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Prioritizing the effective criteria in locating green spaces using AHP approach (Case study: Mahmoudabad Nemuneh City)

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Abstract

Objectives: In this research, it has been tried to determine the local priorities of urban green space development in Mahmoud Abad city in order for correct locating of this land use.
Methods/Statistical analysis: The local priorities of the development of green space in the city have been determined by using Analytical Hierarchy Process Analysis technique (AHP). After collecting data, we analyzed them and investigated the current status of urban green spaces in Mahmoudabad city by using Geographic Information System (GIS). And finally In the Expert Choice software, the effective criteria in locating green space are weighted and their priority by each other is specified.
Findings: The current per capita status of this land use is 0.66 square meters, which is much lower than its standard per capita, so there is a need to build new green spaces. In this paper, population density, land value, air pollution, distance from existing urban parks, proximity to the center of the area, proximity to residential centers and accessibility are considered as locating criteria of green spaces. Among these criteria land value and centrality were identified as the most important criteria for locating green space in Mahmoudabad Nemuneh city.
Application/Improvements: It is suggested that the optimal placement and distribution of this land use should be addressed up with considering mentioned in order to increase the citizens' access to this land use and following that improve the quality of urban environment.
Keywords: Urban Green Space, Criteria, Locating, AHP, Mahmoudabad Nemuneh City.

1. Introduction

By increasing population and the development of urbanization, humans have been gradually gone away from nature. Over-population density, interference in the natural environment and the creation of human environments has increased the environmental, physical and mental needs of humans [1]. On the other hand, the over-concentration of social, economic and cultural activities in large cities has caused an influx of population to these cities, and following that, the need for urban respiration spaces becomes more tangible [2].
Urban green spaces, by definition, are open spaces in urban areas that are primarily covered by vegetation which can be public or private [3]. Using this definition, urban green space can include parks, community gardens, natural reserves, golf courses, and forests. In [4] this study, only public green spaces including parks and street green spaces are being studied because these public green spaces are free of charge and most people are not able to access private green spaces such as golf courses.

The more public green space succeeds in attracting population and offering services to them, the more social productivity of green space improves. Therefore, they should include the qualification and criteria of parks management. In [5] the past, the dominant role of green spaces was its beautification but today urban green space is important from both social and environmental aspects for citizens. Urban green spaces provide various social, economic and ecological roles [6]. Urban parks and green spaces play an important role for environmental services such as air and water purification, wind and noise filtering, and microclimate stabilization. They also provide social and psychological services, which are important for public wellbeing. The use of parks and green spaces can reduce stress, provide a sense of peacefulness and tranquility, enhance psychological and mental health, and promote the development of social ties.

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The functions of urban parks and green spaces can provide economic benefits as well as the aforementioned social and psychological benefits. The aesthetic, historical and recreational values of urban parks and green spaces increase the attractiveness of the city and promote its tourism potential, thus generating employment and revenues [7]. A very important point in locating public green spaces is the social necessities of creating a park. Consequently, Jane Jacob; a contemporary urban critic, believes that a park should be in a place where the life flows, "where jobs, cultures, commercial and residential activities exist. A number of urban areas have such valuable life spots that are considered suitable for creating local parks or public plaza" [8]. The incorrect location of urban green spaces ultimately leads to abnormalities such as: Low users' use of created green spaces, creating limitation on presenting the appropriate architectural design, creating limitation on suitable plant selection and arrangement, Disturbance in urban landscape, problems related to irrigation and soil reformation, lack of proper social interactions, management and maintenance problems, decrease of mental and social security and so on [9].

2. Research method

The present study is to determine the local priorities of urban parks and green space development based on 8 criteria and using AHP approach. The preliminary data were collected through documentary studies, population and housing census results, plans and maps of the current status of Mahmoudabad Nemuneh that have been gotten by referring to the relevant organizations. Then according to standards, these data were processed and analyzed using GIS software. In the Expert Choice software, the effective criteria in locating green space are weighted and their priority by each other is determined.

3. Research background

Due to the importance of parks and green spaces in the sustainable development of the city and the quality of citizens' life, this issue has been evaluated and studied by researchers and urban planners in various aspects.
In [9] an article entitled "Locating green spaces using GIS in Khorramabad city" presented a suitable model for distributing green space in the range. In [10] published an article entitled "Monitoring and Valuation of Urban Lands in order for the Establishment of Parks and Green Space in Yasouj City". This paper evaluates the distribution of green space in the city by providing an appropriate model for optimal distribution of parks and green space in each region. In [11] studied physical and perceived accessibility to urban green space in the UK, and they found that only 15% of the population in Leicester meets the physical access up to 300m.

