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## Original Research

# Locating the Public Sport Stations in Shahrood City by Combining Multi-Criteria Decision Making Methods in GIS Technology

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## ABSTRACT

The main purpose of this study was to locate the public sport stations in Shahrood city by combining multi-criteria decision making methods in the Geographic Information System environment. The present study was practical and developmental in nature. It was also descriptive-analytical in terms of method. The method was based on the decomposition, locating public sport stations in Shahrood, and analyzing and overlapping information layers using the combination of multi criteria decision making including best-worst method and technique for order preference by similarity to ideal solution in the geographic information system environment. The present study was conducted in four stages. According to the experts' opinions in this study, attractiveness and environmental conditions were selected as the most important criterion and the potential for interference as the least important criterion. The calculated values for the stations also showed that Bolvar, Baharestan, Abshar, Shahrak Alborz and Shohada Mehrab parks are considered as top priorities and other parks as lower priorities for public sport in Shahrood, respectively. Using the results of this study, it can be stated that the officials and those involved have a clear and concise plan through which they will make fewer mistakes. According to the findings of the present study, it was suggested that the attractiveness index and environmental conditions of public sports stations be paid more attention and that the items that are not of high importance be given the last priority.

**Keywords:** Sports technology, Public sport, Locating, Geographic Information System, Multi Criteria Decision Making, Best-worst.

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## **INTRODUCTION**

One of the most important current problems in the cities of our country is the inappropriate placement of sports spaces among other urban uses [1]. In general, human beings have always been willing to consider their place of activity due to lower costs, higher profits, and access to resources [2]. One of the basic requirements for establishing high-productivity sports venues was to choose the optimal location for their construction [3]. This issue has been considered by the government in recent years, especially the Management and Planning Organization as well as the Protection and Environment Organization [4]. Location was an attempt to choose the best place to perform activities that, with the available material and spiritual facilities, provided the most productivity in line with the predetermined goal [5]. In fact, it was a process that evaluated a physical environment that provided conditions and supported human activity [6] And was one of the key steps in creating a center [7]. Every sports place that is built for physical activity, recreation, or sports is a social and vital place that contributes to the health and general well-being of people in the community [8]. In recent years, GIS has been used as a suitable tool for location [9].

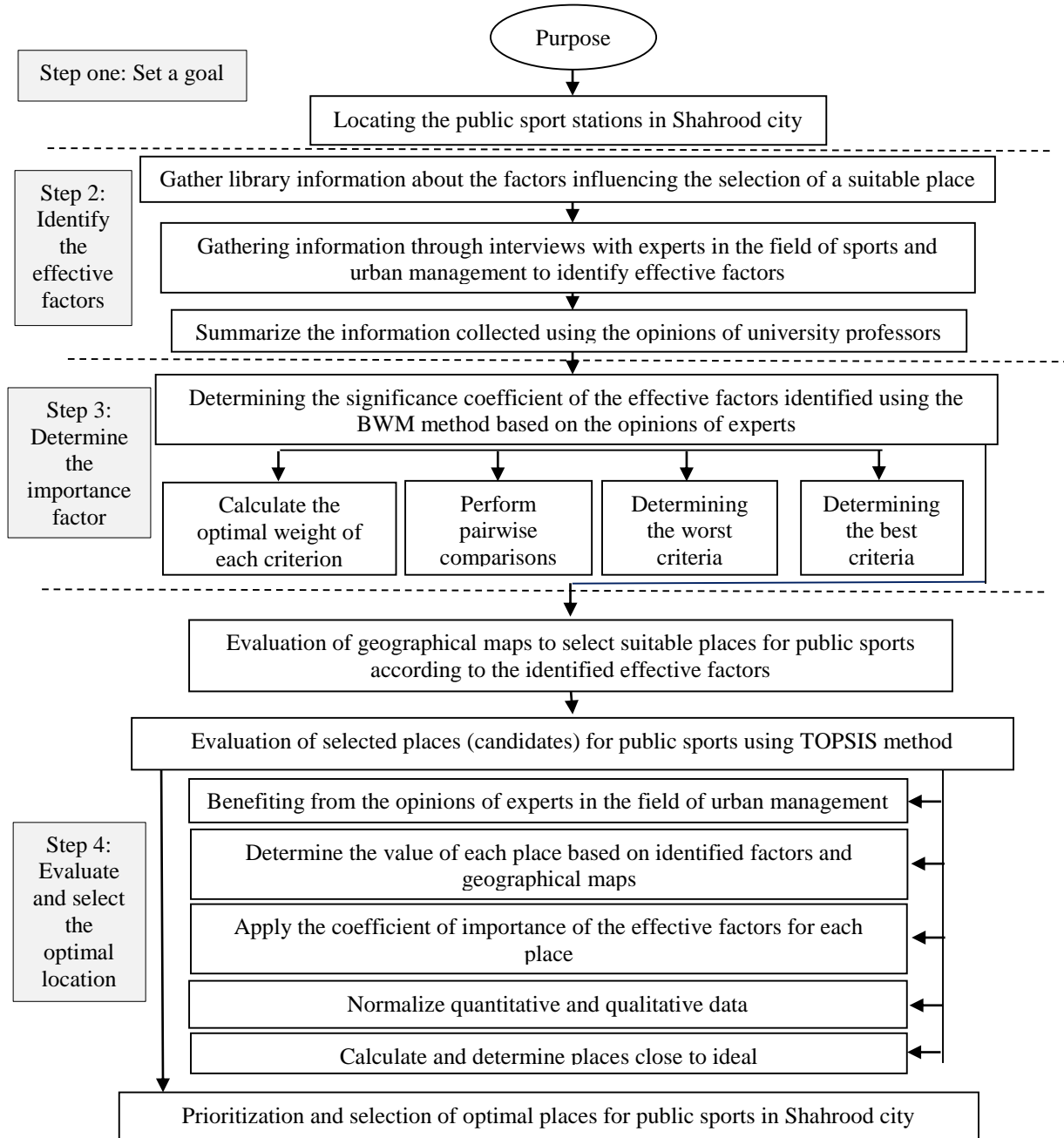
A geographic information system is a system that processes information about a reference location or geographic information and obtains information about phenomena that are somehow related to location [10]. Currently, this system is used in many areas and locations such as hospital locations, health centers [11], walking trails and residential mobility [12], various sports centers [13-15], various sports such as skiing and cycling [16-21] Etc. has been used and has had a desirable performance. Numerous researches were performed by researchers using continuous and discrete spatial models based on the combination of two models, AHP and TOPSIS [3] or a combination of Thyssen and Orly analytical functions [22] in location Sports venues, or a combination of GIS and AHP, in locating playgrounds and sports centers [9, 23].

