A Two-Stage MCDM Model for Exploring the Influential Relationships of Sustainable Sports Tourism Criteria in a City

Abstract:

Many countries advocate sports for all to cultivate people's interest in sports. In cities, cross-industry alliances between sports and tourism are one of the common practices. The following two important issues need to be discussed, that is, what factors should be paid attention to in the development of sports tourism, and what are the mutual influential relationships among these factors. This study proposes a novel two-stage MCDM model to incorporate the concept of sustainable development into sports tourism. First, the Bayesian Best Worst Method (Bayesian BWM) is used to screen out important criteria. Bayesian BWM solves the problem of expert opinion integration of conventional BWM. It is based on the concept of statistical probability to estimate the optimal criterion weight of a group. Secondly, the Rough Decision Making Trial and Evaluation Laboratory (Rough DEMATEL) technique is used to map out complex influential relationships. The introduction of DEMATEL from the rough set theory has better practicality. In the calculation program, interval types are used to replace crisps in order to retain more expert information. A city in central Taiwan was used to demonstrate the effectiveness of the model. The results show that the quality of urban security, government marketing, business sponsorship, and mass transit planning are the most important criteria. In addition, in conjunction with local festivals is the most influential factor for the overall evaluation system.

Keywords:

1. Introduction

Including some sports activities or watching sports events in the tourist itinerary has become one of the major development projects of the tourism industry (Weed, 2009). Sports tourism is defined as "combining sports events with tourism", and it can be divided into six types, including sports events, sports resorts, sports cruises, sports attractions, sports adventures, and sports tours (Kurtzman, 2005). Many studies have pointed out that organizing related sports tourism in cities is conducive to the development of social image and local economy. For this reason, many cities have also set up special organizations to organize sports events to

increase regional exposure and sports image (Giulianotti et al., 2018; Pouder et al., 2018; Whitley et al., 2019). Many countries are actively seeking viable marketing strategies to attract foreign and domestic tourists to travel there. The most typical way is to increase the number of tourists by using sports events. For example, in 2017, Taipei hosted a 13-day Universiade and sold a total of 720,000 tickets to the sports event. This event not only attracted more foreign tourists, but also promoted the local culture of Taipei. In addition, some well-known cities have been successfully transformed into sports tourism attractions, and have established their image as sports cities. For example, Perth is known as City of Sporting Events, Lausanne is known as Olympic Capital City, and Lake Placid is built as Winter Sports Capital of United States (Kurtzman, 2005).

Due to abnormal climate change and frequent natural disasters, many international organizations (such as the World Health Organization (WHO), European Union (EU) and World Trade Organization (WTO)) have called on all industries to pay attention to "sustainable development" and formulated many regulations and agreements on environmental protection (Peng et al., 2018; Chang et al., 2019). Therefore, the tourism industry is also actively moving towards the developmental vision of sustainable tourism, and many researches on sustainable sports tourism have been released. Gibson et al. (2012) explored the cooperation between six small-scale sports events and local sports agencies (the evaluation includes economic, social, and environmental protection aspects), and surveyed 447 sports event participants and spectators in terms of sports planning satisfaction. Pouder et al. (2018) used expert interviews to explore how for-profit organizations can develop the market for sports tourism. Their research is particularly focused on economic development, with the goal of maximizing returns. The topics of the expert interviews include: (i) what are the key factors affecting the sports market; (ii) how to increase revenue after identifying a specific sports market; (iii) what are the emerging sports with potential; and (iv) where are the potential locations for sports tourism. Gil-Alana et al. (2019) examined whether fluctuations in financial exchange rates have a significant impact on the returns of Brazilian sports tourism. The study used a multiple linear regression model to analyze the structure of tourism revenue structure over 20 years. Hsu et al. (2020) developed an island-type sustainable tourism attitude scale focusing on the environmental protection perspective of sports attractions. Their data came from a survey of three islands in Taiwan. The results show that local culture and environmental protection are the most important factors in tourism development.

It is an important task to develop an effective urban tourism development evaluation model (Nesticò and Maselli, 2020; Lee and Xue, 2020). Multi-Criteria Decision-Making (MCDM) is widely used in various evaluation and selection problems, and it has excellent evaluation performance under many constraints. In contrast to statistical methods, MCDM does not need

to establish basic assumptions for criteria or variables. MCDM has developed many soft calculation methods to process a variety of complex data (including data from expert interviews and data from actual surveys), and provide valuable management information to support decision makers in formulating optimal strategies (Lo et al., 2018; Liu et al., 2018; Zavadskas et al., 2018; Zhao et al., 2018). At present, there have been some studies using MCDM to study tourism-related issues, such as surveys of service quality in tourism (Lin and Kuo, 2019; Martin et al., 2019; Stević et al., 2019), hotel performance evaluation and selection (Liao et al., 2019; Popovic et al., 2019), tourism development and management (Talebi et al., 2019; Séraphin et al., 2019), and tourism personnel selection (Urosevic et al., 2017).

According to the literature review, the evaluation system of urban sustainable sports tourism for cities has not been established yet. The purpose of this study is to propose a novel two-stage MCDM model to establish evaluation criteria for cities to develop sustainable sports tourism, and to explore the mutual influential relationships among the criteria. In the first stage, preliminary evaluation criteria were established based on the literature discussions on sports tourism and sustainable tourism. Due to the large number of evaluation criteria, screening must be performed to retain key criteria. Based on the interview data of several experts, the Bayesian Best Worst Method (Bayesian BWM) was used to calculate the weight of the best group criterion and select the key criteria. Bayesian BWM, proposed by Mohammadi and Rezaei (2019), effectively integrates the judgments of multiple experts and shortens the computational procedures of the conventional BWM. In the second stage, the Rough Decision Making Trial and Evaluation Laboratory (Rough DEMATEL) technique is used to map a cause-and-effect diagram of a criterion to examine the strength of the impact relationship between the criteria. This article combines rough set theory with conventional DEMATEL. On the one hand, the consensus of the decision-making group can be known; on the other hand, the interval value operation can be retained to avoid the loss of information. In summary, the proposed two-stage MCDM model brings some contributions and innovations to sustainable tourism development for the cities:

(i) The addition of Institutional Sustainability makes the evaluation structure more complete;
(ii) Bayesian BWM is used as a criteria screening method. Compared to the Analytic Hierarchy Process (AHP), the number of pairwise comparisons questionnaire content in the Bayesian BWM is significantly reduced, and it has better consistent results.
(iii) In the calculation of DEMATEL, it combines rough set theory to optimize the applicability of the conventional DEMATEL;
(iv) The mutual influential relationships among the criteria are identified using Rough DEMATEL to support decision makers in developing urban sports tourism development

strategies.

