100617. [CrossRef]
8. Musavengane, R.; Siakwah, P.; Leonard, L. The nexus between tourism and urban risk: Towards inclusive, safe, resilient and sustainable outdoor tourism in African cities. *J.Outdoor Recreat. Tour.* **2020**, *29*, 100254. [CrossRef]
9. Pope, J.; Annandale, D.; Morrison-Saunders, A. Conceptualising sustainability assessment. *Environ. Impact Assess. Rev.* **2004**, *24*, 595–616. [CrossRef]
10. Nunkoo, R.; Ramkissoon, H.; Gursoy, D. Public trust in tourism institutions. *Ann. Tour. Res.* **2012**, *39*, 1538–1564. [CrossRef]
11. Asmelash, A.G.; Kumar, S. Assessing progress of tourism sustainability: Developing and validating sustainability indicators. *Tour. Manag.* **2019**, *71*, 67–83. [CrossRef]
12. Pouder, R.W.; Clark, J.D.; Fenich, G. An exploratory study of how destination marketing organizations pursue the sports tourism market. *J. Destin. Mark. Manag.* **2018**, *9*, 184–193. [CrossRef]
13. Knop, P.D. Some thoughts on the influence of sport on tourism. In Proceedings of the International Seminar and Workshop on Outdoor Education, Recreation and Sport Tourism, Wingate Institute for Physical Education and Sport, Netanya, Israel, 1987; pp. 38–45.

14. Cho, H.; Joo, D.; Chi, C.G. Examining nostalgia in sport tourism: The case of US college football fans. *Tour. Manag. Perspect.* **2019**, *29*, 97–104. [CrossRef]
15. Gibson, H.J.; Kaplanidou, K.; Kang, S.J. Small-scale event sport tourism: A case study in sustainable tourism. *Sport Manag. Rev.* **2012**, *15*, 160–170. [CrossRef]
16. Lo, H.-W.; Liou, J.-J.; Huang, C.-N.; Chuang, Y.-C.; Tzeng, G.-H. A new soft computing approach for analyzing the influential relationships of critical infrastructures. *Int. J. Crit. Infrastruct. Prot.* **2020**, *28*, 100336. [CrossRef]
17. Khan, A.A.; Shameem, M.; Kumar, R.R.; Hussain, S.; Yan, X. Fuzzy AHP based prioritization and taxonomy of software process improvement success factors in global software development. *Appl. Soft. Comput.* **2019**, *83*, 105648. [CrossRef]
18. Zhou, X.; Wang, L.; Qin, J.; Chai, J.; Muñoz, C.Q.G. Emergency rescue planning under probabilistic linguistic information: An integrated FTA-ANP method. *Int. J. Disaster Risk Reduct.* **2019**, *37*, 101170. [CrossRef]
19. Rezaei, J. Best-worst multi-criteria decision-making method. *Omega* **2015**, *53*, 49–57. [CrossRef]
20. Rani, P.; Mishra, A.R.; Pardasani, K.R.; Mardani, A.; Liao, H.; Streimikiene, D. A novel VIKOR approach based on entropy and divergence measures of Pythagorean fuzzy sets to evaluate renewable energy technologies in India. *J. Clean. Prod.* **2019**, *238*, 117936. [CrossRef]
21. Lo, H.-W.; Liou, J.; Wang, H.-S.; Tsai, Y.-S. An integrated model for solving problems in green supplier selection and order allocation. *J. Clean. Prod.* **2018**, *190*, 339–352. [CrossRef]
22. Hsu, C.-C.; Liou, J.; Lo, H.-W.; Wang, Y.-C. Using a hybrid method for evaluating and improving the service quality of public bike-sharing systems. *J. Clean. Prod.* **2018**, *202*, 1131–1144. [CrossRef]
23. Yu, X.; Zhang, S.; Liao, X.; Qi, X. ELECTRE methods in prioritized MCDM environment. *Inf. Sci.* **2018**, *424*, 301–316. [CrossRef]
24. Vivas, R.; Sant'Anna, Â.M.O.; Esquerre, K.; Freires, F.G.M. Measuring Sustainability Performance with Multi Criteria Model: A Case Study. *Sustainability* **2019**, *11*, 6113. [CrossRef]
25. Lu, M.-T.; Hsu, C.-C.; Liou, J.; Lo, H.-W. A hybrid MCDM and sustainability-balanced scorecard model to establish sustainable performance evaluation for international airports. *J. Air Transp. Manag.* **2018**, *71*, 9–19. [CrossRef]
26. Tamošaitienė, J.; Gaudutis, E. Complex Assessment of Structural Systems Used for High-Rise Buildings. *J. Civ. Eng. Manag.* **2013**, *19*, 305–317. [CrossRef]
27. Mohammadi, M.; Rezaei, J. Bayesian best-worst method: A probabilistic group decision making model. *Omega* **2019**, 102075. [CrossRef]