It seems that in order to achieve a specific goal, it is more necessary for the decision-maker to evaluate several criteria together and evaluate different options according to the criteria. Such a process is called multi-criteria decision making analysis [11]. This method involves a series of techniques, including some weights or convergence analysis, that allow a range of criteria related to a particular topic to be scored and weighted and then ranked by experts and stakeholders [8]. Limited research combining GIS and multi-criteria decision making analysis to locate sports spaces [8] and various sports such as cycling [20, 24, 25] has been done by researchers. Studies in this area are more limited to identifying and evaluating different places and spaces using one of the methods of hierarchical analysis of AHP, GIS and in a few cases multi-criteria decision making analysis or a combination of two. The correct and optimal location of different urban land uses, using these techniques and powerful scientific models in accordance with the principles and rules of urban planning, has been efficient and effective in solving urban land use problems [13]. In the current world system, upgrading and creating urban environments with suitable and optimal sports facilities without spending much time and extra cost is also one of the important strategies of active and living organizations [26]. On the other hand, Shahrood is one of the cities of Semnan province and one of the largest cities in Iran. According to the results of the 2016 census, Shahrood is the first most populous city in the province, which has the highest percentage of young people (25.8%) after Semnan. Considering that most people in Semnan province, especially in Shahrood city, are interested in sports and a large population works in the public sports sector, this issue becomes more important. Public sports are an essential factor in ensuring the health and quality of life of people in society. Since the municipality of Shahrood, for the purpose of achieving the aim of having sports available for all, tries to bring citizens closer to sports at the lowest cost, the researcher in the present study tried to study and evaluate the environmental potential of Shahrood city as a small continent of Semnan province in order to develop public sports by combining multi-criteria decision making methods in the GIS environment.

## **MATERIAL AND METHODS**

The present study was an applied and developmental research in terms of nature and descriptive-analytical research in terms of method. During the research process, the effective factors in selecting a suitable and

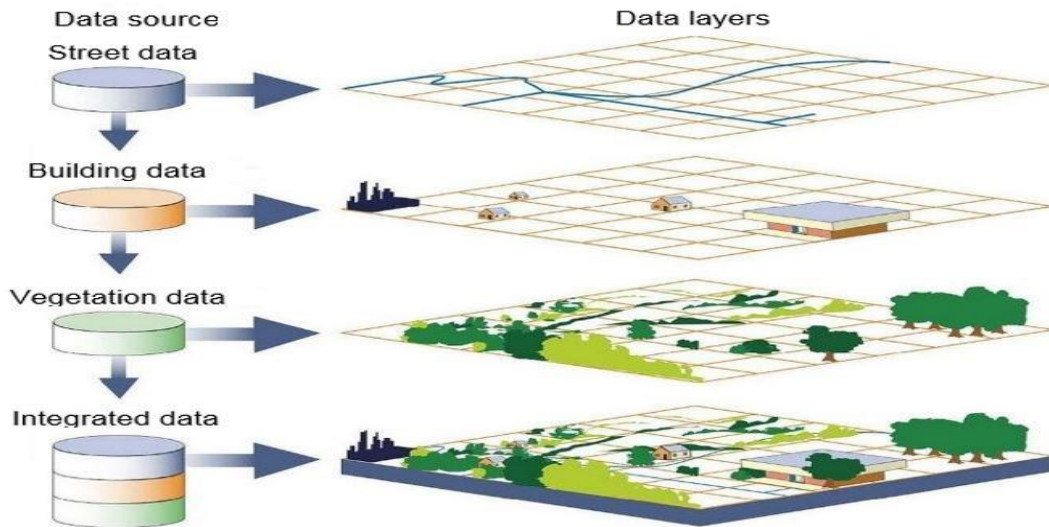
optimal station for public sports were first identified. To identify the effective factors, the opinions of professors, managers and experts in the field of sports and urban management were used. Due to the difference in the importance of each criterion, the best-worst (BWM) method was used to determine the significance coefficient of each criterion. Using geographic map analysis, suitable stations for public sports were identified. The identified stations for public sports in Shahrood were evaluated according to the effective factors using the ideal preference method. In the end, according to the prioritization of the desired stations, the appropriate and optimal station were selected (Figure 1).



**Figure 1.** Conceptual model of research

In fact, the working method was based on analysis, location of public sports stations in Shahrood city, and analysis and overlap of information layers using a combination of multi-criteria decision making methods such as BWM method (Best-Worst) and TOPSIS method in The system environment is GIS.

As shown in Figure 1, the GIS allowed the display of multiple layers of information in a single map [24]. In GIS, a separate layer was created for each data type. Layers could vary in shape and information depending on the objects they depict. In addition, the shape of objects may be raster or vector data [27].