(v) The proposed methodology is not limited to any industry, and various industries can imitate and develop their own decision-making systems.

The rest of this article is organized as follows. Section 2 briefly reviews the literature on sports tourism and presents the proposed evaluation framework for sustainable urban tourism development. Section 3 introduces the proposed two-stage MCDM model, including the implementation steps of Bayesian BWM and Rough DEMATEL. Section 4 presents a real case in Taiwan to illustrate the feasibility and practicality of the proposed model. Section 5 includes discussions and model comparisons, and concludes with conclusions and future research possibilities.

2. Literature Review for Sustainable Sports Tourism Evaluation Criteria

Many countries promote sports tourism by joining sports, setting up specialized sports tourism agencies whether in large cities or local towns (Huang et al., 2015; Pouder et al., 2018). Sports tourism is a special type of tourism that provides tourists with an active (active participation in sports events as competitors) or passive (passive participation in sports events as spectators) experience that is different from traditional tourism. People interact with events, people, and places when participating in sports tourism-related events (Perić et al., 2019). Kim et al. (2015) pointed out that large-scale sports tourism activities can attract many domestic and foreign participants and spectators, and these sports events can increase local income and opportunities for urban development. On the contrary, these events also have negative impacts, that is, traffic congestion, environmental pollution, safety issues, and damage to residents' rights. Therefore, the concept of sustainable development combined with research on tourism has been proposed. Nunkoo et al. (2012) emphasized that the establishment of public trust and the formulation of environmental protection policies can develop excellent urban tourism. Gkoumas (2019) proposes a comprehensive assessment index for sustainable tourism for the Mediterranean tourism industry, and local governance is the most critical factor for the development of sports tourism. Musavengane et al. (2020) explored the security of tourism in African countries, holding that cultural tolerance, local security, medical and rescue flexibility, and the integrity of environmental awareness are all key items for evaluation. Yang et al. (2020) first proposed a complete MCDM model of sustainable sports tourism, which established an effective evaluation system for tourist attractions in central Taiwan. Unfortunately, to our knowledge, no research has been conducted to examine the performance of sustainable sports tourism in the cities. In addition, the mutual influential relationships among evaluation criteria have not been explored.

This study proposes a novel evaluation framework to determine the evaluation criteria and their mutual influential relationships. For cities to develop sustainable sports tourism, they

must receive support from local governments and the tourism industry. First, important criteria should be fully integrated into the evaluation system to reflect the characteristics and connotation of sports tourism. The initial criteria review was based on relevant academic literature and expert interviews (a decision group was formed, including tourism industry, Taiwan Tourism Bureau, local government and environmental protection experts). The main framework includes four dimensions, namely Society (S), Environmental (G), Economic (E) and Institutional (I). Each of these four dimensions contain several criteria, and a total of 30 evaluation criteria are included in the evaluation framework. The criteria, descriptions, and literature are shown in **Table 1**.

Table 1. Evaluation criteria and descriptions

Dimension	Criteria	Description	References
Society (S)	Strengthening the image of the city (S1)	The culture of the region will affect the development of sports, and it is necessary to strengthen the image of the city.	Huang et al. (2015); Perić et al. (2019); Lee and Xue (2020);
	Maintaining the lifestyle of urban residents (S2)	While promoting urban sports tourism, it is necessary to ensure that it does not affect the original life style and quality of residents.	Huang et al. (2015); Perić et al. (2019); Gkoumas (2019); Yang et al. (2020)
	Providing additional benefits for urban area residents (S3)	Providing additional benefits or subsidy programs for local residents, so that residents can better accept sports events and provide assistance.	Huang et al. (2015); Perić et al. (2019); Yang et al. (2020)
	Promoting social equity (S4)	Respecting for equality and protection of participation rights of disadvantaged ethnic groups.	Huang et al. (2015); Perić et al. (2019); Yang et al. (2020)
	Insuring for participants (S5)	Insuring for each participant and staff.	Huang et al. (2015);
	Actively donating part of the income to public welfare (S6)	Some of the incomes from sports events will be donated to social welfare or public welfare organizations.	Huang et al. (2015); Perić et al. (2019);
	Formulating procedures for handling emergencies (S7)	Prior to the event, all emergency situations must be prepared, and the handling procedures must be carefully planned.	Huang et al. (2015); Perić et al. (2019); Yang et al. (2020)
	Maintaining the quality of urban	Paying attention to the law and order of the city to ensure that all event personnel can	Huang et al. (2015); Gkoumas (2019); Yang et al.

	public order (S8)	feel safe and secure.	(2020)
Environmental (G)	Using the city's existing infrastructure (G1)	New facilities or buildings should not be built for sporting events. The existing facilities should be used to maintain the original look of the city.	Huang et al. (2015); Pouder et al. (2018); Perić et al. (2019); Lee and Xue (2020); Yang et al. (2020)
	Compliance with environmental protection regulations (G2)	All activities must be prepared in an environmentally friendly manner and must be as natural as possible.	Huang et al. (2015); Perić et al. (2019); Nesticò and Maselli (2020); Lee and Xue (2020); Yang et al. (2020)
	Developing protection measures for natural ecological areas (G3)	Establishing protection regulations for the city's natural ecological area to ensure that the area is not damaged by activities.	Huang et al. (2015); Nesticò and Maselli (2020); Lee and Xue (2020); Yang et al. (2020)
	Restrictions on plastic materials (G4)	Consumables and items used in the event shall be controlled according to the amount of consumed plastic materials.	Huang et al. (2015); Perić et al. (2019); Lee and Xue (2020); Yang et al. (2020)
	Well-planned urban cleanup plan (G5)	Sports events bring crowds and waste, and a complete cleaning plan should be developed to maintain the cleanliness of the city.	Huang et al. (2015); Nesticò and Maselli (2020); Lee and Xue (2020); Yang et al. (2020)
	Planning the city's mass transit system (G6)	A sound mass transit system can effectively reduce the problem of traffic congestion and reduce carbon emissions from self-driving cars.	Perić et al. (2019); Nesticò and Maselli (2020); Lee and Xue (2020);
	Controlling noise pollution (G7)	Gathering of people will generate huge noise, and noise control should be done at specific times and places.	Lee and Xue (2020);
	Monitoring the quality of drinking water (G8)	The source of drinking water and the filtration system should be controlled in detail to ensure the water quality of the participants.	Nesticò and Maselli (2020);
Economic (E)	Providing information on accommodation in the city (E1)	Providing complete accommodation and related information to facilitate participants in planning their accommodation.	Huang et al. (2015); Perić et al. (2019);
	Providing	Providing comprehensive dining	Huang et al. (2015); Perić et

