Evaluation of Ecological Power of Yazd City for Sustainable Urban Development Using AHP Method

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Abstract

In recent years, the importance of environmental protection has increased. On the other hand, the phenomenon of urbanization, which is increasing every day, is one of the main challenges of climate and environmental changes. To control and manage the conditions, it is very important to pay attention to the concept of ecological development. This concept has a long history and theorists such as Sarda, Howard, Geddes have studied the form and human life in the field of urban planning. In this descriptive-analytical article, according to the records and opinions of experts, based on 12 criteria, the assessment and prioritization of the ecological indicators of Yazd city were discussed. In reviewing the results, the neighborhood security index with a weight of 0.2345 was the most important and the private vehicle ownership index with a weight of 0.0092 was the least important. According to the purpose of the research, which considered the ecological limitation, solutions were proposed, which are: carrying out urban development plans using multi-criteria decision-making and paying attention to the power of the environment, strengthening the security body of the city, strengthening the engineering and expert body of the municipality. Use of correct and more accurate field studies, wider study with more number of ecological criteria.

Keywords: Ecological Index, Urban Development, Hierarchical Method, Yazd

1. Introduction

In recent years, the whole world has actively promoted environmental protection. A series of environmental problems have emerged in some growing cities, such as intensifying the heat island effect, air quality degradation, biodiversity loss, and habitat fragmentation (Jumapour et al., 2019). Urbanization is considered as a necessary driver and one of the main challenges for global climate change and sustainable development (Mohammadi Ghafari, Al-modaresi, and Moradi, 2022). The phenomenon of urbanization after the industrial revolution has intensified especially in recent years. Especially, rapid urban development has occupied a large amount of agricultural and ecological land, which has led to the loss of natural habitat in many areas. Rapid urbanization has significantly changed

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the spatial pattern of regional habitats and is considered a serious threat to habitats and biodiversity (Mahmoudzadeh and Harishchian, 2017). Human activities have drastically changed landscape patterns around the world. Paying attention to the concept of ecological development has a long history, and in the previous thousand years, thinkers have mentioned the issue of climate and people's health (Asmervik and Simensen, 2005). Theorists such as Sarda, Howard and Geddes have specifically dealt with the form and life of man in the field of urban planning (IEFS, 2011). In 1975, Richard Register and activists in this field proposed the term city ecology (Le et al., 2022). For the first time in 1987, this term was mentioned at the Berkeley conference in America, and then in 2003, ecological urbanism was specifically considered at the University of Oregon (Liu et al., 2022). Among the contemporary thinkers, Richard Register, Mark Roseland, David Enguichet, Mohsen Mostafavi, Ken Votti, John Kenz, Rodney Erwight, Bantegar and Darko Radukovich have mentioned the issue of ecological city in different fields. Ghafari et al., in the assessment and prioritization of ecological city indicators, found that landscape and urban landscape index and urban health as independent variables have the greatest impact and urban pollution index has the least importance on the structure of ecological urban development as a dependent variable (Mostafavi, 2012). Mahmoudzadeh, in measuring the ecological sustainability level of Tabriz, showed that not all parts of Tabriz metropolitan area are sustainable; So that the northern neighborhoods are at low levels of urban ecological sustainability, the middle neighborhoods are at medium levels, and the southern and southeastern neighborhoods are at high levels of sustainability (Rosland, 1997). In the article explaining the principles, dimensions and components of the ecological city approach, Jumapour et al. stated the role of factors in improving the situation of urban waste and waste, urban smartness, using public transportation and clean energy, developing comprehensive, codified and integrated laws in the field of ecological area, culture and lifestyle. Citizenship, the existence of valuable cultural bodies in the context of the old city, control and management of marginalization and informal settlements have the highest degree of adaptability, and they suggested that the role of these factors should be taken into consideration in the realization of the ecological city in the future (Spirin and Whiston, 2011). In fact, among all the different approaches related to sustainable urban development, the ecological city is proposed as a new solution to replace the existing developments as an inevitable necessity (Zenglin et al., 2022). The concept of ecological city can be expressed as follows; It is a human settlement model that is ecologically healthy, self-sufficient and flexible, and its function is compatible with natural ecosystems. Its structure seeks to provide health without excessive consumption of energy from non-renewable sources and replace it with renewable sources in the biological zone. The ecological effects of the inhabitants of such a city reflect the fundamental principles of justice, responsibility, flexibility and a sufficient level of happiness (URL: 1).