**Figure 2.** Combination of different layers of GIS. Source: Lepuschitz, 2015 (28)

In this article, Arch GIS software was used to consider spatial data for the location of public sports stations in the city of Shahrood. In order to make decisions about solving urban problems, using an integrated multi-criteria decision model with GIS could be very effective [8]. When faced with practical issues, multi-criteria decision-making consists of two parts: 1. Obtaining decision information including weight and value of criteria; 2. Gathering information and ranking options [29]. What was important in this article was the way through which the weight and importance of each of the criteria could be calculated in order to select suitable places for public sports stations in Shahrood city. In recent decades, several MCDM methods have been proposed for weight gain criteria. Some of these methods were the simple multi-feature evaluation method, analytic hierarchical process, and network analysis process. These methods used double comparisons to compare a set of decision-making options based on the judgment of decision-makers or experts. Several factors could affect the continuity of comparisons such as complex questionnaires, lack of knowledge, and respondent fatigue [30]. Rezaei, (2015), argued that this is a methodological problem that could be solved by a more structured comparative method, and proposed a new MCDM method for solving this problem called the best and worst method [31]. In this study, we used the best and worst methods introduced by Rezaei (2015) [31] to prioritize the identified criteria. After prioritizing and determining the importance of each of the criteria, it was necessary to prioritize the places introduced using GIS maps based on the importance of the identified criteria in order to be the best places for public sports stations in the city of Shahrood. For this purpose, there were several multi-criteria decision-making methods such as the prioritization method based on similarity to the ideal solution, the multi-criteria optimization method and compromise solution, and trans-rank methods such as the approximate and perimeter mastery method. Due to the simple and fast systematic method of the TOPSIS method, this method has been proven as one of the best methods to solve the problem of reverse ranking. In this research, the TOPSIS method was used for the final prioritization of optimal places for public sports stations in Shahrood city.

In the best-worst method, suppose there are  $n$  criteria for a research goal, these criteria can be compared based on the language variables (terms) of the decision-makers, including "equal importance", "poor importance", "relatively important", "very important" and "absolutely important", according to the hourly scale shown in Table (1) for pairwise comparisons.

**Table 1.** Hour scale for pairwise comparisons

The importance of us between	Quite important	Very important	Relatively important	Poor importance	Equal importance	Significance values
2,4,6,8	9	7	5	3	1	Numerical scale

Then the matrix of pairwise comparisons will be as follows:

$$A = \begin{matrix} & c_1 & c_2 & \dots & c_n \\ \begin{matrix} c_1 \\ c_2 \\ \vdots \\ c_n \end{matrix} & \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \end{matrix} \quad (1)$$

Where  $a_{ij}$  represented the relative priority of criterion  $i$  to the index  $j$ , which is a number. In fact, the relation  $a_{ij} = 1$  will exist if  $i = j$ . The steps of the BWM analysis process (worst-best method) to determine the weight of the criteria were as follows.

Step 1. Build a decision criteria system: The decision criteria system consisted of a set of decision criteria  $\{c_1, c_2, c_3, \dots, c_n\}$  that were used to perform the evaluation.

Step 2. Determining the best criterion and the worst criterion: Based on the system of decision criteria, the best criterion and the worst criterion should be identified by decision-makers in this stage. The best criterion is shown as  $C_B$ , and the worst criterion is shown as  $C_w$ .

Step 3. Perform reference comparison for the best criteria: The reference comparison consisted of two parts: one part for the binary comparison of  $a_{ij}$  as to whether  $i$  is the best element  $C_i$  is the best criterion ( $C_B$ ); the other part for the two-by-two comparison of  $a_{ij}$  as to whether  $j$  is the worst element or  $C_j$  is the worst criterion ( $C_w$ ). At this point, the first part will be done. Using the linguistic point of view of the decision makers listed in Table (1), the best criteria settings compared to other criteria could be determined. The vector  $A_B$  represented the pairwise comparison of the best criterion compared to the other criteria.

$$\tilde{A}_B = (\tilde{a}_{B1}, \tilde{a}_{B2}, \dots, \tilde{a}_{Bn}) \quad (2)$$

Step 4. Perform a fuzzy reference comparison for the worst case: In this step, another part of the reference comparison will be performed. Using the language evaluation of the decision-makers listed in Table (1), the settings of all criteria for the worst case can be determined. The  $A_w$  vector indicated the relative importance of all criteria to the worst case.

$$\tilde{A}_w = (\tilde{a}_{1w}, \tilde{a}_{2w}, \dots, \tilde{a}_{3w}) \quad (3)$$

Step 5. Determining the optimal weight: The optimal weight for each criterion is the place where for each pair of  $\frac{w_B}{w_j}$  and  $\frac{w_j}{w_w}$ , there should be  $\frac{w_B}{w_j} = a_{Bj}$  and  $\frac{w_j}{w_w} = a_{jw}$ . To satisfy these conditions for all  $j$ s, we must determine a solution in which the maximum absolute gap of  $|\frac{w_B}{w_j} - a_{Bj}|$  and  $|\frac{w_j}{w_w} - a_{jw}|$  for all  $j$  is minimized [31]. In fact, we can obtain the finite optimization problem to determine the optimal weight 2 as Equation (4).

$$\begin{aligned} & \text{Min } \xi \\ & \text{S.t:} \\ & \begin{cases} \left| \frac{w_B}{w_j} - a_{Bj} \right| \leq \xi \\ \left| \frac{w_j}{w_w} - a_{jw} \right| \leq \xi \\ \sum_{j=1}^n R(w_j) = 1 \\ j = 0, 1, 2, \dots, n \end{cases} \end{aligned} \quad (4)$$

Prioritization method based on similarity to the ideal TOPSIS solution is a simple and fast systematic method that has been proven as one of the best methods to solve the problem of reverse ranking [32]. The

main idea of TOPSIS is that the best decision is selected from a number of options based on different effective criteria based on similarity to the ideal solution [33].