In [7] studied attitudes of citizens towards urban parks and green spaces, and the results have shown that the main purpose of visiting parks was relaxation and walking. The type of parks most commonly visited by the respondents was pocket parks around home. And the main reason for going to the frequently visited parks was "close to home". In [12] in the article entitled "Investigating the distribution, standards and calculating urban green space's per capita based on Bahram Soltani's model "evaluated the citizens' satisfaction with the performance and status of the available green space in Qom district 1. By understanding the condition of green space in the region, they have suggested a suitable per capita for green space based on Bahram Soltani's model.

4. Theoretical foundations

One of the most important and first steps to recognize each topic and planning for it is to know the definitions and concepts of that subject. In [13] this study, the definitions of green space have been discussed in order to know more about it. Urban green space is a collection of open spaces and vegetation that is planned within urban environments with specific goals, and certain functions have been assigned to them. From the urbanization perspective, urban green space is part of the city's skeleton structure and morphology. In [14] other words, the green space along with the physical structure of the city determines the figure, and in general, the image of city. Therefore, if the design of the city is done correctly, and is also carefully implemented, the logic of designing determines that the two factors; the inanimate and living part of urban morphology will be balanced in such a way. The function of green spaces is different, according to their scale. Common types of green space based on scale are:

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Urban Parkon the Scale of the Region: A park located in a region at least is twice the size of maximum Park in the scale of an area. The visitor can reach the park from the farthest point of the area by a vehicle in a quarter of an hour or more [15].

Urban Park on the Scale of the Area: The area of this park should be about 2 up to 4 hectares, and access by walking for residents from the farthest point to the park should not exceed half an hour [16]. Predicting a water closet (WC) is required per hectare. This park should be located adjacent to commercial-recreational centers and educational centers such as high school [17].

Urban Park on the Scale of the Neighborhood: A park is proposed for each neighborhood, with an area of approximately one hectare, and a 9-year-old child should be able to walk to the park with the foot and cross the neighborhood slow street [15]. Predicting a water closet (WC) is required per 2000 meters. Also, this park should be adjacent to residential houses and educational facilities such as primary [17].

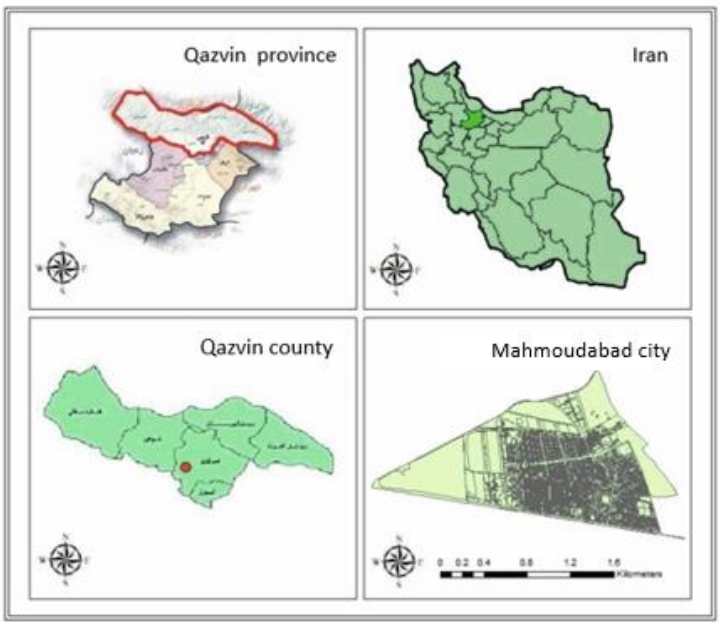
Urban Park on the Scale of the Neighborhood Unit: It's said to a park which is located on the Neighborhood scale. The park has an area of less than half a hectare. According to standards, Pedestrian connectivity for a 9 year-old child from the farthest point of the neighborhood with the foot should be possible and this path way cannot cross the fast street [15]. The type of connection of this park should be close to the main pedestrian pathways, and it is better to be adjacent to the residential units or educational centers such as kindergarten [17].

Street Green Space: Street green space includes green spaces, marginal areas of highways, sidewalks and streets. The green space of the streets is part of the access networks construction that have ecological, social, traffic safety and beautification function of urban spaces [18].