	information on dining in the city (E1)	information, and presenting local food and beverage to tourists from other places.	al. (2019);
	Providing information on attractions & shopping in the city (E2)	Providing information on places that can be visited during non-match times, allowing participants to flexibly arrange their free time.	Huang et al. (2015); Perić et al. (2019);
	Increasing employment opportunities for urban residents (E4)	Local residents serve as staff during sports events, increasing employment opportunities for local residents.	Huang et al. (2015); Nesticò and Maselli (2020); Lee and Xue (2020); Yang et al. (2020)
	Sponsorship and support from local businesses (E5)	Local companies support the development of urban sports and provide more event sponsorship, funding and assistance.	Pouder et al. (2018);
	Sponsored Brand Exposure (E6)	Logos of sponsoring companies are placed in or around the venue, or sports merchandises are provided by the brands.	Pouder et al. (2018);
	Increasing the number of visits to the attractions in the city (E7)	Enhancing the richness of attractions around the city to attract more people and increase visits.	Lee and Xue (2020); Yang et al. (2020)
Institutional (I)	Combined with smart wearable device (I1)	Smart devices are used in sports events to monitor the physiological status and conditions of the contestants.	該研究提出。
	Maintenance of urban tourism website (I2)	Maintaining and updating information on urban sports events.	Pouder et al. (2018); Perić et al. (2019);
	Enhancing participant reward system (I3)	Increasing the prizes and bonuses of the event to increase participants' willingness to participate.	Huang et al. (2015); Perić et al. (2019);
	In conjunction with festivals in the city (I4)	Urban sports events combined with local festivals and events can bring participants richer experiences.	Huang et al. (2015); Lee and Xue (2020); Yang et al. (2020)

	Promotion of urban culture and heritage (I5)	Developing plans for the promotion of the city's historical culture and heritage.	Nesticò and Maselli (2020); Lee and Xue (2020); Yang et al. (2020)
	Land planning for sports events (I6)	Drawing up complete protection measures for the event venue, and clearly marking the event areas and related events.	Nesticò and Maselli (2020); Yang et al. (2020)
	Marketing and promotion by local governments (I7)	Local governments organize sporting events from time to time and plan marketing strategies.	Pouder et al. (2018); Yang et al. (2020)

3. The Proposed Two-Stage MCDM Model

This section describes the evaluation method used and its detailed calculation process. In the first stage, the Bayesian BWM is introduced, which is used to screen important evaluation criteria. In the second stage, the cause and effect diagram among the criteria by using the R-DEMATEL technique is introduced. The analysis procedure diagram of this study is shown in **Figure 1.**

(**Figure 1** 編修完再補上)

3.1 Stage 1: Bayesian BWM

Bayesian BWM is a method for optimizing conventional BWM. It is proposed by Mohammadi and Rezaei (2019). This method effectively integrates the opinions of multiple experts to generate a set of optimal group weights. Its survey process is simple and intuitive. Experts are asked to choose the most important and least important criteria, and then they are compared pairwise with other criteria to form a structured set of two vectors. Based on the concept of statistical distribution, the optimal group criterion weight is estimated. The detailed Bayesian BWM derivation and proof can be found in the study of Mohammadi and Rezaei (2019). Next, the implementation steps of Bayesian BWM are explained as follows:

Step 1. Determining the set of criteria in the evaluation system

N evaluation criteria $\{c_1, c_2, \ldots, c_n\}$ were identified through literature review and expert

interviews.

Step 2. Choosing the most important and least important criteria

Based on the set of criteria $\{c_1, c_2, \ldots, c_n\}$, each expert chooses what s/he considers the most important and least important criteria.

Step 3. Comparing the most important criteria with other criteria to generate the BO (Best-to-Others) vector

Each expert evaluates the relative importance of the most important criteria to other criteria to generate the BO vector. The ratings of BWM are shown in **Table 2**.

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

where a_{Bj} indicates the importance of the most important criterion *B* relative to criterion *j*.

Step 4. Comparing other criteria with the least important criteria to generate the OW (Others-to-Worst) vector

Similar to Step 3, each expert evaluates the relative importance of the other criteria to the least important criteria to generate the OW vector.

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

where a_{jW} indicates the importance of the other criterion *j* relative to the least important criterion *W*.

Table 2. BWM evaluation levels

Linguistic variable	Crisp value
Equally important	1
Equal to moderately more important	2
Moderately more important	3
Moderately to strongly more important	4
Strongly more important	5
Strongly to very strongly more important	6
Very strongly more important	7
Very strongly to extremely more important	8
Extremely more important	9

Step 5. Calculating the optimal weight of the group

Each expert follows Step 1 to Step 4 to get multiple sets of BO and OW vectors. According to the MATLAB program software provided by Mohammadi and Rezaei (2019), the evaluation values of all experts are used as input data to obtain the best criterion weight.

Step 6. Testing confidence for ranking

After the group criterion weight is obtained, it must be checked whether the ranking of the weight is consistent. Assume that the two criteria in the criteria set are c_i and c_j, and use the concept of Credal Ranking to test their confidence. Then the probability that c_i is better than c_j is

$$P\left(c_i > c_j\right) = \int I\left(w_i^{agg} > w_j^{agg}\right) P\left(w^{agg}\right) \tag{3}$$

where w^{agg} is the group criterion weight, $P\left(w^{agg}\right)$ is the posterior probability of w^{agg}, and I is the condition parameter, which can be calculated when $\left(w_i^{agg} > w_j^{agg}\right)$ is true, otherwise it is 0. The Markov-chain Monte Carlo (MCMC) technique is used to perform multiple simulations, and the number of samples Q obtained by it is used to calculate its average confidence level.

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

$$P\left(c_j > c_i\right) = \frac{1}{Q}\sum_{q=1}^{Q} I\left(w_j^{agg_q} > w_i^{agg_q}\right) \tag{4}$$

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

Step 7. Screening criteria by α-cut

The α-cut is the threshold value of the screening criteria. There are n criteria in the criteria set, $\{c_1, c_2, \ldots, c_n\}$. α-cut is shown below..

$$\alpha\text{-cut} = \frac{1}{n} \tag{5}$$

This step can distinguish the relatively important and relatively unimportant criteria groups.

We retain the rules that are larger than α-cut.