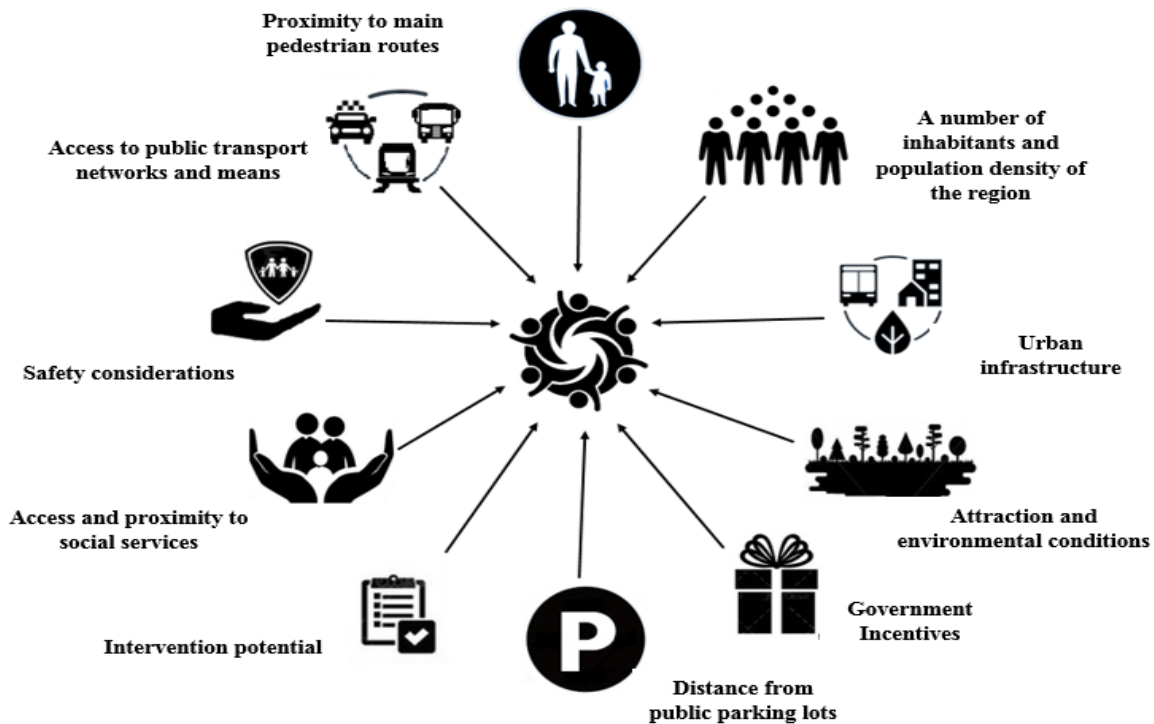
## RESULTS

Shahrood is located between two humid and rainy climates in the north and the southern desert, which has provided a favorable climate for this city [9]. There were several steps in analyzing the obtained information:

The first step is to determine the effective criteria for locating public sports stations in Shahrood by studying and searching in books and various researches and interviewing professors and experts in the field of sports and management. Urban 10 factors affecting the location of public sports stations in Shahrood were identified (Figure 3).

Attraction and environmental conditions: means natural features and environmental conditions that include such things as geomorphic conditions, topography, orientation, plant species, rain, wind, sun, lands with smooth and suitable surfaces. A number of inhabitants and population density of the region: refers to the same demographic and social characteristics as the pattern of distribution and capacity (athlete-spectator) and land ownership. Intervention potential: It is the prediction of the development and possibility of the necessary spaces, which include its expansion in the future. Government Incentives: The same as government considerations and regulations. Distance from public parking lots: means to know the neighborhoods and uses. Access and proximity to social services: means access to and index of public and welfare services. Ease of access to the city's service and infrastructure equipment: includes transportation considerations and communication routes.

Proximity to main pedestrian routes: means existing communication routes and proximity to main pedestrian routes. Access to public transport networks and means: means access to public and private transport networks and means. Safety considerations are the same as environmental safety, especially for children and women.



**Figure 3.** Effective factors in locating public sports stations in Shahrood

The second step, determining the significance coefficient of the criteria using the best-worst method: After identifying the effective factors by the opinions of experts, the best-worst method was used to determine

the degree of importance of each criterion. The data collected from the questionnaire is the best-worst method in the form of pairwise comparisons in which first the best and worst criteria are identified by experts and then pairwise comparisons are made between the criteria [30]. Table 2 shows the pairwise comparisons between the best and worst criteria and other criteria.

