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A fuzzy multi-criteria approach for hosting-right selection: A case study of sport event

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A B S T R A C T

Decision-making process is an integral part of every sporting event across the globe. This process uses inputs from single to multi-decision makers. To make a sporting event a success, appropriate decision making needs to be made starting from hosting-right to the end of the event. Thus, this study presents a framework that scientifically determines the hosting-right for a sporting event. The framework is based on techno-economic analysis of potential hosting locations for a sporting event. Techno-economic criteria are analysed using fuzzy TOPSIS (technique for order preference by similarity to ideal solution) method. The analysis of the hosting-right is also performed through technical, economic, techno-economic and cost-benefit ratio perspectives. A case study of national sports festival in Nigeria is used to demonstrate the applicability of the proposed framework. Twelve technical and eight economic criteria are considered in the proposed framework. Six locations are considered during the implementation of the proposed framework. The results obtained show that the issue of hosting-right award depends on the evaluation criteria that are considered by decision-makers.

1. Introduction

Sports programmes serve as means of integrating people of diverse cultural background and creed under the same environment. This creates opportunities for them to interact and share the unique attributes of their culture with new friends, while income is being generated by the organisers of these programmes (Liu, 2012). The host communities of these programmes often generate incomes from tourists that attend the programme (Whitson & Macintosh, 1996). In some cases, tourists often revisit these communities with their family after the conclusion of these programmes. This opportunity is usually desired by the hosting communities of sporting programmes. It helps them to open up their communities to investment opportunities, while casing the unique features of their environment to the world. These advantages of show casting have made governments to invest in sports programmes that are of global interests. The involvement of government agencies in hosting-right bidding often introduce political angle to the award of such rights. This is necessary in order to reduce the chance of losing such bids (Lenskyj, 1996). The political prowess of a location is often combined with other requirements in order to make a bid to be successful. The decision on the locations which these programmes will take place is often adjudged by

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central bodies. These bodies are in-charge of planning, maintaining and updating the programmes. Their aims are not limited to the successful implementation of assigned task, but also to enforce discipline among competing athletes and to select appropriate locations for these programmes (Yuan et al., 2011). The selection of locations for these programmes is based on a bidding process by interested communities that have put in place basic facilities that can be used to host such programmes.

During the sporting programmes, several requirements have been used to determine the hosting-right of bidders. In terms of technical requirements, facility availability, security, reliability, safety and among others are often considered by decision-makers. Maintenance, security, transportation and accommodation costs are among the economic criteria that are considered by decision-makers during the hosting-right evaluation process. This is necessary in order to enhance the feasibility of bidder to successfully host sporting programmes. Till date, sparse information exists on how best these requirements can be combined into a single performance index. This problem is further compounded by the presence of linguistic terms in evaluating hosting-right criteria. In some cases, available information on these requirements is imprecise and vague. Thus, this makes some of the available models in literature unsuitable for this kind of data analysis.

The issue of hosting-right selection has been addressed using inputs from different decision-makers under a multi-criteria framework. However, sparse information exists on how to address this problem using multi-criteria decision-making (MCDM) tools. A recent attempt at addressing this issue was reported by Karaca et al. (2019). They used entropy method and complex proportional assessment to evaluate the selection of a place for Olympic. Detailed evaluation of the fundamental criteria for hosting-right was presented in their work. Hiller (2000) examined the bidding plan for Cape Town. Their work observed that apart from winning a bid, there is the need for optimal analysis of the actual event costs.

The objective of this study is to presents a framework for hosting-right locations ranking using techno-economic criteria. The proposed framework is based on the concept of fuzzy TOPSIS (technique for order preference by similarity to ideal solution) method. Fuzzy entropy method is used to address the issue of the technical and economic criteria importance. The fuzzy TOPSIS method addresses the issue of integrating the techno-economic criteria into a single performance index. Furthermore, the hosting locations are evaluated from technical, economic and cost-benefit ratio perspectives using the fuzzy TOPSIS method. This provides an avenue to evaluate the significance of using technical, economic and techno-economic perspectives in the evaluation of hosting-right for a sports event.