3.2 Stage 2: Rough DEMATEL

DEMATEL technology was proposed by Battelle Memorial Institute in 1972. This method is used to solve the problem of the complex structures in real society (Gabus and Fontela, 1972). DEMATEL aims to establish a structure diagram that can show the mutual influential relationships among the criteria. It is called a cause-and-effect diagram, which effectively supports decision makers in understanding the interaction and influence relationships in the entire system to influence network relationships. The conventional DEMATEL uses arithmetic averages to integrate evaluation data from multiple experts. This research combines rough set theory with DEMATEL, called Rough DEMATEL or R-DEMATEL. This method not only can know the consensus degree of the decision-making group, but also retain the calculation of interval values to avoid the loss of information. The calculation steps of the rough number can be found in Lo et al. (2019), Chang et al. (2019) and Lo et al. (2020). We use a simple example to illustrate how to integrate the rough number calculations of multiple experts. Assume that the evaluation values of the five experts in evaluating event A are 4, 4, 3, 2 and 2, respectively, then lower and upper bounds of rough numbers ($\underline{Lim}$ and $\overline{Lim}$) are

$$\underline{Lim}(4)=(4+4+3+2+2)/5=3,\ \overline{Lim}(4)=(4+4)/2=4$$
$$\Rightarrow \tilde{A}^{(1)}=\tilde{A}^{(2)}=\tilde{4}=[3,\ 4];$$

$$\underline{Lim}(3)=(3+2+2)/3=2.333,\ \overline{Lim}(3)=(3+4+4)/3=3.667$$
$$\Rightarrow \tilde{A}^{(3)}=\tilde{3}=[2.333,\ 3.667];$$

$$\underline{Lim}(2)=(2+2)/2=2,\ \overline{Lim}(2)=(4+4+3+2+2)/5=3$$
$$\Rightarrow \tilde{A}^{(4)}=\tilde{A}^{(5)}=\tilde{2}=[2,\ 3].$$

where the symbol "~" indicates that those are rough numbers. This set of scores can be obtained by averaging as follows:

$$\tilde{A}=\left[(3+3+2.333+2+2)/5,\ (4+4+3.667+3+3)/5\right]=[2.467,\ 3.533].$$

After screening criteria by Bayesian BWM, the R-DEMATEL procedure is further performed. The detailed steps are stated below:

Step 1. Obtaining rough direct relation matrix $\tilde{\boldsymbol{Q}}$

After screening, there are n^* criteria, and each expert evaluates the direct impact of the criteria i on the criteria j according to DEMATEL's evaluation levels (**Table 3**). Then, the subjective opinions of all experts will be converted into a set of interval-type interval numbers by the rough number operation in rough theory, and a rough direct relation matrix $\tilde{\boldsymbol{Q}}$ can be obtained. As shown in Eq. 6.

$$\tilde{\boldsymbol{Q}} = [\tilde{q}_{ij}]_{n^* \times n^*}, i = j = 1, 2, \ldots, n^* \tag{6}$$

where $\tilde{q}_{ij} = [q_{ij}^L, q_{ij}^U]$.

Table 3. DEMATEL's evaluation levels

Linguistic variable	Crisp value
No influence	0
Low influence	1
Medium influence	2
High influence	3
Very high influence	4

Step 2. Establishing the normalized rough influence relation matrix $\tilde{\boldsymbol{D}}$

The rough direct relation matrix $\tilde{\boldsymbol{Q}}$ can obtain a normalized rough influence relation matrix $\tilde{\boldsymbol{D}}$ through Eqs. 7 and 8. The normalized program can convert the evaluation value to between 0 and 1.

$$\tilde{\boldsymbol{D}} = \varepsilon \times \tilde{\boldsymbol{Q}} \tag{7}$$

$$\varepsilon = \min \left\{ 1 / \max_i \sum_{j=1}^{n} q_{ij}^U, 1 / \max_j \sum_{i=1}^{n} q_{ij}^U \right\}, i = j = 1, 2, \ldots, n \tag{8}$$

where $\tilde{\boldsymbol{D}} = [\tilde{d}_{ij}]_{n^* \times n^*}$, $0 \le \tilde{d}_{ij} < 1$, and $\tilde{d}_{ij} = \left[d_{ij}^L, d_{ij}^U \right]$. In $\sum_{j=1}^{n} d_{ij}^U$ and $\sum_{i=1}^{n} d_{ij}^U$, the sum of any row or column is less than or equal to 1.

Step 3. Deriving the rough total influence matrix

The normalized rough influence relation matrix $\tilde{\boldsymbol{D}}$ uses Eq. 9 to calculate the degree of each direct influence relationship and indirect influence relationship, and finally integrates a rough

total influence matrix $\tilde{\boldsymbol{T}}$ as shown in Eq. 10

$$\begin{aligned}\tilde{\boldsymbol{T}} &= \tilde{\boldsymbol{D}} + \tilde{\boldsymbol{D}}^2 + \cdots + \tilde{\boldsymbol{D}}^{\Theta} = \tilde{\boldsymbol{D}}\left(\boldsymbol{I} + \tilde{\boldsymbol{D}} + \tilde{\boldsymbol{D}}^2 + \cdots + \tilde{\boldsymbol{D}}^{\Theta-1}\right) \\ &= \tilde{\boldsymbol{D}}\left(\boldsymbol{I} - \tilde{\boldsymbol{D}}^{\Theta}\right)\left(\boldsymbol{I} - \tilde{\boldsymbol{D}}\right)^{-1} = \tilde{\boldsymbol{D}}\left(\boldsymbol{I} - \tilde{\boldsymbol{D}}\right)^{-1}, \text{when } \Theta \to \infty, \tilde{\boldsymbol{D}}^{\Theta} = [0]_{n^* \times n^*}\end{aligned} \tag{9}$$

where $\boldsymbol{I}$ is the identity matrix.

$$\tilde{\boldsymbol{T}} = [\tilde{t}_{ij}]_{n^* \times n^*} \tag{10}$$

where $\tilde{t}_{ij} = \left[t_{ij}^L, t_{ij}^U\right]$.

Step 4. Establishing rough influential network relationship map

The rough total influence matrix $\tilde{\boldsymbol{T}}$ can obtain the degree of rough affecting relationship ($\tilde{\boldsymbol{s}}_i$) and the degree of rough affected relationship ($\tilde{\boldsymbol{o}}_i$) of each criterion through Eqs. 11 and 12.

$$\tilde{\boldsymbol{s}} = [\tilde{s}_i]_{n^* \times 1} \tag{11}$$

$$\tilde{\boldsymbol{o}} = [\tilde{o}_j]'_{1 \times n^*} = [\tilde{o}_i]_{n^* \times 1} \tag{12}$$

where the symbol " ' " stands for transpose. In addition, $\tilde{s}_i = \left[\sum_{j=1}^{n} t_{ij}^L, \sum_{j=1}^{n} t_{ij}^U\right]$ and $\tilde{o}_j = \left[\sum_{i=1}^{n} t_{ij}^L, \sum_{i=1}^{n} t_{ij}^U\right]'$.