5. Introducing study area

Mahmoudabad Nemuneh city is located in the western Eqbal village of Qazvin city and the central part at geographical latitude and longitude of 48 degrees and 59 minutes up to 50 degrees and 53 minutes of east longitude from meridian and 36 degrees and 7 minutes up to 36 degrees and 49 minutes of northern latitude.

Figure 1. Location of Mahmoudabad Nemuneh



This city is located at height of 1315 meters above sea level. Mahmoudabad city is connected to the Qazvin-Rasht highway from the north and it is connected to the Qazvin-Rasht road from the south. This city has been located in south of complex as peripheral set center of Mahmoudabad Nemuneh city. The peripheral set of Mahmoudabad Nemuneh includes 4 districts of rural development.

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The Mahmoudabad city allocated an area of 132.64 square kilometers to it, and has a population of 28,000 according to the 2011 census (https://en.wikipedia.org). Map (1) shows the location of Mahmoudabad Nemuneh.

6. Results and Discussion

1. Review of current statuses of green spaces in Mahmoudabad City

The green space of Mahmoudabad has an area of 14326 square meters, which includes parks, refuges and triangle green spaces and allocates 0.8% of total area of the city to itself. There are only 3 parks in the city, with a total area of 10314 square meters. All of the green spaces and parks in the Mahmoudabad city, and their functional radius, have been shown in maps (2) and (3) respectively.

Figure 2. Map of current status of Mahmoudabad Nemuneh's green space

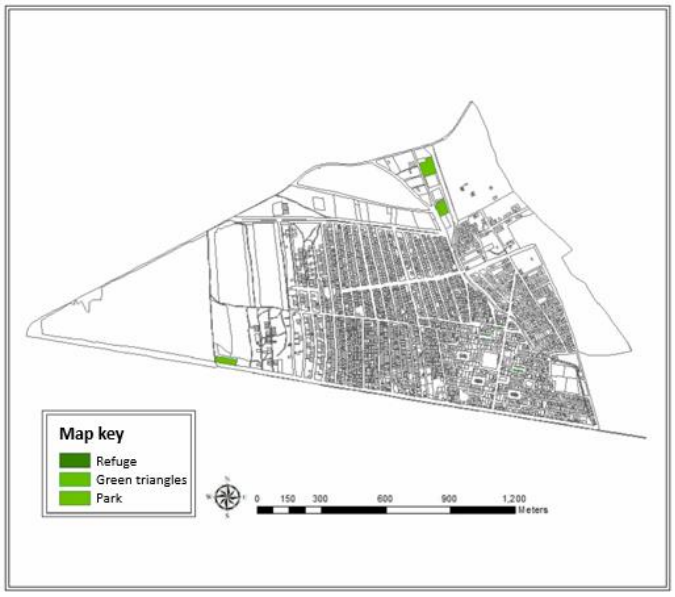
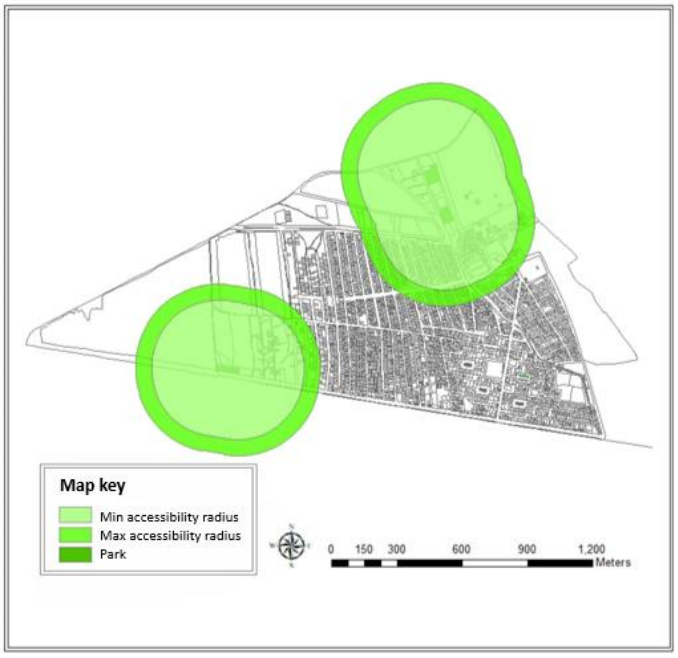