2. Methodology

Fuzzy TOPSIS method is a robust tool that has been used extensively for a multi-criteria analysis (Wang & Lee, 2007; Hung & Chen, 2009; Kahraman & Kaya, 2011; Askarifara et al., 2018). This is due to its unique attribute of using the best and worst values of criteria in making decisions. The information that is used for analysis is presented in a decision-matrix format (Eq. (1)). This information could be from a datasets from a survey or experiment.

$$D = \begin{pmatrix} C_{11} & \cdots & C_{1n} \\ C_{21} & \cdots & C_{2n} \\ & & \\ C_{m1} & \cdots & C_{mn} \end{pmatrix} \tag{1}$$

The aggregated responses from the decision-makers are combined using Eq. (2). This creates the opportunity for the alternative normalised value determination (Saghafian & Hejazi, 2005). However, consideration is given to the criteria orientations (desire value directions) of the criteria in a decision matrix (Eq. (1)). Criteria which are benefit-oriented are normalised using Eq. (3), while Eq. (4) is used to normalise cost-oriented (Wang et al., 2003).

$$\left\{C_{ij}^1, C_{ij}^2, C_{ij}^3\right\} = \frac{1}{K}\left\{\sum_{k=1}^{K} C_{ijk}^1, \sum_{k=1}^{K} C_{ijk}^2, \sum_{k=1}^{K} C_{ijk}^3\right\} \tag{2}$$

$$\left\{v_{ij}^1, v_{ij}^2, v_{ij}^3\right\} = \left\{\frac{C_{ij}^1}{C_*^3}, \frac{C_{ij}^2}{C_*^3}, \frac{C_{ij}^3}{C_*^3}\right\} \tag{3}$$

$$\left\{v_{ij}^1, v_{ij}^2, v_{ij}^3\right\} = \left\{\frac{C_*^1}{C_{ij}^3}, \frac{C_*^1}{C_{ij}^2}, \frac{C_*^1}{C_{ij}^1}\right\} \tag{4}$$

$$C_*^1 = \min_j \left\{C_{ij}^1\right\} \tag{5}$$

$$C_*^3 = \max_j \left\{C_{ij}^1\right\} \tag{6}$$

The weighted normalised values of the criteria in a decision-matrix are determined in order to generate the alternatives ideal and not-ideal solutions. This process entails the combination of the criteria weights and their normalised values (Eq. 7).

$$\left\{r_{ij}^1, r_{ij}^2, r_{ij}^3\right\} = \left\{w_{ij}^1 v_{ij}^1, w_{ij}^2 v_{ij}^2, w_{ij}^3 v_{ij}^3\right\}. \tag{7}$$

The computation of the ideal and not-ideal distances of the alternatives is based on the assumption that the ideal and not-ideal distances of each criterion are expressed as Eqs. (8-9), respectively. Given these equations, the ideal and not-ideal distances of an alternative are expressed as Eqs. (10-11), respectively (Ighravwe & Oke, 2016).

$$\left\{r_1^+, r_2^+, r_3^+\right\} = \left\{1,1,1\right\} \tag{8}$$

$$\left\{r_1^-, r_2^-, r_3^-\right\} = \left\{0,0,0\right\} \tag{9}$$

$$d_i^+ = \sum_{j=1}^{n} \sqrt{\frac{1}{3}\left\{\left(r_{ij}^1 - r_1^+\right)^2 + \left(r_{ij}^2 - r_2^+\right)^2 + \left(r_{ij}^3 - r_3^+\right)^2\right\}} \tag{10}$$

$$d_i^+ = \sum_{j=1}^{n} \sqrt{\frac{1}{3}\left\{\left(r_{ij}^1 - r_1^-\right)^2 + \left(r_{ij}^2 - r_2^-\right)^2 + \left(r_{ij}^3 - r_3^-\right)^2\right\}} \tag{11}$$

where, d_i^+ and d_i^- the ideal and not-ideal distances of alternative *i*, respectively. The closeness coefficient of the alternatives is expressed as the relationship between their ideal and not-ideal distances (Eq. 12). The best alternative is taken as the alternative with the highest closeness coefficient (Hsu & Chen, 1996; Wang & Lee, 2007; Hung & Chen, 2009).

$$d_i = \frac{d_i^-}{d_i^- + d_i^-}. \tag{12}$$

Based on the closeness co-efficient of the technical and economic criteria, the cost-benefit of hosting a sporting festival in each alternative is expressed as Eq. (13). The best alternative is taken as the alternative with the highest cost-benefit ratio.

$$CB_i = \frac{d_i^t}{d_i^c}, \tag{13}$$

where, d_i^t and d_i^c denotes the closeness co-efficient of the technical and economic criteria for alternative i, respectively, and CB_i denotes the cost-benefits of alternative i. The steps for implementing the fuzzy TOPSIS approach for the current problem are outlined in Appendix A.

4. Case study

Over the years, the requirements for hosting-right of sports events have been modified. This is necessary in order to accommodate the ever-changing demands of spectators and stakeholders. In practice, technical, environmental and economic criteria are often used to determine the suitability of locations for sporting programmes. Given that the environmental criteria that affect the award of hosting-right are difficult to control, decision-makers have the opportunity to rely on technical and economic information. This section discusses selected techno-economic criteria that will aid informed decisions on the award of hosting-right to a location.