$\tilde{s}_i + \tilde{o}_i$ represents the rough total influence of the criterion within the evaluation system, and is called the prominence. $\tilde{s}_i - \tilde{o}_i$ represents the rough net influence of the criterion within the evaluation system and is called the net cause-effect. If $\tilde{s}_i - \tilde{o}_i > 0$, it represents the degree of rough net influence of the criterion on other criteria; on the contrary, if $\tilde{s}_i - \tilde{o}_i < 0$ it represents the degree of rough net influence of the criterion by other criteria. The detailed cause-and-effect diagram results are presented in Section 4.3.

4. Empirical Example

Participating in sports activities not only can promote the physical health of people of all ages, but also bring social benefits and improve people's happiness. Healthy people will be the biggest asset of a country, and the physical fitness of the people will be the foundation of the country's competitiveness. Moderate exercise promotes physiological metabolism and helps to resist stress. In order to enhance the country's sports competitiveness and protect people's sports rights, the promotion of sports has become the focal policy of advanced countries to learn and observe from each other. In Taiwan, the most common sports activities include outdoor leisure sports, ball sports, stretching, dancing, water sports and so on. Among them, outdoor leisure sports account for more than 80% of total sports events (Sports Administration Ministry of Education, 2016). Therefore, the sports projects that this study explores to promote in sustainable sports tourism are mainly outdoor leisure sports. This section introduces the background of the case, as well as the practical application of Bayesian BWM and rough DEMATEL.

4.1. Case background

The chosen case is Taichung City, Taiwan. The Taichung City Government actively promotes sports infrastructure and promotes the correct sports concept to implement "sports for all ages". In December 2019, the Taichung City Sports Bureau decided to organize marathons to connect the sports events with local specialties in order to serve the purpose of marketing the city and promoting culture. In 2020 alone, Taichung City has already prepared at least 35 marathon events. However, building an image of a sports city is a difficult and complex project, and many factors and restrictions must be considered, including economic feasibility, social development, environmental awareness and policy support. Only through continuous review and improvement can we move towards the vision of urban sports for all ages. At present, there has not been a sustainable sports tourism evaluation system developed specifically for the cities. In addition, most studies have not examined the mutual influential relationships among criteria. Which evaluation criteria are the main factors that affect the success or failure of urban sports tourism? How do these criteria affect other criteria? These two issues are the focal points of this study.

In the study the decision-making team consisted of ten experts, including tourism managers, members of the Ministry of Tourism, and academics. These ten experts have at least 8 years of qualifications in sports events or tourism-related jobs, and their current jobs are highly relevant to the development of sports tourism. The proposed evaluation framework is presented in Section 2, and 4 dimensions with 30 criteria classified under them were

identified.

4.2. Screening the criteria by using Bayesian BWM

Based on the Bayesian BWM calculation described in Section 3.1, firstly, each expert was required to make pairwise comparisons of the criteria in each dimension. A total of four BWM questionnaires needed to be filled out. Since the function of Bayesian BWM at this stage is for screening criterion, there is no need to perform pairwise comparisons for the dimensions. Consistency ratio (CR) were performed on the recovered BWM questionnaires to check the logic of the experts in the response process. Based on the consistency test formula proposed by Rezaei (2015), the average CR value in the study is 0.014 (with high consistency). **Table 4** lists the optimal group criterion weights. According to the judgment of the threshold (α-cut), 16 relatively important criteria were identified, which are important factors for the sustainable development of urban tourism, including S6, S7, S8, G1, G2, G4, G6, G8, E4 , E5, E6, E7, I1, I2, I4 and I7. The mutual influential relationships of these criteria included in the evaluation system were analyzed by the rough DEMATEL technique.

Table 4. Criterion weights obtained through Bayesian BWM

Dimension	Criteria (weight)	Ranking	Dimension	Criteria (weight)	Ranking
Society (S)	S1 (0.086)	7	**Environmental (G)**	G1 (0.129)*	4*
	S2 (0.087)	6		G2 (0.137)*	3*
	S3 (0.090)	5		G3 (0.070)	8
	S4 (0.116)	4		G4 (0.182)*	2*
	S5 (0.054)	8		G5 (0.075)	7
	S6 (0.143)*	3*		G6 (0.203)*	1*
	S7 (0.202)*	2*		G7 (0.078)	6
	S8 (0.223)*	1*		G8 (0.126)*	5*
	α -cut = **0.125**			α -cut = **0.125**	
Economic (E)	E1 (0.096)	5	**Institutional (I)**	I1 (0.194)*	3*
	E2 (0.090)	6		I2 (0.150)*	4*
	E3 (0.083)	7		I3 (0.071)	7
	E4 (0.196)*	2*		I4 (0.204)*	2*
	E5 (0.204)*	1*		I5 (0.086)	5
	E6 (0.165)*	4*		I6 (0.074)	6
	E7 (0.167)*	3*		I7 (0.220)*	1*
	α -cut = **0.143**			α -cut = **0.143**	

Note: The "*" symbol represents the criteria that exceed the threshold value. These criteria would be calculated

by DEMATEL.

In order to check whether the optimal group weights obtained and the ranking are reliable, a ranking confidence test is performed. Among the four dimensions, their confidence levels of ranking are 0.926, 0.871, 0.868 and 0.904, respectively. It represents the criteria ranking in each dimension is highly confident. Next, R-DEMATEL analysis was performed on the criteria incorporated in the evaluation system.

4.3. Obtaining the cause-and-effect diagram by using rough DEMATEL

The implementation process of rough DEMATEL is explained in Section 3.2. The data of 10 experts' surveys are calculated according to this process to obtain the rough influence degree of each criterion, as shown in Table 5. The consensus degree of the experts can be viewed by average sample gap index ($\left(n\left(n-1\right)\right)^{-1}\times\sum_{i=1}^{n}\sum_{j=1}^{n}\left(\left|t_{ij}^{p}-t_{ij}^{p-1}\right|/t_{ij}^{p}\right)\times100\%$), where n is the number of samples, p is the number of experts, and t is the evaluation value in the matrix. Based on this index, the average gap of the 10 experts is 4.8%, which means the confidence level is 95.2%, indicating that these experts have a high degree of consensus.

Table 5 shows the total influence ($\tilde{s}_i+\tilde{o}_i$) and net influence ($\tilde{s}_i-\tilde{o}_i$) for all criteria. The larger $\tilde{s}_i-\tilde{o}_i$, the greater the degree to which this criterion affects other criteria. In addition, $\tilde{s}_i+\tilde{o}_i$ can indicate the total influence in the overall evaluation system to show the proportion of importance. We use $\tilde{s}_i+\tilde{o}_i$ as the horizontal axis and $\tilde{s}_i-\tilde{o}_i$ as the vertical axis to draw the cause-and-effect diagram of the criteria, as shown in **Figure 2.** This approach allows policy makers to quickly understand which criteria are the main causes and which are the effects to support the formulation of an appropriate management strategy. In **Figure 2**, the upper-right criteria indicate a high total influence and net influence, which are the main causes. In contrast, the lower-left criteria indicate lower total and net influences, which are the effects (Lo et al., 2020). Obviously, I4 is the most important affecting factor for cities to promote sustainable sports tourism, and the rest are E7, I7, E5 and I2. In addition, G4, G8, S7 are the factors most affected by other criteria. The management implications derived from Rough DEMATEL's analysis are discussed in Section 5.

