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Investigating urban livability using global TOPSIS in Bojnord city

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Abstract

With the increase in the population living in cities, the need to adapt urban development to the priorities of citizens more than before. In order to achieve a livable city must to examine the current state of the city and inform the city managers about planning. For this purpose, there are various methods to check the current situation of the city. One of these location-based methods is the use of the global Topsis with GIS. In this study, livability was analyzed using 6 layers including: access to green space, transportation, public libraries and museums, urban traffic, restaurants and medical services in 49 neighborhoods of Bojnord city. The results showed that the development of Bojnord city has not been the same and the central part is better than the new parts of the city despite the older texture. Also, its central and eastern parts have better conditions than other parts of the city, and the southern part was shown to be very unsuitable. The results of this research are highly consistent with previous research. Therefore, it is suggested that, in addition to the development of all neighborhoods of the city, the southern, southwestern and eastern parts of the city should be prioritized.

1. Introduction

At the beginning of the 20th century, only about 15% of the world's population lived in cities, but with the intensification and growth of urbanization since 1950, in 2007, more than half of the world's population lived in urban areas (Baker et al. 2022; Buckner et al. 2019). It is estimated that by 2050, more than 72% of the world's population will live in cities. Therefore, nowadays, special attention has been paid to the quality and living conditions of people and human settlements in cities, and concepts such as livability have become the subject of interest in research and research in recent decades (Bayat et al. 2019; Pilleron et al. 2019). At this time, being among the most livable cities in the world is an honor for policymakers and planners who seek to improve the position of their cities at the top of the sustainable urban development competition (Oviedo et al, 2022; Carpentieri et al. 2020). Livability, which is a concept with multiple interpretations and definitions (Sujatha et al, 2023; Huang et al. 2018), is often defined as suitable for humans, for life and providing good quality of life, sustainability, identity and community health (Yeung et al. 2022; Leng et al. 2022). This concept is used to evaluate the performance of cities, in terms of the standard of living that it provides for residents, and includes the best to the worst standard of living. Although the history of studies in this field goes back to the 1970s, the recent popularity of research on this concept is related to the diverse measurable characteristics and criteria of livability at different local, urban and rural scales (Noroozian et al, 2012; Steels 2015). The selection of indicators for studying and measuring viability is very vital and important, it has considerable variety and frequency (Srichuae et al. 2016). Obviously, the indicators are a tool for understanding the existing conditions, and on the other hand, they show the trends and transformations that have occurred during a certain period. Therefore, their choice is an important and debatable issue (Chen et al. 2016; Plouffe et al, 2010). In this regard, it is important to pay attention to the indicators and variables that have the most repetition in livability studies at the city level, and to pay attention to the facilities, infrastructure and native culture of the studied community, on the other hand (Hosingholizade et al. 2020; Ezeh et al. 2017). Bojnord city is the capital of the newly established province of North Khorasan, which has grown and

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expanded rapidly since 2004, with a population, and various rool.

Due to the extensive economic, social and cultural changes caused by the political consequences of Bojnord city, which have affected the city and urbanization process in this region. Therefore, information and study of the livability of the current situation and future plans for the city of Bojnord are essential.

The current research was conducted with the aim of evaluating the livability of Bojnord city using Topsis techniques. By studying the literature and the background of the research done in measuring and evaluating livability inside and outside the country, in this study, access to green spaces, restaurants, libraries and museums, medical services such as hospitals and pharmacies, the state of transportation and traffic as the indicators affecting the livability of Bojnord city are studied.

2. Method

2.1. Study area

Bojnord city is the capital of North Khorasan province and is located in the northeast of Iran. This city is built in the foothills of Aladagh mountain range. According to the census of Iran Statistics Center, this city has a population of 233,810 people and 68,753 households. Bojnord city has 49 neighborhoods, which is the study area of the current research. This city has a cold and semi-arid climate based on Kopen criteria. The average rainfall of Bonjord city is 260 mm per year.

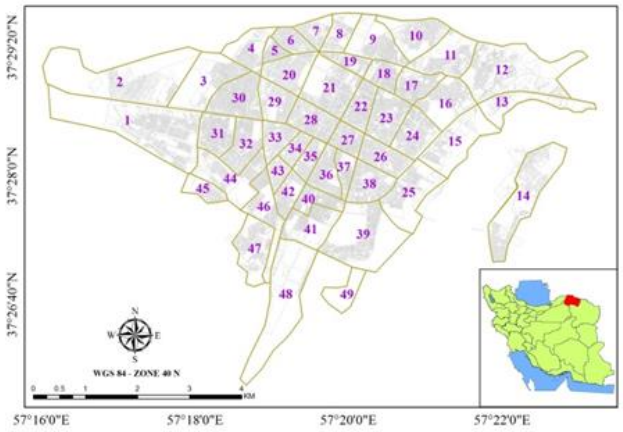

Figure 1. Iran and the study area

2.2. Determining criteria and collecting data

To select the evaluation criteria, first, a number of available sources in this field were reviewed and then the expert's point of view related to urban livability was collected. Since the local conditions are different in each place, similar criteria were combined with each other and the existing criteria were localized at the local level. In this research, six criteria were used to investigate urban livability: green space, restaurants, traffic, medical centers, transportation, and restaurants. In selecting data, the full year of 2022 was used as the basis for data collection, and all data was extracted from Google map and Google traffic archive.