It considers the technical criteria that are pivotal towards awarding a location the hosting-right of a sporting event. It focuses on the benefits that are associated with the award of a hosting-right. These criteria are both organiser and spectators-based (Table 1).

Table 1
Selected technical criteria

Criteria	Description
Facility availability (C_{11})	This criterion is used to evaluate the capacity of a location to provide the equipment and facility that are required for a successful hosting of a sporting programme.
Facility reliability (C_{12})	It measures the reliability of the available equipment and facility that a location is using as a means for awarding them a hosting-right for a sporting programme.
Facility security (C_{13})	It looks at how secure a location will be during the hosting of a sporting programme. It covers the security of life and properties within a location during this programme.
Facility safety (C_{14})	It covers the issue of safety of life and properties within a location for a sports programme. The safety of lives is expected to cover that of the spectators, the organisers and the athletes.
Facility accessibility (C_{15})	This criterion focuses on the accessibility of the areas where the different equipment and facility for a sporting programme in a location are situated. This access covers the ease of locating the faculties and equipment by athletes, officiating personnel and spectators.
Facility standard (C_{16})	It measures the quality of equipment and facility that are provided by the hosting community of a sporting programme. This is done by comparing the facility and equipment that are provided with the required of the benchmarks.
Facility revenue generation capacity (C_{17})	It measures the potential of a location in creating adequate revenues that will cover the expenses that will be incurred during a sporting programme. The revenue sources are expected to cover the sales of tickets, the award of image-right and among others.
Facility attractiveness to sponsor (C_{18})	This criterion deals with the potential of a location to attract people that will provide financial support for a sporting programme.
Facility attractiveness to spectators (C_{19})	This criterion looks that the potential of a location to attract spectators during a sporting programme. This is necessary in order to increase the revenue generation capacity of the organisers as well as the hosting community.
Facility attractiveness to technocrats (C_{110})	It looks at the willingness of technocrats to officiate in a sporting programme with respect to a particular location. The need for this criterion considering is associated with the issue of this personnel security and safety.
Facility parking lot (C_{111})	This criterion examines the provision of an adequate parking lot for spectators that will attend a sporting programming using personal means of transportation.
Facility proximity to hotels (C_{112})	It examines the possibility of provision of accommodation for people that will travel from areas within and beyond the location where a sporting programme will take place.

During sporting programmes, several expenses are incurred by the organisers, officiating teams, athletes, officiating teams, spectators and among others. These expenses determine the attractiveness of locations to be awarded a hosting-right. This article attempts to describe selected economic criteria for hosting-right awarding in order to provide decision-makers with empirical information on this issue (Table 2).

Table 2
Selected economic criteria

Criteria	Description
Maintenance cost (C_{21})	It evaluates the cost of planned and unplanned maintenance activities that will be incurred during a sporting programme in a particular location.
Ticketing cost (C_{22})	This criterion measures the average ticket cost for attending a sporting programme in a particular location.
Security cost (C_{23})	It looks at the expenses that will be incurred as security cost during a sporting programme in a particular location.
Energy cost (C_{24})	It measures the cost of providing electricity for a sporting programme with respect to a particular location.
Officiating cost (C_{25})	This criterion focuses on the average amount of money that an officiating member for a sporting programme will be paid with respect to a location.
Transportation cost (C_{26})	It measures the expenses that the spectator, officiating teams and among others will incur in order to transport themselves to the venue of a sporting programme on a daily basis.
Accommodation cost (C_{27})	This criterion evaluates the average expenses that spectators and other interested individuals will pay for accommodation that are either provided by the host community or private organisation during a sporting programme.
Image-right cost (C_{28})	It evaluates the cost that interested organisations will pay in order to televise a sporting programme with respect to a particular location.

A case study of National Sports Festival in Nigeria is used to demonstrate the applicability of the proposed framework. During the application of the proposed framework, a well-structured questionnaire was used to obtained relevant information from three decision-makers (Govindan et al., 2012). The questionnaire is made up of two sections. The first section contains information about the importance of the techno-economic criteria. In the second section, information on the effectiveness of hosting locations is presented. The linguistic terms in Tables 3-5 were used to design the questionnaire. Six locations were considered during the implementation of the proposed model.