Table 5. Sum of the defuzzification of rough influences given and received by criteria

	$\tilde{s}_i$	$\tilde{o}_i$	$\tilde{s}_i + \tilde{o}_i$	$\tilde{s}_i - \tilde{o}_i$	s_i	o_i	$s_i + o_i$	s_i - o_i
S6	[0.581, 2.551]	[0.759, 2.539]	[1.340, 5.090]	[-1.958, 1.792]	1.566	1.649	3.215	-0.083
S7	[0.424, 2.055]	[0.828, 2.848]	[1.252, 4.903]	[-2.423, 1.228]	1.240	1.838	3.078	-0.598
S8	[0.788, 3.000]	[0.895, 3.116]	[1.683, 6.116]	[-2.328, 2.105]	1.894	2.006	3.900	-0.112
G1	[0.866, 3.011]	[0.755, 2.873]	[1.621, 5.884]	[-2.007, 2.256]	1.939	1.814	3.753	0.125
G2	[0.790, 2.761]	[0.891, 2.850]	[1.681, 5.611]	[-2.059, 1.870]	1.776	1.870	3.646	-0.095
G4	[0.466, 2.112]	[0.643, 2.413]	[1.109, 4.525]	[-1.947, 1.468]	1.289	1.528	2.817	-0.240
G6	[0.740, 2.935]	[1.129, 3.476]	[1.869, 6.411]	[-2.736, 1.806]	1.837	2.303	4.140	-0.465
G8	[0.467, 2.121]	[0.645, 2.683]	[1.112, 4.804]	[-2.216, 1.476]	1.294	1.664	2.958	-0.370
E4	[0.643, 2.944]	[0.883, 2.987]	[1.526, 5.931]	[-2.344, 2.061]	1.793	1.935	3.728	-0.142
E5	[1.049, 3.646]	[0.938, 3.140]	[1.986, 6.786]	[-2.091, 2.708]	2.347	2.039	4.386	0.308
E6	[0.813, 2.604]	[0.815, 2.843]	[1.629, 5.447]	[-2.030, 1.789]	1.709	1.829	3.538	-0.120
E7	[1.423, 3.935]	[1.068, 3.389]	[2.491, 7.323]	[-1.966, 2.867]	2.679	2.228	4.907	0.450
I1	[0.389, 1.832]	[0.236, 1.789]	[0.624, 3.621]	[-1.401, 1.596]	1.110	1.012	2.122	0.098
I2	[1.200, 3.683]	[1.056, 3.392]	[2.256, 7.075]	[-2.192, 2.628]	2.442	2.224	4.665	0.218
I4	[1.501, 3.910]	[0.900, 2.949]	[2.401, 6.860]	[-1.448, 3.010]	2.706	1.925	4.631	0.781
I7	[1.499, 3.820]	[1.200, 3.632]	[2.699, 7.453]	[-2.133, 2.621]	2.660	2.416	5.076	0.244

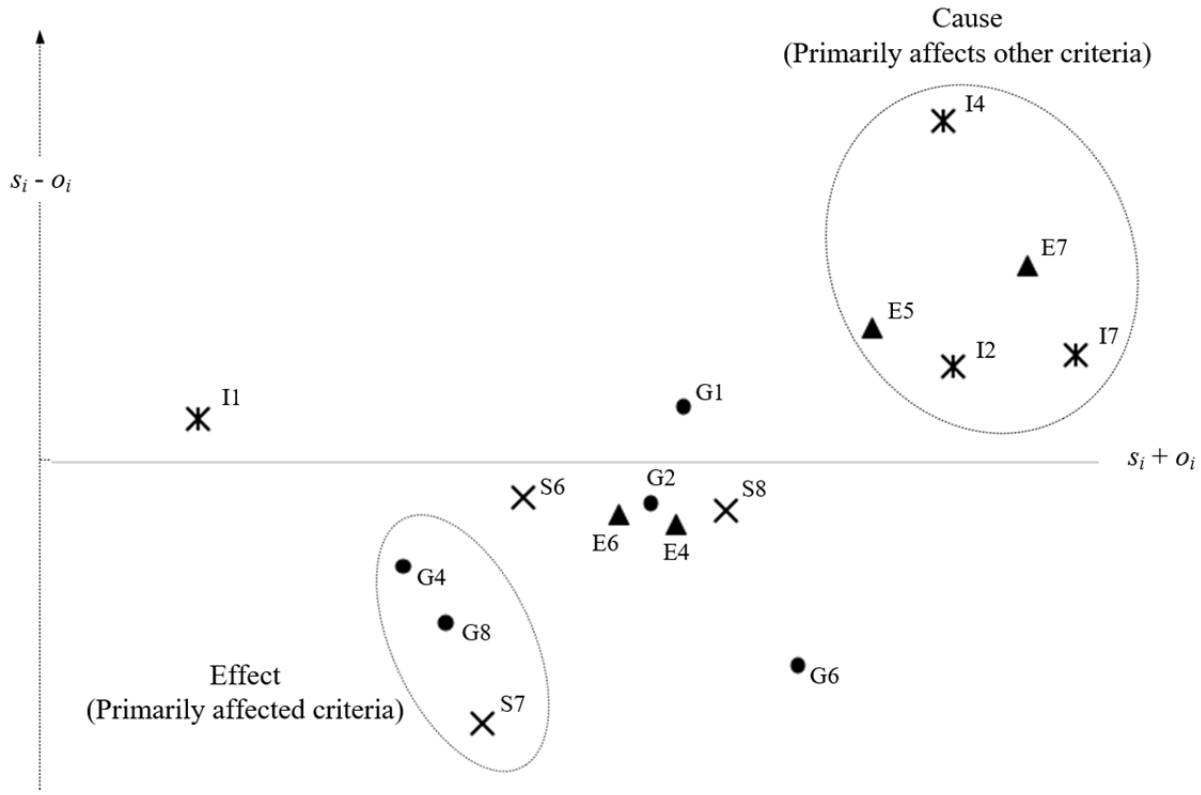

Figure 2. Cause-and-effect diagram of criteria.