**Table 2.** Paired comparisons between the best and worst criteria and other criteria

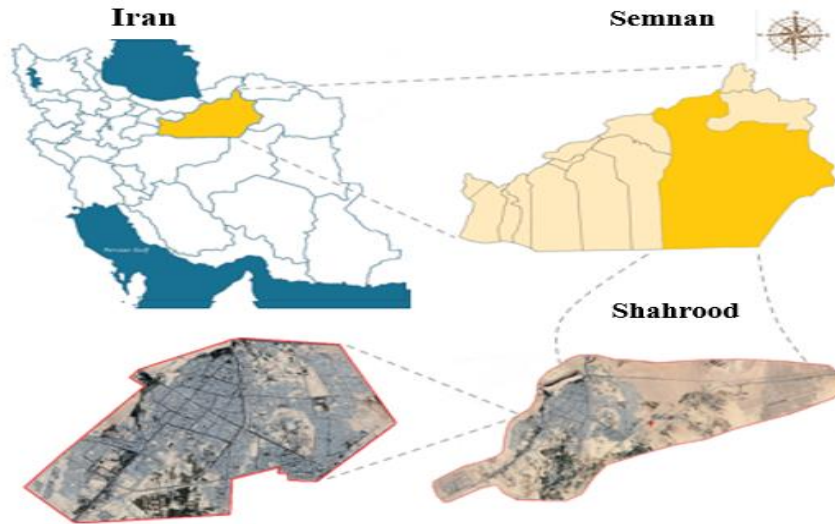
-	Identified criteria	The best criteria Charm and local conditions	The worst criterion Interference potential
C1	Charm and local conditions	1	9
C2	Number of inhabitants and population density of the region	7	2
C3	Interference potential	9	1
C4	Government incentives	3	4
C5	Distance from public parking	3	4
C6	Access to and proximity to social services	4	3
C7	Ease of access to urban service equipment and infrastructure	4	3
C8	Proximity to main pedestrian routes	3	5
C9	Access to networks and public transportation	2	7
C10	Safety considerations (environmental safety for children and women)	3	3

According to experts, attractiveness and environmental conditions have been selected as the best criterion and interference potential as the worst criterion. By placing numerical scales in Equation (4) and solving the model in Lingo software, the coefficient of importance or optimal weight for each of the criteria was obtained. The results of the calculated weights for each of the criteria can be seen in Table 3.

**Table 3.** Importance coefficient of effective factors

Effective factors	Significance factor
Charm and local conditions	0.261
Number of inhabitants and population density of the region	0.034
Interference potential	0.027
Government incentives	0.095
Distance from public parking	0.088
Access to and proximity to social services	0.071
Ease of access to urban service equipment and infrastructure	0.071
Proximity to main pedestrian routes	0.115
Access to networks and public transportation	0.168
Safety considerations (environmental safety for children and women)	0.07

The third step was to identify suitable stations for public sports in Shahrood: Shahrood city is one of the important cities of Semnan province. The location of Shahrood is unique. This means that this route connects North Khorasan and Razavi Khorasan in the east (Figure 4). Also, the historical location of Shahrood is a situation that has made it one of the major cities of Iran. Shahrood is one of the coolest cities in Semnan province. Perhaps the most important advantage of Shahrood is the existence of eternal natural resources that God has provided for this region. Therefore, it is extremely important.



**Figure 4.** Location of Shahrood city

In recent years, increasing the quality of life, promoting sports culture and mobility, as well as increasing public participation in public sports have been the main programs of officials in Shahrood. Shahrood city is prone to learning public sports. However, encouraging people to play sports and engage in public activities without a suitable location is harmful. Therefore, it is necessary to provide opportunities for public sports for families and provide more facilities and a more suitable atmosphere. According to the analysis of geographical maps and the study of potential places for the selection of public sports stations, 10 parks in the city of Shahrood were selected from 21 parks in the city for review and evaluation to select the optimal locations.

Due to the existing restrictions, including privacy and conflict with some criteria, no gym, and sports complex were selected for selection as a public sports station. The parks selected for evaluation include Madar Park, Boulvar Park, Altar Shohada-e-Mihrab Park, Abshar Park, Shahrak Alborz Park, Baharestan Park, Mellat Park, Shohada-e-Mersad Park, Nama Park, and Nofel Loshato Park, which according to the criteria identified in the stage, will be evaluated beforehand. The geographical location of the 10 selected parks is shown in Figure (5).



**Figure 5.** Location of parks selected for evaluation as public sports stations



According to the ideal preference method, it is necessary to evaluate the selected locations for public sports stations according to the identified effective factors. Table 4 is the result of summarizing the information obtained from geographical maps and the opinions of experts and experts in the field of urban management working in the municipality of Shahrood. A noteworthy point is the negative effect of the two factors of distance from the parking lot and distance from the sidewalks, which are specified in Table (4).

**Table 4.** Information related to the evaluation of selected locations for public sports stations in Shahrood

	Environmental charm	Population density	Intervention potential	Encouragers	Parking distance	Access to social services	Access to urban equipment	Distance to footpaths	Access to the transport network	Security considerations
Madar Park	5	6000	7	Very much	100	50	8	550	Much	7
Boulvar Park	9	20000	8	Very much	20	10	9	85	Very much	8
Shohada-e-Mehrab	6	5000	9	Very much	20	10	6	14	Much	6
Abshar Park	9	1000	9	Very much	20	10	8	350	Very much	6
Shahrak Alborz Park	4	15000	4	Medium	10	5	5	6	Low	8
Baharestan Park	7	21000	7	Medium	10	5	4	6	Medium	8
Mellat Park	4	12500	5	Low	10	5	4	6	Low	7
Shohada-e-Mersad Park	3	10000	3	Low	6	3	3	190	Very Low	6
Nama Park	9	6000	9	Very much	40	20	8	650	Much	4
Nofel Loshato Park	5	10000	5	Low	10	5	5	210	Very Low	6

As can be seen, due to the heterogeneity of the data, it is necessary to normalize all the data in Table (4) using Equation (6). Normalization data along with the weight of the criteria are shown in Table (5).