Table 3
Linguistic terms and fuzzy numbers for the criteria importance

Linguistic terms	Fuzzy numbers
Extremely important (EI)	(0.90, 1.00, 1.00)
Highly important (HI)	(0.70, 0.90, 1.00)
Important (I)	(0.50, 0.70, 0.90)
Unimportant (U)	(0.30, 0.50, 0.70)
Highly unimportant (HU)	(0.10, 0.30, 0.50)

Table 4
Linguistic terms and fuzzy numbers for the technical criteria evaluation

Linguistic terms	Fuzzy numbers
Extremely satisfactory (ES)	(0.70, 0.90, 1.00)
Highly satisfactory (HS)	(0.50, 0.70, 0.90)
Satisfactory (S)	(0.30, 0.50, 0.70)
Unsatisfactory (US)	(0.10, 0.30, 0.50)
Highly unsatisfactory (HS)	(0.00, 0.10, 0.30)

Table 5
Linguistic terms and fuzzy numbers for the economic criteria evaluation

Linguistic terms	Fuzzy numbers
Extremely high (EH)	(0.70, 0.90, 1.00)
Very high (VH)	(0.50, 0.70, 0.90)
High (H)	(0.30, 0.50, 0.70)
Low (L)	(0.10, 0.30, 0.50)
Very low (VL)	(0.00, 0.10, 0.30)

The information in Table 3 was used to sample the opinion of three experts (DM1, DM2 and DM3) on the award of hosting-right to six locations (i.e., L1 to L6). The responses cover the importance of the technical and economic criteria (Table 6).

Table 6
Linguistic terms of the techno-economic criteria importance

	Technical Criteria											
DM	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}	C_{110}	C_{111}	C_{112}
DM1	HI	HI	HI	HI	HI	HI	HI	HI	HI	HI	HI	HI
DM2	HI	HI	I	HI	HI	HI	I	HU	HU	HU	HU	HU
DM3	HI	HI	HI	HI	HI	HI	I	EI	EI	EI	HI	EI
	Economic Criteria											
	C_{21}	C_{22}	C_{23}	C_{24}	C_{25}	C_{26}	C_{27}	C_{28}				
DM1	HI	I	HI	HI	HI	HI	HI	HI				
DM2	HU	I	I	EI	HI	HI	HI	HI				
DM3	EI	HI	EI	EI	EI	EI	EI	HI				

The information in Table 5 and Table 6 are aggregated using Eq. (2). The results obtained showed that some of the technical and economic criteria had the same aggregated values (see Table 7).

Table 7
Aggregated fuzzy numbers for the techno-economic criteria importance

Technical criteria		Economic criteria	
C_{11}	(0.70,0.90,1.00)	C_{21}	(0.57,0.73,0.83)
C_{12}	(0.70,0.90,1.00)	C_{22}	(0.57,0.77,0.93)
C_{13}	(0.63,0.83,0.97)	C_{23}	(0.70,0.87,0.97)
C_{14}	(0.70,0.90,1.00)	C_{24}	(0.83,0.97,1.00)
C_{15}	(0.70,0.90,1.00)	C_{25}	(0.77,0.93,1.00)
C_{16}	(0.70,0.90,1.00)	C_{26}	(0.77,0.93,1.00)
C_{17}	(0.43,0.63,0.80)	C_{27}	(0.77,0.93,1.00)
C_{18}	(0.57,0.73,0.83)	C_{28}	(0.70,0.90,1.00)
C_{19}	(0.57,0.73,0.83)		
C_{110}	(0.57,0.73,0.83)		
C_{111}	(0.57,0.73,0.83)		
C_{112}	(0.57,0.73,0.83)		

The linguistic values for the performance of the various locations are determined using the information in Table 4 for the technical criteria (Table 8), while the information in Table 4 was used to evaluate the economic criteria of the locations (Table 9).

Table 8
Linguistic values for the economic criteria

	DM1						DM2					
	L_1	L_2	L_3	L_4	L_5	L_6	L_1	L_2	L_3	L_4	L_5	L_6
C_{21}	EH	VH	VH	H	VH	H	EH	VL	VH	H	L	H
C_{22}	VH	VH	VH	EH	VH	H	VH	VL	H	H	L	L
C_{23}	EH	EH	EH	EH	VH	EH	EH	VL	H	H	H	H
C_{24}	EH	EH	EH	EH	EH	EH	VH	VL	VH	H	H	H
C_{25}	EH	EH	EH	EH	VH	EH	VH	VL	H	H	H	H
C_{26}	EH	EH	EH	EH	VH	EH	EH	L	VH	H	H	H
C_{27}	EH	EH	EH	EH	VH	EH	VH	H	H	H	L	H
C_{28}	EH	EH	H	H	VH	EH	VH	H	VH	H	H	H
	DM3											
	L_1	L_2	L_3	L_4	L_5	L_6						
C_{21}	EH	EH	EH	EH	EH	EH						
C_{22}	VH	VH	VH	VH	VH	VH						
C_{23}	EH	EH	EH	EH	EH	EH						
C_{24}	EH	EH	EH	EH	EH	EH						
C_{25}	EH	EH	EH	EH	EH	EH						
C_{26}	EH	EH	EH	EH	EH	EH						
C_{27}	EH	EH	EH	EH	EH	EH						
C_{28}	VH	VH	VH	VH	VH	VH						