5. Discussion and Conclusions

The awakening of the consciousness of "sports for all" has forced major cities to invest resources to host sports events, and thus shape the image of the sports cities. In order to achieve sustainable urban development, economic, social and environmental aspects are the main evaluation dimensions (Nesticò and Maselli, 2020; Lee and Xue, 2020; Yang et al., 2020). Many literatures advocate the importance of institutional substantiality, so this study includes the institutional aspect as one of the evaluation dimensions to make the evaluation structure more comprehensive. By reviewing the literature and integrating the opinions of multiple experts, an evaluation system for sustainable urban tourism development was established. However, it is important to understand those criteria and to explore their mutual influential relationships. To our knowledge, these issues have not been studied and discussed.

This study proposes a two-stage MCDM decision model. Bayesian BWM is used to determine the importance weights of the criteria, and rough DEMTAEL is used to identify the mutual influential relationships of the important criteria. The studies of A and B point out that Bayesian BWM solves the problem of integrating expert opinions for the conventional BWM and obtains a set of optimal group criterion weights. This study reduced 30 evaluation criteria to 16, which are relatively important criteria for measuring the performance of sustainable sports tourism. In terms of the Society (S) dimension, maintaining the quality of urban public order (S8) is the most important criterion in the evaluation system, with a weight of 0.223. This result echoes the findings of Gkoumas (2019) and Musavengane et al. (2020), where they mentioned that public order in the region affects the safety of the tourists. Some famous tourist attractions have had negative incidents, including theft, robbery, scams, traffic accidents, viral infections and racial discrimination. Before large-scale sports events are held, public security management must be strengthened, and rigorous planning and control of personnel entry and exit to ensure passenger confidence in safety. In terms of the Institutional (I) dimension, the development efficiency of sports tourism depends on the marketing and promotion by local governments (I7). In order to prevent urban tourism from falling into the off-season, periodic events should be organized to maintain the stability of the number of tourists. Sponsorship and support from local businesses (E5) is the most important criterion in the Economic (E) dimension. It is not difficult to understand that business sponsorship often brings more and more resources to sports activities. The sponsors and the organizers can achieve a win-win result by mutual benefit, and for the participants, they can further understand the sponsor brands and experience their products. When it comes to environmental protection (G), planning for the city's mass transit system (G6) helps reduce

the city's transportation carbon emissions and noise. At present, many environmental sports events have promoted zero-pollution itineraries. The measures include using electric vehicles, not using plastic materials, and using recyclable containers.

Rough DEMATEL maps out the main causes and effects. The promotion of sustainable sports tourism in the cities must particularly focus on the following criteria: In conjunction with festivals in the city (I4), increasing the number of visits to the attractions in the city (E7), marketing and promotion by local governments (I7), sponsorship and support by local businesses (E5) and maintenance of the urban tourism website (I2). These criteria will affect the performance of other criteria. This result echoes the management implications of many studies, including Pouder et al. (2018), Huang et al. (2015), Lee and Xue (2020) and Yang et al. (2020). The government must pay special attention to the performance of these five criteria. In order to let the public understand that the city is promoting sports tourism plans, print and online media promotion should be strengthened, and sports events should be organized in conjunction with festivals. Business sponsorship also helps to increase the spread of sports ethos and makes the implementation of sports tourism plans more effective. In addition, for restrictions on plastic materials (G4), monitoring the quality of drinking water (G8), and formulating procedures for handling emergencies (S7), they require the development of other criteria to achieve high performance. The development of sports tourism in the city is a complex and difficult project, and continuous simulation and review are required to make subsequent sports events more successful.

This study also compared the criteria screening results of AHP, conventional BWM, and Bayesian BWM. As shown in **Table 6**, AHP and BWM have fewer screening criteria than Bayesian BWM (without G8 and I2). This is because AHP and BWM use arithmetic averages when integrating experts' opinions. This method is vulnerable to the influence of extreme values, resulting in the loss of some information. In contrast, Bayesian BWM, which pays extra consideration for G8 and I2, makes the influential relationship system of the criteria more complete. It must be noted here that I2 and G8 are important affecting and affected factors in the analysis of rough DEMATEL.

Table 6. Criterion screening results for three different methods

Method	(Criteria through screening)
AHP	S6, S7, S8, G1, G2, G4, G6, E4, E5, E6, E7, I1, I4 and I7
BWM	S6, S7, S8, G1, G2, G4, G6, E4, E5, E6, E7, I1, I4 and I7
Bayesian BWM (Used in this study)	S6, S7, S8, G1, G2, G4, G6, G8, E4, E5, E6, E7, I1, I2, I4 and I7

In summary, the two-stage evaluation model proposed in this study provides a complete and systematic method, providing the management implications of the development of sports

tourism in the cities. This effective soft calculation method can reduce the subjectivity of management decisions. The academia has not yet studied and explored the mutual influential relationships among the criteria for sustainable sports tourism. Our model integrates several state-of-the-art methods and takes into account a variety of realistic factors, including the consideration of message uncertainty and the introduction of the concept of rough set theory. Our research proves the effectiveness and reliability of the proposed model. It should bring several benefits to practitioners and sports-related sectors: (i) identifying the most important and influential criteria; (ii) providing an improved basis for urban development sports tourism; (iii) helping decision-makers in the decision-making process to be more systematic. In the future, researchers can further investigate the quantitative data of the actual evaluation, making the evaluation results more accurate.

References

1. Chang, M. H., Liou, J. J., & Lo, H. W. (2019). A Hybrid MCDM Model for Evaluating Strategic Alliance Partners in the Green Biopharmaceutical Industry. *Sustainability*, *11*(15), 4065.
2. Chang, T. W., Lo, H. W., Chen, K. Y., & Liou, J. J. (2019). A novel FMEA model based on rough BWM and rough TOPSIS-AL for risk assessment. *Mathematics*, *7*(10), 874.
3. Gabus, A., & Fontela, E. (1972). World problems, an invitation to further thought within the framework of DEMATEL. Battelle Geneva Research Center, Geneva, Switzerland.
4. Gibson, H. J., Kaplanidou, K., & Kang, S. J. (2012). Small-scale event sport tourism: A case study in sustainable tourism. *Sport management review*, *15*(2), 160-170.
5. Gil-Alana, L. A., dos Santos Figueiredo, O. H., & Wanke, P. (2019). Structural breaks in Brazilian tourism revenues: Unveiling the impact of exchange rates and sports mega-events. *Tourism Management*, *74*, 207-211.
6. Giulianotti, R., Darnell, S., Collison, H., & Howe, P. D. (2018). Sport for development and peace and the environment: The case for policy, practice, and research. *Sustainability*, *10*(7), 2241.
7. Gkoumas, A. (2019). Evaluating a standard for sustainable tourism through the lenses of local industry. *Heliyon*, *5*(11), e02707.
8. Hsu, C. Y., Chen, M. Y., Nyaupane, G. P., & Lin, S. H. (2020). Measuring sustainable tourism attitude scale (SUS-TAS) in an Eastern island context. *Tourism Management Perspectives*, *33*, 100617.
9. Huang, F. H., Ye, Y. J., & Kao, C. H. (2015). Developing a novel Intuitionistic Fuzzy Importance–performance Analysis for evaluating corporate social responsibility in sport tourism event. Expert Systems with Applications, 42(19), 6530-6538.
10. Kim, W., Jun, H. M., Walker, M., & Drane, D. (2015). Evaluating the perceived social

impacts of hosting large-scale sport tourism events: Scale development and validation. *Tourism management*, *48*, 21-32.