**Table 5.** Normalized data for public sports stations in Shahrood

	Environmental charm	Population density	Intervention potential	Encouragers	Parking distance	Access to social services	Access to urban equipment	Distance to footpaths	Access to the transport network	Security considerations
Weight criteria	.261	0.034	0.027	0.095	0.088	0.071	0.071	0.115	0.168	0.07
Madar	0.2443	0.1539	0.3195	0.4016	0.8692	0.4	0.3698	0.5687	0.152	0.4529
Boulvar	0.4397	0.5129	0.3652	0.4016	0.1738	0.45	0.4623	0.0879	0.625	0.3397
Shohada-e-Mehrab	0.2931	0.1282	0.4108	0.4016	0.1738	0.3	0.3698	0.1448	0.25	0.3397
Abshar	0.4397	0.0256	0.1408	0.4016	0.1738	0.4	0.4623	0.3619	0.375	0.3963
Shahrak Alborz	0.1954	0.3847	0.1826	0.2410	0.0869	0.25	0.1894	0.0062	0.375	0.2831
Baharestan	0.3420	0.5386	0.3195	0.2410	0.0869	0.2	0.2774	0.0062	0.375	0.2265
Mellat	0.1954	0.3206	0.2282	0.1606	0.0869	0.2	0.1849	0.0062	0.125	0.2265
Shohada-e-Mersad	0.1466	0.2565	0.1369	0.1606	0.0522	0.15	0.0925	0.1965	0.125	0.2831
Nama	0.4397	0.1539	0.4108	0.4016	0.3477	0.4	0.3698	0.6721	0.25	0.3397
Nofel Loshato	0.2443	0.2565	0.228	0.1606	0.0869	0.25	0.0925	0.2172	0.125	0.1698

After ensuring the normality of the data, to include the significance coefficient of the identified effective factors, the weight calculated for each of the effective factors in accordance with Equation (7) is multiplied by the data of public sports stations. Table (6) shows the normal weighted data for public sports stations in Shahrood.

**Table 6.** Weighted normalized data for public sports stations in Shahrood

	Environmental charm	Population density	Intervention potential	Encouragers	Parking distance	Access to social services	Access to urban equipment	Distance to footpaths	Access to the transport network	Security considerations
Madar	0.0638	0.0052	0.0089	0.0382	0.0765	0.0284	0.0263	0.0654	0.021	0.0319
Boulvar	0.1148	0.0174	0.0099	0.0382	0.0153	0.032	0.0328	0.0101	0.105	0.0238
Shohada-e-Mehrab	0.0765	0.0044	0.0111	0.0382	0.0153	0.0213	0.0263	0.0167	0.042	0.0238
Abshar	0.1148	0.0009	0.0111	0.0382	0.0153	0.0284	0.0328	0.0416	0.063	0.0277
Shahrak Alborz	0.051	0.0131	0.0049	0.0229	0.0076	0.0178	0.0131	0.0007	0.063	0.0198
Baharestan	0.0893	0.0183	0.0086	0.0229	0.0076	0.0142	0.0197	0.0007	0.063	0.0159
Mellat	0.051	0.0109	0.0062	0.0153	0.0076	0.0142	0.0131	0.0007	0.021	0.0159
Shohada-e-Mersad	0.0383	0.087	0.0037	0.0153	0.0046	0.0107	0.0066	0.0226	0.021	0.0198
Nama	0.1148	0.0052	0.0111	0.0382	0.0306	0.0284	0.0263	0.0773	0.042	0.0238
Nofel	0.0638	0.0087	0.0062	0.0153	0.0076	0.0178	0.006	0.025	0.021	0.0119
Loshato										

According to Equation (8), the ideal positive and negative solutions were selected from the data in Table (6). Table (7) shows the positive and negative ideal solutions based on the ideal preference method.

**Table 7.** Positive and Negative Ideal Solutions

<b>Positive ideal</b>	0.1148	0.0183	0.0111	0.0382	0.0046	0.032	0.0328	0.0007	0.105	0.0319
<b>Negative ideal</b>	0.0384	0.0009	0.0037	0.0153	0.0765	0.0107	0.0066	0.0773	0.021	0.0119

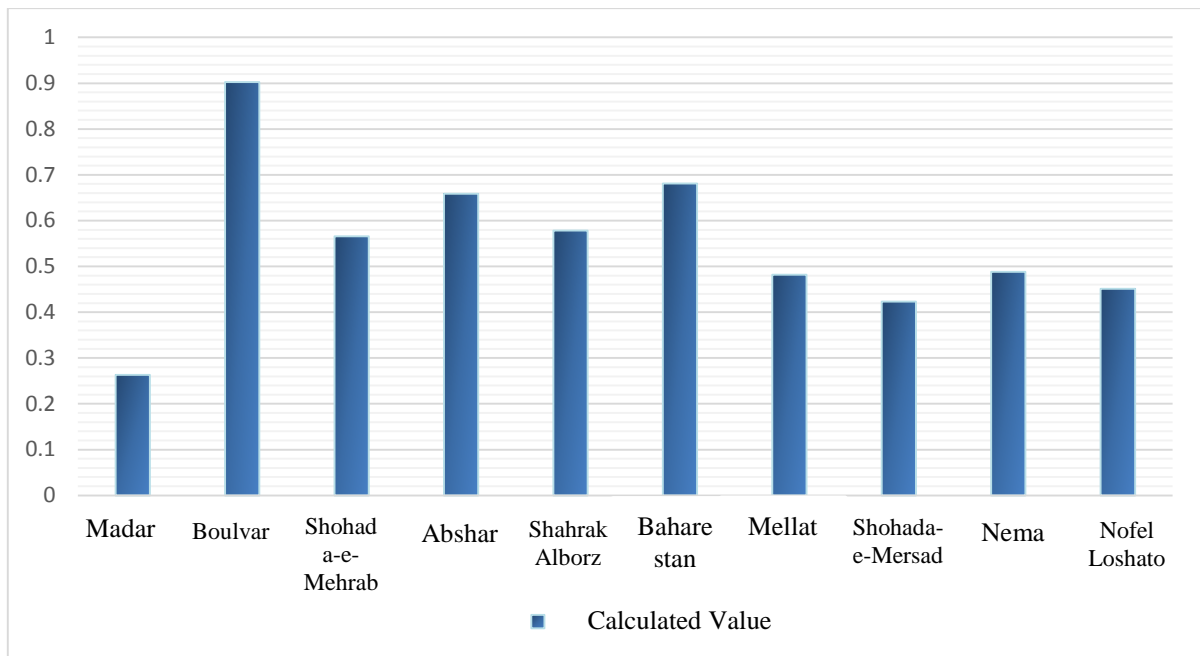
The positive ideal and the negative ideal of Equation (9) were used to calculate the distance between each of the public sports stations. The calculated distance for each station can be seen in Table (8). By calculating the distance of each station from the positive ideal and the negative ideal, the optimal stations for public sports in the city of Shahrood can be selected using Equation (10). Also, by calculating the rank of each station, the value of each station can be seen based on the value it has obtained. In addition to the distance of each station from the positive ideal and the negative ideal, table (8) shows the value and, in other words, the rank of each of the public sports stations under evaluation.