Table 9
Linguistic values for the technical criteria

	DM1							DM2					
	L_1	L_2	L_3	L_4	L_5	L_6		L_1	L_2	L_3	L_4	L_5	L_6
C_{11}	HS	HS	HS	S	S	S	C_{11}	HS	ES	HS	S	HU	ES
C_{12}	HS	HS	HS	S	S	S	C_{12}	ES	HS	HS	HS	HS	HS
C_{13}	HS	HS	HS	S	S	S	C_{13}	ES	HS	HS	HS	HS	HS
C_{14}	HS	HS	HS	S	S	S	C_{14}	ES	HS	HS	HS	HS	HS
C_{15}	HS	HS	HS	S	S	S	C_{15}	ES	HS	HS	HS	HS	HS
C_{16}	HS	HS	HS	S	S	S	C_{16}	ES	HS	HS	HS	HS	HS
C_{17}	HS	HS	HS	S	S	S	C_{17}	ES	HS	HS	HS	HS	HS
C_{18}	HS	HS	HS	S	S	S	C_{18}	ES	HS	HS	HS	HS	S
C_{19}	HS	HS	HS	S	S	S	C_{19}	ES	HS	HS	HS	HS	S
C_{110}	HS	HS	HS	S	S	S	C_{110}	ES	HS	HS	HS	HS	HS
C_{111}	HS	HS	HS	S	S	S	C_{111}	ES	HS	HS	HS	HS	HS
C_{112}	HS	HS	HS	S	S	S	C_{112}	ES	HS	HS	HS	HS	HS

	DM3					
	L_1	L_2	L_3	L_4	L_5	L_6
C_{11}	HS	ES	HS	S	HU	ES
C_{12}	ES	HS	U	HU	U	HS
C_{13}	S	HS	S	ES	S	S
C_{14}	U	ES	HU	ES	ES	U
C_{15}	HS	S	ES	HS	HS	HU
C_{16}	ES	HS	S	S	S	U
C_{17}	HS	HU	HU	HU	U	ES
C_{18}	HU	HS	HS	HU	HU	HS
C_{19}	HS	ES	HU	U	ES	U
C_{110}	HS	HU	ES	S	HS	HU
C_{111}	HU	HU	U	ES	S	ES
C_{112}	HU	S	ES	S	U	HS

Based on the information in Tables 8 and 9, the aggregated values for the locations technical and economic criteria are evaluated using Eq. (2). The results obtained are presented in Tables 10 and 11 for the technical and economic criteria, respectively. The information in these tables showed that there are consistencies in the aggregated values for some of the criteria and locations. Based on these results, the normalised values for the technical criteria were obtained using Eq. 3, while Equation 4 was used to determine the normalised values for the economic criteria (Table 13).

The information in Table 7 was combined with the results presented in Table 12 and Table 13 in order to determine the weighted normalised values for the technical and economic criteria using Eq. (7). The results obtained were used to determine the locations ideal and not-ideal solutions for the case study (Table 14). This was achieved by considering Eq. (10) and Eq. (11). The results obtained were used during the evaluation of the locations closeness coefficients when Eq. (12) was considered. Based on the locations technical and economic closeness coefficients, their cost-benefit ratios were calculated using Eq. (13).