In this matter, the appropriate criteria and indicators for city development should be chosen in such a way that it can provide ecological and environmental support to the development of the city and guarantee the sustainability of urban development (Mirktoli, 2019). Until now, various methods have been taken into consideration to evaluate the ecological capacity, one of the most important of which in Iran is the ecological capacity assessment by Dr. Makhdoom, which is one of the powerful tools for quantifying the evaluation and weighting, using the hierarchical analysis method as one He mentioned the most famous multi-criteria decision-making techniques (MCDM) (Valikhani et al., 2019).

The ultimate goal of studies in the field of evaluation is to determine the best place for urban development that has the least adverse effects, is economically affordable, and has the most favorable characteristics from an engineering point of view (Koshki et al., 2018).

2. Theoretical Foundations of Research

Yazd city is the central part of Yazd province and covers an area of 140.40 square kilometers. The average height of the area is 1243 meters above sea level. In the last census of 2015, the population of this city was estimated at 529/673. Yazd city is bordered by Meibod and Ashkazar cities from the north, Ardakan and Bafaq cities from the east, Isfahan province from the west, and Taft, Abarkoh and

Mehriz cities from the south. The average height of Yazd city is 1200 meters above sea level.

As it was said, the ecological city is presented as a new concept and solution to improve the quality of the conditions of the cities. The city of Yazd also needs special attention to ecological issues in order to survive due to its specific climatic and geographical conditions on the one hand and the industrial pole of the country on the other hand. The presence of various industries and the strategic location of this city, which is located in the center of Iran and naturally makes it easy to access all parts of the country, has attracted many immigrants. In order to meet people's needs and maintain a healthy base of the city, effective indicators should be identified and prioritized. Which variables are at the top of the pyramid from the perspective of citizens should be studied.

The current research is descriptive-analytical in terms of method and has a developmental-applicative nature. According to the existing records, based on 12 criteria and with the weighted overlap method, the measurement and prioritization of the ecological indicators of Yazd city were investigated as the main subject of the research, and four physical, environmental, social and economic components were studied. they got. The physical dimension of the quality indicators of residential units and the level of residents' access to urban services; environmental aspect of green space quality indicators, drinking water quality, and waste collection and disposal quality; The social dimension is made up of indicators of neighborhood security, educational, medical and recreational facilities, the level of pedestrian and rider safety, and the amount of participation of residents for development, and the economic dimension consists of indicators of the level of personal vehicle ownership and the level of employment of residents.

The selection of criteria has been made according to studies of standard criteria and consultation with experts and their importance according to the conditions of the region. Hierarchical analysis process was used for the analysis by identifying and prioritizing elements including goals, criteria or characteristics and possible options in prioritization. This process includes modeling, pairwise comparisons and consistency in judgments. To facilitate the calculations related to AHP analysis, expert choice software has been used.

The AHP method was proposed by a researcher named "Thomas El Saati" in the 1970s. This method is one of the widely used methods for ranking and determining the importance of factors, which prioritizes each of the criteria using paired comparisons of options. The purpose of this technique is to select the best option based on different criteria through pairwise comparison. To prioritize among the selected criteria, the criteria were weighted so that the degree of importance of each factor could be calculated. The weighting in this section is relative and is for prioritizing criteria. Weighting of criteria and options was done by pairwise comparison method.