**Table 8.** Distance of public sports stations in Shahrood from positive and negative ideals

Stations	Positive ideal	Negative ideal	Calculated value	Rank
<b>Madar Park</b>	0.1387	0.0496	0.2634	10
<b>Boulvar Park</b>	0.0165	0.1526	0.9024	1
<b>Shohada-e-Mehrab</b>	0.0789	0.1027	0.5655	5
<b>Abshar Park</b>	0.0623	0.1203	0.6588	3
<b>Shahrak Alborz Park</b>	0.0829	0.1136	0.5781	4
<b>Baharestan Park</b>	0.0584	0.1248	0.6812	2

<b>Mellat Park</b>	0.1127	0.1047	0.4816	7
<b>Shohada-e-Mersad Park</b>	0.1239	0.0910	0.4235	9
<b>Nama Park</b>	0.1039	0.0992	0.4884	6
<b>Nofel Loshato Park</b>	0.1104	0.0908	0.4513	8

According to the ideal preference method framework, the value calculated for each station was between zero and one, which the closer it is to one, the higher and better the priority. According to the results, Boulvar, Baharestan, Abshar, Alborz and Shohada-e-Mihrab parks were considered as top priorities and other parks as lower priorities, respectively. Graph 1. shows the prioritization of selected public sports stations in Shahrood.



**Graph 1.** Ranking of selected public sports stations in Shahrood city

## DISCUSSION

According to the studies [9], it has been determined that a large part of Shahrood city does not have the necessary conditions and infrastructure to locate large-scale sports land use. Therefore, considering the sensitivity of this category, the present study presents a general and scientific framework for identifying and evaluating the effective factors in locating public sports stations in Shahrood. For this purpose, the first ten criteria affecting the location of public sports were determined using the opinions of experts. These criteria were somehow researched by Azimidelarestani et al, (2016) [14], in order to select a number of location indicators for the design and construction of sports facilities, including the location and characteristics of the land, compatibility, and incompatibility of land uses, climate, etc. (as The factor of attractiveness and environmental conditions) was the same.

According to the results of this study, attractiveness and environmental conditions have been selected as the most important and the potential for interference as the least important criteria. In general, it was consistent with the results of Kelarestaghi et al (2019)[34], because they considered the improvement of the environment and infrastructure as very effective factors in this field. This part of the findings was not consistent with the results of research by Jahanshahi et al, (2019) [35], Jamshidi et al, (2018)[36], Salimi et al, (2016) [37], Babatunde & Ighravwe, (2019) [38]. Most of the research done in this regard was mostly related to bicycle stations, as Jahanshahi et al (2019) considered proximity to metro stations, distance from

important intersections, and distance from population centers as effective factors in locating bicycle stations [35]. Jamshidi et al, (2018) identified three indicators of accessibility, proximity to other urban uses, and safety in selecting sports venues [36]. In Salimi et al (2016), research price criteria, geomorphic conditions, ownership, and accessibility were the most important, respectively [37]. Babatunde & Ighravwe, (2019), in their research also achieved twelve technical criteria and eight economic criteria in locating the hosting of sporting events (38).

Analysis and comparison of findings showed that in most studies, access factors, proximity, and population density have been of high importance; However, attractiveness and environmental conditions were the most important factors in the present study. As mentioned earlier, most of the research on location in the field of sports was related to cycling and skiing, and this research was the first research work on the location of public sports stations in Iran. Perhaps the difference in the nature of the sports under study was one of the possible reasons for the difference in the effective factors and their coefficient of importance. In general, environments such as parks and green spaces are always one of the places that have a variety of opportunities, and good environmental conditions are very attractive to the general public. According to this part of the findings, it is better to first pay more attention to the attractiveness index and environmental conditions of public sports stations as a spatial characteristic of a sports center, and the items that lack high importance and high points in the last priorities must be contracted or deleted.

On the other hand, a noteworthy point in the present study was the negative effect of two factors: distance from parking and distance from sidewalks. Parking lots play a major role in reducing marginal parking and traffic. According to experts in the field of traffic, urban planning, and urban planning, parking lots next to centers such as commercial, office, and service centers such as stadiums and hospitals are usually more efficient and their unprincipled dispersion not only makes these parking lots inefficient but also increases traffic and air pollution. It will increase urban traffic and air pollution [39]. In the field of public sports, walking distance is not an important factor and its main nature is included, and if the walking distance is not considered an important factor, in more remote areas, enough space can be found for parking cars and existence not too much parking is important and even being too close to the parking lots can lead to a lot of traffic and waste of time in these cases. The population density was also less important; It seems that without the attractive space, facilities, and security, people will not want to be in the desired place to do sports.