Figure 3. Map of accessibility radius of Mahmoudabad Parks



This map shows the accessibility radius of the parks of Mahmoudabad city that has beendetermined by using Buffer analysis in GIS software. Considering the area of these parks, all of them are neighborhood Park, Based on the accessibility radius specified in the "per capita of urban land use" by [19], the minimum accessibility radius of park on the scale of neighborhood has been considered equal to 300 meters and a maximum of 375 meters. As can be seen in the map, only a small part of residential area accesses to the park, and most of the areas don't access to it. In addition, the green space per capita in Mahmoudabad is 0.66 square meters per person, which is much lower than the standard per capita of this land use. The green space standard per capita of the Ministry of Housing and Urban Planning in Iran is between 7 and 12 square meters and the UN standard per capita is 20 to 25 square meters. According to experts, the International green space Standard for each person is between 15 and 50 square meters that have been considered as an average of 30 square meters, although the standards in developing countries are lower than in Europe and the US [20].

Accordingly, if we consider the minimum per capita, that is, 7 square meters for this land use, the area of the green space in the city should be 152572 square meters, that with due consideration the area of its current status, this land use has a shortage of 138246 square meters. In this study, we seek to identify the criteria for determining the location of green spaces and their valuation by using Analytical Hierarchy Process (AHP).

2. Determining the criteria for locating green space

Different environmental, social, economic and other criteria should be considered in order to locate green space at different levels of city [21]. The criteria for locating urban green space in this research are as follows:

1. Demographic criterion

Paying attention to demographic problems is one of the important criteria in locating urban green space. Since the all green spaces are created for the use of citizens and more utilization of human beings; therefore, the access of more citizens to this land use and the attention to over populated urban areas can be considered as a criterion to measure the proportionality of presence of green space land use [22].

2. Land value criterion

Another important criterion for optimizing the location of urban parks is to focus on economic issues. The necessity and justification of creating green space in comparison with other land uses must be proven in order that a site within the city is allocated to the green space; otherwise, the site will be allocated to any land use with more economic efficiency [23].

3. Pollution criterion

Pollution centers or adjacent areas need more green space. The existence of a dense green area can eliminate the undesirable effects of air pollution in a large extent and modify the health future of people from a physical, mental, intellectual and psychological comfort point of view [24].

4. Criterion of distance from existing urban parks

The more the distance from existing parks, the more acceptability for locating an urban park. Selection of this criterion prevents the overlap of penetration radius of existing parks with under studying parks, and creates a balance in distribution of parks in the city [25].

5. Criterion of proximity to the center of the area (Centrality)

The public green spaces land use should be located in urban centers, including centers of urban neighborhoods, areas and regions [9].

6. The Criterion of proximity to residential centers

Since the green space land use is created for the use of citizens and spending their leisure time, they should be located in the proximity of residential centers in order that the accessibility to them is facilitated.

7. Accessibility criterion

Accessibility is one of the most important factors in locating park. Each urban park must have access to the communications network from the four sides in order to attract more population and also increase social monitoring and security of the park. At the same time, visual exploitation of park's beautiful views for passers from the four sides should be feasible [16].

3. Weighing the criteria for locating green space

After selecting the effective criteria for locating green space, the weight of each criterion according to their importance should be determined through one of the weighting methods. The paired comparison method was used in this research; this method has been presented in the Analytic Hierarchy Process (AHP). AHP is one of the most effective methods for deciding on multivariate problems.

1. Analytic Hierarchy Process (AHP)

Analytic Hierarchical Process (AHP) is a flexible, robust, and simple method that was suggested by Saaty in 1980, and is used to decide in situations where conflicting decision-making criteria make choices between options difficult and decisions are made in a multi-dimensional space [26]. This method allows us to determine the weights (significances) of hierarchically non-structured or particular hierarchical level criteria in respect of those belonging to a higher level [27]. A basic method for testing in AHP model is pair wise comparison method, which consists of three main steps:

a. Create a pair wise comparison matrix.
b. Calculating the weight of criteria
c. Estimating the ratio of consistency [28].

A. Create a pair wise comparison matrix

To create a pair wise comparison matrix, the sifting method which uses numbers from 1 to 9was used in order to determine the relative priority of two criteria, (Table 1). In this way, criteria are compared with each other to specify their weight. In Table (2), the pair wise comparison matrix of the criteria has been presented for the desired research.