Table 10
Aggregated values for technical criteria with respect to locations

	L1	L2	L3	L4	L5	L6
C_{11}	(0.50,0.70,0.90)	(0.63,0.83,0.97)	(0.50,0.70,0.90)	(0.30,0.50,0.70)	(0.10,0.30,0.50)	(0.50,0.70,0.87)
C_{12}	(0.63,0.83,0.97)	(0.50,0.70,0.90)	(0.37,0.57,0.77)	(0.27,0.43,0.63)	(0.30,0.50,0.70)	(0.43,0.63,0.83)
C_{13}	(0.50,0.70,0.87)	(0.50,0.70,0.90)	(0.43,0.63,0.83)	(0.50,0.70,0.87)	0.37,0.57,0.77)	(0.37,0.57,0.77)
C_{14}	(0.43,0.63,0.80)	(0.57,0.77,0.93)	(0.33,0.50,0.70)	(0.50,0.70,0.87)	(0.50,0.70,0.87)	(0.30,0.50,0.70)
C_{15}	(0.63,0.83,0.97)	(0.43,0.63,0.83)	(0.57,0.77,0.93)	(0.43,0.63,0.83)	(0.43,0.63,0.83)	(0.27,0.43,0.63)
C_{16}	(0.63,0.83,0.97)	(0.50,0.70,0.90)	(0.43,0.63,0.83)	(0.37,0.57,0.77)	(0.37,0.57,0.77)	(0.30,0.50,0.70)
C_{17}	(0.57,0.77,0.93)	(0.33,0.50,0.70)	(0.33,0.50,0.70)	(0.27,0.43,0.63)	(0.30,0.500.70)	(0.50,0.70,0.87)
C_{18}	(0.40,0.57,0.73)	(0.50,0.70,0.90)	(0.50,0.70,0.90)	(0.27,0.43,0.63)	(0.27,0.43,0.63)	(0.37,0.57,0.77)
C_{19}	(0.57,0.77,0.93)	(0.57,0.77,0.93)	(0.33,0.50,0.70)	(0.30,0.50,0.70)	(0.50,0.70,0.87)	(0.23,0.43,0.63)
C_{110}	(0.57,0.77,0.93)	(0.33,0.50,0.77)	(0.57,0.77,0.93)	(0.37,0.57,0.77)	(0.43,0.63,0.83)	(0.43,0.63,0.83)
C_{111}	(0.40,0.57,0.73)	(0.33,0.50,0.77)	(0.37,0.57,0.77)	(0.50,0.70,0.87)	(0.37,0.57,0.77)	(0.50,0.70,0.87)
C_{112}	(0.40,0.57,0.73)	(0.43,0.63,0.83)	(0.57,0.77,0.93)	(0.37,0.57,0.77)	(0.30,0.50,0.70)	(0.43,0.63,0.83)

Table 11
Aggregated values for economic criteria with respect to locations

	L1	L2	L3	L4	L5	L6
C_{21}	(0.70,0.90,1.00)	(0.57,0.77,0.93)	(0.57,0.77,0.93)	(0.43,0.63,0.80)	(0.37,0.57,0.73)	(0.43,0.63,0.80)
C_{22}	(0.50,0.70,0.90)	(0.50,0.70,0.90)	(0.50,0.70,0.87)	(0.50,0.70,0.87)	(0.30,0.50,0.70)	(0.30,0.50,0.70)
C_{23}	(0.70,0.90,1.00)	(0.63,0.83,0.97)	(0.57,0.77,0.90)	(0.57,0.77,0.90)	(0.43,0.63,0.80)	(0.43,0.63,0.80)
C_{24}	(0.63,0.83,0.97)	(0.63,0.83,0.97)	(0.63,0.83,0.97)	(0.57,0.77,0.90)	(0.57,0.77,0.90)	(0.57,0.77,0.90)
C_{25}	(0.63,0.83,0.97)	(0.63,0.83,0.97)	(0.57,0.77,0.90)	(0.57,0.77,0.90)	(0.43,0.63,0.80)	(0.43,0.63,0.80)
C_{26}	(0.70,0.90,1.00)	(0.50,0.700.83)	(0.63,0.83,0.97)	(0.57,0.77,0.90)	(0.43,0.63,0.80)	(0.43,0.63,0.80)
C_{27}	(0.63,0.83,0.97)	(0.57,0.77,0.90)	(0.57,0.77,0.90)	(0.57,0.77,0.90)	(0.37,0.57,0.73)	(0.43,0.63,0.80)
C_{28}	(0.63,0.83,0.97)	(0.57,0.77,0.90)	(0.50,0.70,0.87)	(0.43,0.63,0.80)	(0.43,0.63,0.80)	(0.43,0.63,0.80)

Table 12
Normalised values of the technical criteria with respect to the locations