The calculated value for the stations showed that the parks of Bouvar, Baharestan, Abshar, Shahrak Alborz, and Shohada-e-Mihrab are considered as top priorities and other parks as lower priorities for public sports in Shahrood, respectively. Shahrood Bouvar Park with an area of 10,000 square meters is located in the north of Shahrood. This park is a suitable place for relaxation and entertainment due to its old and tall trees, air conditioning and amenities as well as special topography. This park has a suitable environment and has facilities for recreation, games, entertainment, and green space is equipped with sports equipment and is also close to Shahrood Health Road. The environmental attractiveness of Bouvar Park is high due to its suitable environment and scenery. Also, the proximity of this park to Shahrood Health Road, where most public sports programs and walking conferences are held on this road in Shahrood, has multiplied its importance. Baharestan Park is also one of the very good parks in Shahrood, where morning sports are performed with the participation of the Public Sports Board and Shahrood Municipality. Shahrood Abshar Park complex with an area of 50,000 square meters is located in the northeast of Shahrood, this complex has a swimming pool, Abshar, health road, sports facilities, and so on. This park with suitable weather and very good views is a fun place for sports and entertainment of the people of Shahrood. Shahrak Alborz Park is located at the end of Ayatollah Shahroodi Boulevard. Environmental attractiveness in Shahrak Alborz park is moderate and some effective factors in locating public sports stations are also low. However, high-security considerations as well as the relatively high population density of this park have made it one of the suitable places for public sports stations. Sohaday Mehrab Park is located at the end of Sadoughi Street, one of the largest parks in Shahrood, which is located at the foot of a mountain near Shahrood Abshar. This park with several years old trees and near Shahrood health road provides a suitable and calm atmosphere for people. In Bustan Salamat, various and happy cultural and sports programs and competitions are held

with the presence of people and travelers. All these factors and many incentives from the government of this park can make it one of the options in locating public sports stations.

On the other hand, according to the results of Madar, Mellat, Shohada-e-Mersad, Nama, and Nofel Loshato parks, they have low priorities in locating public sports stations in Shahrood. Madar Park can be more effective in this area than public sports due to having a special cycling track. Mellat Park located in Enghelab Town and Sohaday Mehrab Park is also in low priority due to their low score out of ten effective factors in locating public sports stations. Despite its high score in some factors, the facade park is one of the low priorities. This park is almost close to the Abshar complex and Shahrood Sohaday Mehrab Park, access to services and distance from pedestrian paths in this park is more than in other places and its security considerations are at a low level.

## CONCLUSIONS

According to the results, it is necessary to use the correct models of the leading countries in the field of public sports in order to promote and develop it and support it in every way, especially in these identified places. The method used in this study has been used for the first time in the field of locating public sports stations in Iran and in the city of Shahrood, which has a high potential to reduce cost and time and increase accuracy in decision making. The main approach of this method in this research was to locate public sports stations in order to promote public sports among the citizens of Shahrood. The results of this study can be a guide for the municipality and public sports authorities in the city of Shahrood. In fact, by applying the results of this research, we can witness positive developments and better results by providing services with the desired level and with the same opportunities to the citizens of Shahrood. However, the municipality and the authorities must provide the necessary facilities to implement this important issue.

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## مکان‌یابی ایستگاه‌های ورزش همگانی در شهر شاهرود با تلفیق روش‌های تصمیم‌گیری چند معیاره در محیط GIS

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### چکیده

هدف اصلی پژوهش حاضر مکان‌یابی ایستگاه‌های ورزش همگانی در شهر شاهرود با تلفیق روش‌های تصمیم‌گیری چندمعیاره در محیط سیستم اطلاعات جغرافیایی بود. پژوهش حاضر به لحاظ ماهیت از نوع کاربردی و توسعه‌ای می‌باشد. از نظر روش نیز توصیفی - تحلیلی است. روش کار بر مبنای تجزیه، مکان‌یابی ایستگاه‌های ورزش همگانی در شهر شاهرود و تحلیل و همپوشانی لایه‌های اطلاعاتی با استفاده از تلفیق روش‌های تصمیم‌گیری چند معیاره از جمله روش بهترین بدترین و روش اولویت‌بندی بر اساس شباهت به راه‌حل ایده‌آل در محیط سیستم اطلاعات جغرافیایی بود. پژوهش حاضر در چهار مرحله صورت گرفت. با توجه به نظرات خبرگان در این پژوهش، جذابیت و شرایط محیطی به عنوان با اهمیت‌ترین معیار و پتانسیل مداخله‌پذیری به عنوان کم اهمیت‌ترین معیار انتخاب شده‌اند. ارزش محاسبه شده برای ایستگاه‌ها نیز نشان داد که پارک‌های بلوار، بهارستان، آبشار، شهرک البرز و شهدای محراب به ترتیب به عنوان اولویت‌های برتر و سایر پارک‌ها به عنوان اولویت‌های پایین‌تر برای ورزش همگانی در شاهرود می‌باشند. می‌توان بیان کرد که مسئولان و دست‌اندرکاران با استفاده از نتایج این پژوهش، برنامه‌ای روشن و مختصر دارند که از طریق آن کمتر دچار اشتباه خواهند شد. همچنین با توجه به یافته‌های پژوهش حاضر پیشنهاد می‌شود که شاخص جذابیت و شرایط محیطی ایستگاه‌های ورزش همگانی بیشتر مورد توجه قرار گیرد و مواردی که از اهمیت بالایی برخوردار نیستند، در اولویت آخر باشند.

**واژه‌های کلیدی:** فناوری ورزشی، ورزش همگانی، مکان‌یابی، سیستم اطلاعات جغرافیایی، تصمیم‌گیری چندمعیاره، روش بهترین بدترین.