Table 1. Saaty's 9-quantitative scale of relative importance [29]

Definition	Importance
Equally importance	1
Equal to moderately importance	2
Moderately importance	3
Moderately to strongly importance	4
Strongly importance	5
Strongly to very strongly importance	6
Very strongly importance	7
Very strongly to extremely importance	8
Very extremely importance	9

B. Calculating the weight of the criteria

How to calculate the weight of the criteria includes the following steps:

1. Adding up the values of each column of the pair wise comparison matrix.
2. Dividing each matrix component by the sum of its column (the resulting matrix is called the normalized paired comparison matrix).
3. Computing the average of components in each row of the normalized Matrix, that is, dividing the sum of normalized values for each row by the number of criteria [28].
4. All these steps are followed for the research and the result is presented in Table 2 as the weight of the criteria.

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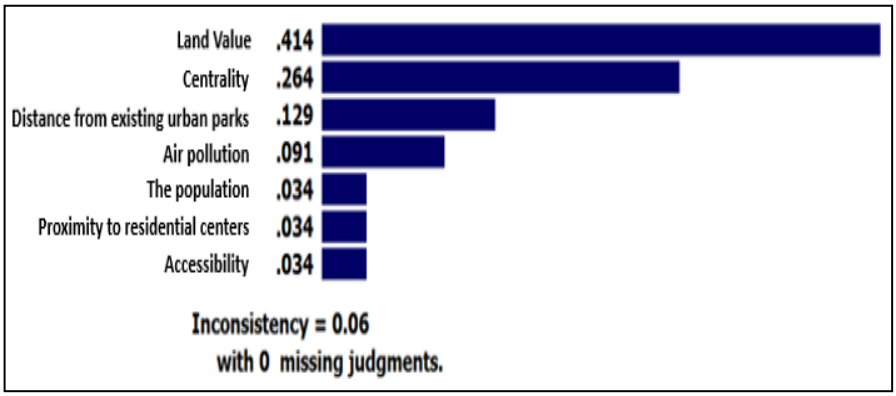
Table 2. Pair wise comparison matrix of criteria

Criterion weight	Accessibility	Proximity to residential centers	Centrality	Distance from existing parks	Air pollution	Land value	The population	Criterion
0.04	1	1	0.17	0.20	0.25	0.14	1	The population
0.44	7	7	3	5	6	1	7	Land value
0.10	4	4	0.20	0.50	1	0.17	4	Air pollution
0.14	5	5	0.25	1	2	0.20	5	Distance from existing parks
0.28	6	6	1	4	5	0.33	6	Centrality
0.04	1	1	0.17	0.20	0.25	0.14	1	Proximity to residential centers
0.03	1	1	0.17	0.20	0.25	0.14	1	Accessibility
1								Criterion weight

C. Estimating the consistency ratio

Estimating consistency ratio indicates the degree of compatibility of the criteria with each other. If the value is less than or equal to 0.1, it shows the acceptable level of consistence in a pairwise comparison. According to the done calculations, in this research the degree of inconsistency is equal to 0.06, which means the level of consistency is acceptable.

Figure 4. The importance coefficient of each criterion and the inconsistency coefficient



2. Prioritizing the criteria and evaluating the consistency in judgments

At this stage, we have calculated the importance of each criterion and their degree of incompatibility using Expert Choice software. The inconsistency degree is equal to 0.06, that it is less than 0.1, and indicates the acceptable weight of the criteria. Accordingly, two criteria of land value and centrality have allocated the highest and accessibility criterion has the lowest weight to them.

7. Conclusion

Due to the occurrence of environmental crises in cities and the reduction of general level of people's life, optimizing urban environments and preserving the environment is significant for future generations, to the extent that it has been propounded as one of the most important developmental factors of the communities, and it also is considered as a criterion for improving the quality of living space. Consequently, the proper location of these spaces in cities is very important. In this study we surveyed the current status of green spaces in Mahmoudabad city, and by comparing its current per capita and accessibility with the standards, we have found that it has significant shortage which leads to create problems and reduce the quality of living environment.

Therefore, we tried to determined criteria, standards and the local priorities of urban green space development in Mahmoudabad in order to build new parks and green spaces in proper sites and approximate it to the minimum level of standards. Accordingly, land value and centrality has been considered as the most important criteria that should be focused in locating urban green space. If urban green space is located in a suitable sites, not only do we can solve the mentioned problems, but we can also improve this land use productivity, human health and wellbeing, social-ecological interactions, condition of the Environment, and finally reach to a better urban environment and living quality.

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