2.3 Global Topsis

2.3.1. Assign weight to criteria

The weight of the criteria obtained is based on the best-worst method. So, the most weight was given to the criteria of access to medical services. The least weight was given to the criterion of access to restaurants.

Table 1. criteria and weights(uncertainty=0.08)

Criteria	W	Criteria	W
medical services	0.3	traffic	0.11
green space	0.19	Transportation	0.23
Library and museum	0.09	Restaurant	0.08

2.3.2. Standardization of criteria

The requirement for combining the criteria layered in MCDA methods is their scaling (without dimensioning). This was done by the score range method. In this method, each of the criteria is normalized based on its minimum or maximum nature with one of the Equations 1 or 2 and it was placed in the range between zero and one.

$$V(a_{ik}) = (a_{ik} - \min(a_{ik})) / r_k \quad (1)$$

$$V(a_{ik}) = (\max(a_{ik}) - a_{ik}) / r_k \quad (2)$$

In Equations 1 and 2, V(aik) is the normalized value of the criterion, aik is the initial value of the criterion, min(aik) and max(aik) are the minimum and maximum values of the criterion. Also, rk is the range of changes initial values of the criterion.

2.3.3. Calculation the distance between each option from positive and negative ideal points

The geometric distance between each option for positive and negative ideal points, also known as similarity to positive and negative points, is calculated using Equations 3 and 4:

$$si = \sqrt{\sum (W_k \times (V_k^* - V_{ik}))^2} \quad (3)$$

$$d_i = \sqrt{\sum (W_k \times (V_{ik} - V_{k*}))^2} \quad (4)$$

In equations 3 and 4, si is the distance between the positive ideal point of the i-th option, di is the distance between the negative ideal point of the i-th option, Wk is the total weight of the criterion, Vk* and Vk* are the maximum and minimum standardized values of the kth criterion, respectively.

2.4. Determining how close each option is to the ideal solution

At this stage, using two parameters obtained from equations 3, 4 and 5, the degree of proximity of each option to the ideal solution is calculated.

2.5. Ranking criteria

In the last step, the criteria available in the study area are ranked with integers and positive numbers starting from one. The number one represents the best Criteria, while the quality of the Criteria decreases as the rank increases.

3. Results

Livability is a broad concept and has various dimensions, so it can be measured based on various criteria. In this research, according to the available data, the urban livability of Bojnord has been studied by emphasizing the criteria of medical centers, green spaces, libraries and museums, transportation, traffic and restaurants using the global Topsis model.

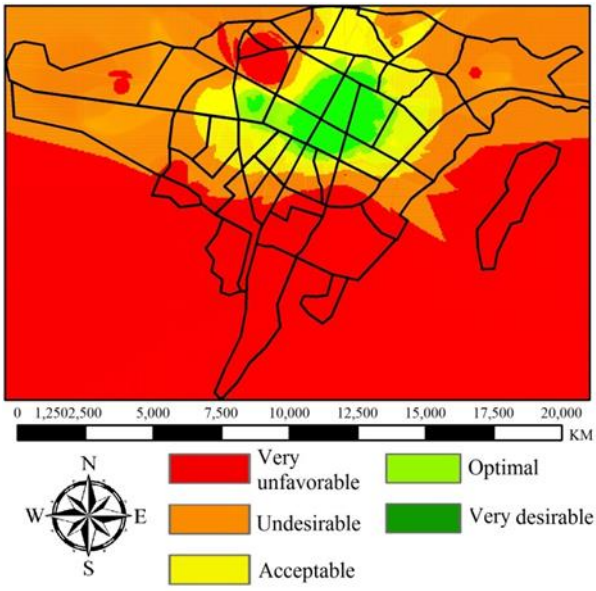

Figure 2. The results of the global Topsis in 5 different classes

4. Discussion

According to the processing done on the data and analysis of the results, it can be seen that the city of Bojnord has many inconsistencies in different localities. If we examine each of the six criteria case by case, we can see that the central parts of the city, with an older texture, have relatively better conditions for urban livability, but in the southern parts, these accesses are weaker.

By processing every layer used in this research and examining their perspective, we can have a better understanding of the situation of each parameter in the city. By combining 6 layers using the global Topsis and preparing the output map and classifying the results into 5 classes including very favorable, favorable, acceptable, unfavorable, completely unfavorable, a suitable location for urban areas can be found. The results of the research are largely consistent with the research of Hosingholizade et al in 2023. In their research, they used the Global OWA method with an ORness of 0.5.

5. Conclusion

The output of the map from global Topsis and the examination of each of the six layers will lead to a better understanding of the distribution of the previous facilities and will show a clear vision of the path ahead to achieve the planned goals. Therefore, due to the importance of studying urban livability in recent years and the direct impact of these evaluations on the planning and design of cities and various industries, it is necessary to be careful in determining the weight, choosing the appropriate layer and pixel size. Also, the results of this study can lead to the evaluation of policies, the ranking of places, the development of management strategies and urban planning with the view of livability in the studied area. On the other hand, facilitating the understanding and prioritization of issues for urban planners and managers in order to promote urban livability, and to city managers help with prioritizing and meeting the needs of different neighborhoods. Another important result is the new residential settlements that, despite the design in the last few years, did not give any priority to livability, and the older neighborhoods are in a much better condition.

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