Table 1. Columnar matrix

	Neighborhood security	Neighborhood educational facilities	Quality of residential units	The quality of green space and recreational space of the neighborhood	Drinking water quality	The quality of waste collection and disposal	The level of access to educational facilities, treatment, etc Facili	Residents' access to city services	The level of safety for pedestrians and riders	The amount of personal vehicle ownership	The employment rate of residents	The amount of participation for the development
Neighborhood security	1	9	8	7	6	7	6	6	7	8	8	7
Neighborhood educational facilities	$\frac{1}{9}$	1	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{8}$	6	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{5}$	6	7	$\frac{1}{7}$
Quality of residential units	$\frac{1}{8}$	6	1	6	$\frac{1}{7}$	7	5	4	$\frac{1}{4}$	6	7	7
The quality of green space and recreational space of the neighborhood	$\frac{1}{7}$	6	$\frac{1}{6}$	1	8	6	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{7}$	7	7	$\frac{1}{5}$
Drinking water quality	$\frac{1}{6}$	8	7	$\frac{1}{8}$	1	8	8	7	8	9	9	8
The quality of waste collection and disposal	$\frac{1}{7}$	$\frac{1}{6}$	$\frac{1}{7}$	$\frac{1}{6}$	$\frac{1}{8}$	1	$\frac{1}{5}$	$\frac{1}{5}$	$\frac{1}{6}$	7	8	3
The level of access to , educational therapeutic and recreational facilities	$\frac{1}{6}$	6	$\frac{1}{5}$	6	$\frac{1}{8}$	5	1	$\frac{1}{4}$	$\frac{1}{5}$	7	7	$\frac{1}{3}$
Residents' access to city services	$\frac{1}{6}$	6	$\frac{1}{4}$	6	$\frac{1}{7}$	5	4	1	$\frac{1}{6}$	7	7	5
The level of safety for pedestrians and riders	$\frac{1}{7}$	5	4	7	$\frac{1}{8}$	6	5	6	1	8	9	8
The amount of personal vehicle ownership	$\frac{1}{8}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{7}$	$\frac{1}{9}$	$\frac{1}{7}$	$\frac{1}{7}$	$\frac{1}{7}$	$\frac{1}{8}$	1	$\frac{1}{5}$	$\frac{1}{7}$
The employment rate of residents	$\frac{1}{8}$	$\frac{1}{7}$	$\frac{1}{7}$	$\frac{1}{7}$	$\frac{1}{9}$	$\frac{1}{8}$	$\frac{1}{7}$	$\frac{1}{7}$	$\frac{1}{9}$	5	1	$\frac{1}{7}$
The amount of participation for the development	$\frac{1}{7}$	7	$\frac{1}{7}$	5	$\frac{1}{8}$	$\frac{1}{3}$	3	$\frac{1}{5}$	$\frac{1}{8}$	7	7	1

According to table number (1), the first step is to calculate the sum of the values of each column in the pairwise comparison, the second step is to standardize the numbers of the matrix in such a way that each component of the matrix resulting from the pairwise comparison is divided by the sum of its column and the matrix of the pairwise comparison is normalized. is obtained and finally the calculation of the average of the components in each row of the matrix is standardized. It means dividing the total standardized scores for each row by the number of criteria, which is the result of a column matrix.

Table 2. Latent variable manifest variable.

weight	manifest variable	Latent variable
0.0977 0.0770	1. Quality of residential units 2. Residents' access to municipal services	physical
0.0846 0.1809 0.0323	1. Quality of green space 2. Drinking water quality 3. Quality of waste collection and disposal 0.0846	environmental
0.2345 0.0326 0.0571 0.1263 0.0537	1. Neighborhood security 2. Educational facilities 3. Access to educational, medical and recreational facilities 4. The level of safety for pedestrians and riders 5. The amount of residents' participation for development	social
0.0092 0.0141	1. Amount of personal vehicle ownership 2. Employment rate of residents	Economic

As shown in Table 2, neighborhood security index with a weight of 0.2345 has the most importance, followed by drinking water quality indicators, pedestrian and rider safety. Finally, the index of ownership of a personal vehicle is the least important from the experts' point of view with a weight of 0.0092. In this study, the inconsistency rate of the matrix is equal to 0.017, which is less than 0.1, and therefore its compatibility is acceptable.

3. Conclusion

According to the conducted studies and the capabilities of Yazd city, such as the world registration in the UNESCO heritage list, industrial hub, medical hub, and also in terms of tourism potential, it is necessary to investigate the ecological factors effective in the growth and development of the city to determine the optimal future development directions. In recent years, the development of the city of Yazd has been carried out regardless of the criteria affecting the development. Correct planning for the placement of users and the use of existing resources based on their potential is an issue that cannot be ignored. In the current research, a multi-criteria decision-making method has been used; Because this method allows the simultaneous entry of several decision makers with various criteria, goals and options. The use of multi-criteria decision-making process has an effective role in the organization and development of the city because by using these models and the opinions of experts in relation to determining the importance of criteria; The priority of the indicators is determined. By using the AHP method and based on the opinions of experts familiar with the affairs of Yazd city and with the investigations, the conclusion was reached that the security of the city should be prioritized in the plans. According to the purpose of this research, which considers the ecological limitation, the following solutions are suggested:

1. Carrying out urban development plans using multi-criteria decision-making and paying attention to the power of the environment

2. Strengthening the security body of the city
3. Strengthening the body of engineering and municipal experts
4. Using correct and more accurate field studies
5. A wider study with more ecological criteria.

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