11. Kurtzman, J. (2005). Economic impact: sport tourism and the city. *Journal of Sport Tourism*, *10*(1), 47-71.
12. Lee, S. W., & Xue, K. (2020). A model of destination loyalty: integrating destination image and sustainable tourism. *Asia Pacific Journal of Tourism Research*, *25*(4), 393-408.
13. Liao, S. K., Hsu, H. Y., & Chang, K. L. (2019). OTAs selection for hot spring hotels by a hybrid MCDM model. *Mathematical Problems in Engineering*, *2019*.
14. Lin, C. L., & Kuo, C. L. (2019). A service position model of package tour services based on the hybrid MCDM approach. *Current Issues in Tourism*, *22*(20), 2478-2510.
15. Liu, A., Xiao, Y., Ji, X., Wang, K., Tsai, S. B., Lu, H., ... & Wang, J. (2018). A novel two-stage integrated model for supplier selection of green fresh product. *Sustainability*, *10*(7), 2371.
16. Lo, H. W., Liou, J. J., Huang, C. N., & Chuang, Y. C. (2019). A novel failure mode and effect analysis model for machine tool risk analysis. *Reliability Engineering & System Safety*, *183*, 173-183.
17. Lo, H. W., Liou, J. J., Huang, C. N., Chuang, Y. C., & Tzeng, G. H. (2020). A new soft computing approach for analyzing the influential relationships of critical infrastructures. *International Journal of Critical Infrastructure Protection*, *28*, 100336.
18. Lo, H. W., Liou, J. J., Wang, H. S., & Tsai, Y. S. (2018). An integrated model for solving problems in green supplier selection and order allocation. *Journal of cleaner production*, *190*, 339-352.
19. Martin, J. C., Saayman, M., & du Plessis, E. (2019). Determining satisfaction of international tourist: A different approach. *Journal of Hospitality and Tourism Management*, *40*, 1-10.
20. Mohammadi, M., & Rezaei, J. (2019). Bayesian best-worst method: A probabilistic group decision making model. *Omega*, 102075.
21. Musavengane, R., Siakwah, P., & Leonard, L. (2020). The nexus between tourism and urban risk: Towards inclusive, safe, resilient and sustainable outdoor tourism in African cities. *Journal of Outdoor Recreation and Tourism*, *29*, 100254.
22. Nesticò, A., & Maselli, G. (2020). Sustainability indicators for the economic evaluation of tourism investments on islands. *Journal of Cleaner Production*, *248*, 119217.
23. Nunkoo, R., Ramkissoon, H., & Gursoy, D. (2012). Public trust in tourism institutions. *Annals of Tourism Research*, *39*(3), 1538-1564.
24. Peng, B., Tu, Y., Elahi, E., & Wei, G. (2018). Extended Producer Responsibility and corporate performance: Effects of environmental regulation and environmental strategy. *Journal of environmental management*, *218*, 181-189.

25. Perić, M., Vitezić, V., & Badurina, J. Đ. (2019). Business models for active outdoor sport event tourism experiences. *Tourism Management Perspectives*, *32*, 100561.
26. Popovic, G., Stanujkic, D., Brzakovic, M., & Karabasevic, D. (2019). A multiple-criteria decision-making model for the selection of a hotel location. *Land use policy*, *84*, 49-58.
27. Pouder, R. W., Clark, J. D., & Fenich, G. G. (2018). An exploratory study of how destination marketing organizations pursue the sports tourism market. *Journal of Destination Marketing & Management*, *9*, 184-193.
28. Séraphin, H., Gowreesunkar, V., Rodríguez, M. A. D., & Pagán, N. D. (2018). Assessing the tourism performance of a destination: Toward a new approach using Cuba as a case study. *Critical Essays in Tourism Research*.
29. Sports Administration Ministry of Education. Sports Policy White Paper. Available online: https://www.sa.gov.tw/Resource/Other/f1448262854502.pdf. 2016 (accessed on 28 February 2020).
30. Stević, I., Stević, S. R., & de Jesus Breda, Z. M. (2019). Application of MCDM Methods to Tourism Evaluation of Cultural Sites. In *Cultural Urban Heritage* (pp. 357-381). Springer, Cham.
31. Talebi, M., Majnounian, B., Makhdoum, M., Abdi, E., Omid, M., Marchi, E., & Laschi, A. (2019). A GIS-MCDM-based road network planning for tourism development and management in Arasbaran forest, Iran. *Environmental Monitoring and Assessment*, *191*(11), 647.
32. Urosevic, S., Karabasevic, D., Stanujkic, D., & Maksimovic, M. (2017). AN APPROACH TO PERSONNEL SELECTION IN THE TOURISM INDUSTRY BASED ON THE SWARA AND THE WASPAS METHODS. *Economic Computation & Economic Cybernetics Studies & Research*, *51*(1).
33. Weed, M. (2009). Progress in sports tourism research? A meta-review and exploration of futures. *Tourism Management*, *30*(5), 615-628.
34. Whitley, M. A., Massey, W. V., Camiré, M., Blom, L. C., Chawansky, M., Forde, S., ... & Darnell, S. C. (2019). A systematic review of sport for development interventions across six global cities. *Sport Management Review*, *22*(2), 181-193.
35. Yang, J.-J.; Lo, H.-W.; Chao, C.-S.; Shen, C.-C.; Yang, C.-C. Establishing a Sustainable Sports Tourism Evaluation Framework with a Hybrid Multi-Criteria Decision-Making Model to Explore Potential Sports Tourism Attractions in Taiwan. *Sustainability* **2020**, *12*, 1673.
36. Zavadskas, E. K., Šaparauskas, J., & Antucheviciene, J. (2018). Sustainability in construction engineering. *Sustainability*, *10*(7), 2236.
37. Zhao, H., Zhao, H., & Guo, S. (2018). Comprehensive Performance Evaluation of Electricity Grid Corporations Employing a Novel MCDM Model. *Sustainability*, *10*(7), 2130.