	L1	L2	L3	L4	L5	L6
C_{11}	(0.52, 0.72, 0.93)	(0.66,0.86,1.00)	(0.52,0.72,0.93)	(0.31,0.52,0.72)	(0.10,0.31,0.52)	(0.52,0.72,0.90)
C_{12}	(0.66,0.86,1.00)	(0.52,0.72,0.93)	(0.38,0.59,0.79)	(0.28,0.45,0.66)	(0.31,0.52,0.72)	(0.45,0.66,0.86)
C_{13}	(0.56,0.78,0.96)	(0.56,0.78,1.00)	(0.48,0.70,0.93)	(0.56,0.78,0.96)	(0.41,0.63,0.85)	(0.41,0.63,0.85)
C_{14}	0.46,0.68,0.86)	(0.61,0.82,1.00)	(0.36,0.54,0.75)	(0.54,0.75,0.93)	(0.54,0.75,0.93)	(0.32,0.54,0.75)
C_{15}	(0.66,0.86,1.00)	(0.45,0.66,0.86)	(0.59,0.79,0.97)	(0.45,0.66,0.86)	(0.45,0.66,0.86)	(0.280.45,0.66)
C_{16}	(0.66,0.86,1.00)	(0.52,0.72,0.93)	(0.45,0.66,0.86)	(0.38,0.59,0.79)	(0.38,0.59,0.79)	(0.31,0.52,0.72)
C_{17}	(0.61,0.82,1.00)	(0.36,0.54,0.75)	(0.36,0.54,0.75)	(0.29,0.46,0.68)	(0.32,0.54,0.75)	(0.54,0.75,0.93)
C_{18}	(0.44,0.63,0.81)	(0.56,0.78,1.00)	(0.56,0.78,1.00)	(0.30,0.48,0.70)	(0.30,0.48,0.70)	(0.41,0.63,0.85)
C_{19}	(0.61,0.82,1.00)	(0.61,0.82,1.00)	(0.36,0.54,0.75)	(0.32,0.54,0.75)	(0.54,0.75,0.93)	(0.25,0.46,0.68)
C_{110}	(0.61,0.82,1.00)	(0.36,0.54,0.82)	(0.60,0.82,1.00)	(0.39,0.61,0.82)	(0.46,0.68,0.89)	(0.46,0.68,0.89)
C_{111}	(0.46,0.65,0.85)	(0.38,0.58,0.88)	(0.42,0.65,0.88)	(0.58,0.81,1.00)	(0.42,0.65,0.88)	(0.580.81,1.00)
C_{112}	(0.43,0.61,0.79)	(0.46,0.68,0.89)	(0.61,0.82,1.00)	(0.39,0.61,0.82)	(0.32,0.54,0.75)	(0.46,0.68,0.89)

Table 13
Normalised values of the economic criteria with respect to the locations

	L1	L2	L3	L4	L5	L6
C_{21}	(0.37,0.41,0.52)	(0.39,0.48,0.65)	(0.39,0.48,0.65)	(0.46,0.58,0.85)	(0.50,0.65,1.00)	(0.46,0.58,0.85)
C_{22}	(0.33,0.43,0.60)	(0.33,0.43,0.60)	(0.35,0.43,0.60)	(0.35,0.43,0.60)	(0.43,0.60,1.00)	(0.43,0.60,1.00)
C_{23}	(0.43,0.48,0.62)	(0.45,0.52,0.68)	(0.48,0.57,0.76)	(0.48,0.57,0.76)	(0.54,0.68,1.00)	(0.54,0.68,1.00)
C_{24}	(0.59,0.68,0.89)	(0.59,0.68,0.89)	(0.59,0.68,0.89)	(0.63,0.74,1.00)	(0.63,0.74,1.00)	(0.63,0.74,1.00)
C_{25}	(0.45,0.52,0.68)	(0.45,0.52,0.68)	(0.48,0.57,0.76)	(0.48,0.57,0.76)	(0.54,0.68,1.00)	(0.54,0.68,1.00)
C_{26}	(0.43,0.48,0.62)	(0.52,0.62,0.87)	(0.45,0.52,0.68)	(0.48,0.57,0.76)	(0.54,0.68,1.00)	(0.54,0.68,1.00)
C_{27}	(0.38,0.44,0.58)	(0.41,0.48,0.65)	(0.41,0.48,0.65)	(0.41,0.48,0.65)	(0.50,0.65,1.00)	(0.46,0.58,0.85)
C_{28}	(0.45,0.52,0.68)	(0.48,0.57,0.76)	(0.50,0.62,0.87)	(0.54,0.68,1.00)	(0.54,0.68,1.00)	(0.54,0.68,1.00)

Table 14
Summary of the fuzzy TOPSIS outputs

Criteria		L1	L2	L3	L4	L5	L6
Technical	d_i^+	1.6945	1.7596	1.9353	1.9741	1.8867	2.7310
	d_i^-	1.9758	2.1695	2.0534	1.8695	1.8279	1.8933
	d_i	0.5383	0.5522	0.5148	0.4864	0.4921	0.4094
Economic	d_i^+	1.5064	1.4940	1.4281	1.2324	1.2681	2.0868
	d_i^-	1.2611	1.5132	1.5293	1.6459	1.9620	1.9075
	d_i	0.4557	0.5032	0.5171	0.5718	0.6074	0.4776
Techno-economic	d_i^+	2.2673	2.3082	2.4052	2.3272	2.2733	3.4370
	d_i^-	2.3533	2.6450	2.5603	2.4908	2.6815	2.6875
	d_i	0.5093	0.5340	0.5156	0.5170	0.5412	0.4388
Cost-benefit	CB_i	1.1814	1.0973	0.9955	0.8506	0.8101	0.8573