28. Liou, J.; Tamošaitienė, J.; Zavadskas, E.K.; Tzeng, G.-H. New hybrid COPRAS-G MADM Model for improving and selecting suppliers in green supply chain management. *Int. J. Prod. Res.* **2015**, *54*, 114–134. [CrossRef]
29. Lo, H.-W.; Liou, J.; Tzeng, G.-H. Comments on "Sustainable recycling partner selection using fuzzy Dematel-Aew-Fvikor: A case study in small-and-medium enterprises". *J. Clean. Prod.* **2019**, *228*, 1011–1012. [CrossRef]
30. Hu, S.-K.; Tzeng, G.-H. A Hybrid Multiple-Attribute Decision-Making Model with Modified PROMETHEE for Identifying Optimal Performance-Improvement Strategies for Sustainable Development of a Better Life. *Soc. Indic. Res.* **2019**, *144*, 1021–1053. [CrossRef]
31. Gibson, H.J. Sport Tourism: A Critical Analysis of Research. *Sport Manag. Rev.* **1998**, *1*, 45–76. [CrossRef]
32. Liu, K.-M.; Lin, S.-H.; Hsieh, J.C.; Tzeng, G.-H. Improving the food waste composting facilities site selection for sustainable development using a hybrid modified MADM model. *Waste Manag.* **2018**, *75*, 44–59. [CrossRef] [PubMed]
33. Rashidi, K.; Cullinane, K. A comparison of fuzzy DEA and fuzzy TOPSIS in sustainable supplier selection: Implications for sourcing strategy. *Expert Syst. Appl.* **2019**, *121*, 266–281. [CrossRef]
34. Zhang, M.; Gu, J.; Liu, Y. Engineering feasibility, economic viability and environmental sustainability of energy recovery from nitrous oxide in biological wastewater treatment plant. *Bioresour. Technol.* **2019**, *282*, 514–519. [CrossRef]
35. Sun, L.-Y.; Miao, C.-L.; Yang, L. Ecological-economic efficiency evaluation of green technology innovation in strategic emerging industries based on entropy weighted TOPSIS method. *Ecol. Indic.* **2017**, *73*, 554–558. [CrossRef]
36. Santarém, F.; Saarinen, J.; Brito, J.C. Mapping and analysing cultural ecosystem services in conflict areas. *Ecol. Indic.* **2020**, *110*, 105943. [CrossRef]

37. Wu, Y.; Yan, Y.; Wang, S.; Liu, F.; Xu, C.; Zhang, T. Study on location decision framework of agroforestry biomass cogeneration project: A case of China. *Biomass Bioenergy* **2019**, *127*, 105289. [CrossRef]
38. Lou, Y.; Jayantha, W.M.; Shen, L.; Liu, Z.; Shu, T. The application of low-carbon city (LCC) indicators—A comparison between academia and practice. *Sustain. Cities Soc.* **2019**, *51*, 101677. [CrossRef]
39. Trudeau, D. Integrating social equity in sustainable development practice: Institutional commitments and patient capital. *Sustain. Cities Soc.* **2018**, *41*, 601–610. [CrossRef]
40. Guillen-Royo, M. Sustainable consumption and wellbeing: Does on-line shopping matter? *J. Clean. Prod.* **2019**, *229*, 1112–1124. [CrossRef]
41. Gillam, C.; Charles, A. Community wellbeing: The impacts of inequality, racism and environment on a Brazilian coastal slum. *World Dev. Perspect.* **2019**, *13*, 18–24. [CrossRef]
42. Chean, M.M.; Alijanpour, A.; Barani, H.; Motamedi, J.; Azadi, H.; Van Passel, S. Economic sustainability assessment in semi-steppe rangelands. *Sci. Total. Environ.* **2018**, *637*, 112–119.
43. Kruschke, J. *Doing Bayesian data analysis: A tutorial with R, JAGS, and Stan*; Academic Press: Cambridge, MA, USA, 2014.
44. Gilks, W. *Markov Chain Monte Carlo in Practice*; Informa UK Limited: London, UK, 1995.
45. Opricovic, S.; Tzeng, G.-H. Compromise solution by MCDM methods: A comparative analysis of VIKOR and TOPSIS. *Eur. J. Oper. Res.* **2004**, *156*, 445–455. [CrossRef]
46. Malchrowicz-Mosko, E.; Munsters, W. Sport tourism: A growth market considered from a cultural perspective. Ido Movement for Culture. *J. Martial Arts Anthropol.* **2018**, *18*, 25–38.
47. Cynarski, W.J.; Swider, P. The journey to the cradle of martial arts: A case study of martial arts' tourism. Ido Movement for Culture. *J. Martial Arts Anthropol.* **2017**, *17*, 24–33.
48. Skowron-Markowska, S. Chinese guó shù (國術 "national art") in Shaolin Temple. Ido Movement for Culture. *J. Martial Arts Anthropol.* **2019**, *19*, 25–31.
49. Cynarski, W.J. Between Taipei and Pensacola. *Own Reflect. Sci. Tour.* **2010**, *10*, 89–101.