5. Discussion of Results

Based on the results presented in Fig. 1, it was observed that the various locations ranks are dependent on the evaluation criteria. For instance, the best-ranked locations using economic and techno-economic criteria was L1, while the cost-benefit ratio and technical criterion ranked L1 and L2, respectively as the best locations. Also, the techno-economic criterion and the cost-benefit ratio ranked the second best location as L2, while in terms of the technical and the economic criteria ranked L2 and L4 as the second best locations, respectively (Fig. 2). These criteria and the cost-benefit ratio results ranked L3 as the third best location, while the techno-economic criterion identified L4 as the third best location. The fourth-ranked location using the criteria in Table 14 did not show any pattern. In terms of the technical and economic criteria, L5 and L2 are ranked as the fourth best locations, respectively, while L3 and L6 are ranked as fourth from the techno-economic and cost-benefit ratio perspectives, respectively. The economic and techno-economic criteria ranked L1 and L6 as the fifth best locations, respectively. The technical and techno-economic criteria ranked L6 as the sixth locations, while L1 and L5 are ranked as the sixth locations in terms of the economic and cost-benefit ratio criteria (Fig. 1).

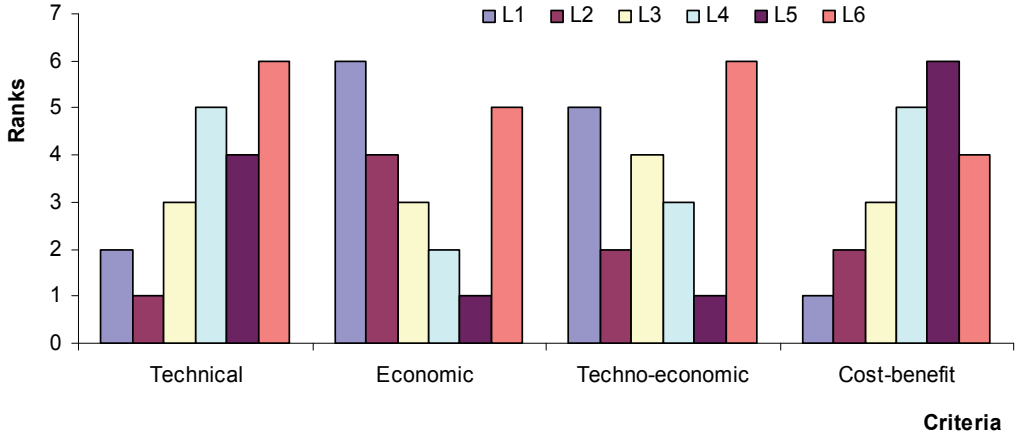

Fig. 1. Comparison of the locations ranks

6. Conclusions

Hosting-right selection problem requires a systematic method in order to incorporate spectators, organisers, officiating teams and among others needs. Their needs have been addressed in this article by proposing a techno-economical approach to this problem. The current article demonstrated how hosting-right can be selected using a scientific framework. It focuses on the use of linguistic values in order to model hosting-right problem under a decision-makers scenario. Thus, it has extended the application of fuzzy TOPSIS method to this problem area. This is one contribution of the current article. The identification of different criteria for hosting-right of a sporting event is one of the contributions of this study. One limitation of this study is that it did not consider the politicking in hosting-right selection.

The proposed framework can be adopted for other event management (conference and exhibition) problems by making a minor modification to the techno-economic criteria in this study. Also, the structure of the proposed framework can be modified to incorporate social-political criteria. Finally, further study can be carried out on the application of MCDM tools that address the problems of sports promotion strategy, sports facility maintenance strategy and sports intervention strategy.

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Appendix A

Step 1: Determine the number of technical and economic criteria for the evaluation process
Step 2: Select the number of potential locations for the sporting programme
Step 3: Determine the number of decision-maker for the evaluation process
Step 4: Select the linguistic terms and the type of fuzzy number for the evaluation process
Step 5: Evaluate the technical and economic criteria importance as well as the alternatives technical and economic criteria values.
Step 6: Set-up decision matrix for the evaluation process using the information in Step 5 (See Eq. 1).
Step 7: Aggregate the decision-makers responses (see Eq. 2) for the criteria importance and their alternative values
Step 8: Create the normalised decision matrix (see Eqs. (3-4)).
Step 9: Based on the results in normalised decision matrix, create the weighted normalised decision matrix (see Eq. (7)).
Step 10: Determine the alternatives ideal and not-ideal solutions using the expression in Eqs. (10-11).
Step 11: Determine alternative closeness coefficient and rank using Eq. (12).