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# Measuring Urban Sustainable Development in Ahvaz Metropolis Using the CORASO Technique

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**ABSTRACT**

**Aims** Achieving sustainable urban development through various urban plans and fair planning has long been a basic strategy for governments. The present study was conducted to introduce the new CORASO technique for measuring urban sustainable development in the metropolis of Ahvaz.

**Methodology** This quantitative analytical research was conducted using data from the city of Ahvaz in 2020 and employed the modern CORASO ranking technique. Of the 16 indicators related to sustainable urban development, 14 were positive, and 2 were negative. The weights of these indicators were used in the weighted normal matrix section of the CORASO technique, and the model's different steps were performed.

**Findings** The highest normal matrix in the indicators of urban sustainable development in the indicators of population, employed population, building permits, residential permits, single-story building permits, neighborhood park and neighborhood park belonged to Region 8, in the indicators of commercial permits, commercial-residential permits, intersections with smart traffic lights, video surveillance cameras and regional parks belonged to Region 1, in the indicators of regional parks and green spaces of squares belonged to Region 3, and in the indicators of violation recording cameras, unemployed population (negative) and divorce (negative) belonged to Region 2. The highest cumulative value of urban sustainable development indicators was observed in Region 1 (0.8076), and the largest deviation from the ideal solution for each option was also observed in Region 1 (4.5560). Regions 1, 2, 8, 4, 3, 6, 7, and 5 were ranked 1 to 8, respectively, based on the final CORASO score.

**Conclusion** Sustainable urban development in the eight regions of Ahvaz metropolis, based on the results of the CORASO technique, has inequality and imbalance.

**Keywords** Urban Sustainable Development; CORASO Technique; Ahvaz Metropolis

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## Introduction

The twenty-first century has been a turning point in the way cities develop, and cities have become the undisputed engines of economic growth, centers of technological innovation, and places of cultural diversity [Becerra-Suárez *et al.*, 2025]. Cities have become the decisive engines of economic growth and are centers of opportunity, prosperity, innovation, and social and cultural interaction [Michalina *et al.*, 2021]. By 2050, almost 70% of the world's population is expected to be urban, which highlights the urgency of achieving sustainable growth in cities. Sustainable urban development is based on planning, good governance, and participation. Its aim is to maximize the use of resources, reduce impacts on the environment, and increase the quality of life in the city [Almatar, 2025].

Urban sustainability has now been recognized as a dilemma, after the World Commission on Environment and Development published the Brundtland Report in 1987, which emphasized the role of cities in sustainable development [Spiliotopoulou & Roseland, 2020]. The Rio Declaration on Environment and Development (1992) supported this idea and emphasized the need to increase the sustainability of urban centers. In particular, the seventh Millennium Development Goal, through its Target 11, aimed to improve the living standards of 100 million slum dwellers by 2020. Thus, the urban dimension was introduced into sustainable development work for the first time [Almatar, 2025].

Rapid urbanization and inadequate environmental planning have considerably increased the pressure on ecosystems and have led to unsustainable urban growth [Shamaee *et al.*, 2024]. For this reason, as part of the United Nations post-2015 sustainable development agenda, the world established its first urban sustainable development goal: making cities and human settlements inclusive, safe, resilient, and sustainable [Klopp & Petretta, 2017].

Rapid urbanization forms the foundation of modern civilization and provides a platform for economic growth, technological innovation, and improved living standards. Properly managed urbanization can lead to sustainable development and provide numerous social and economic benefits that are essential for modern society [Liu *et al.*, 2024]. At present, sustainable urban development has become an important issue at the political level [Michalina *et al.*, 2021]. Achieving the sustainable development goals and fair and equitable planning have always been among the basic strategies and policies of governments, although most developing countries suffer from unsustainable conditions [Hassanzadehkermanshahi & Shirowzhan, 2022].

Sustainable urban development has been influenced by several theoretical traditions and movements: in the past it emphasized reducing the environmental impact of economic growth, but today considerations of equality and justice are increasingly incorporated into the analysis of society [Spiliotopoulou & Roseland, 2020]. Research on urban sustainability has expanded considerably in recent decades [Zuo *et al.*, 2025]. Sustainable urban development is the balance and equilibrium among the various dimensions of urban development, and its main goal is to improve and upgrade the conditions and qualitative standards of citizens' lives. In the present quantitative study, the new CORASO technique was used to compare and measure sustainable urban development in the eight regions of the Ahvaz metropolis.

Maleki and Damanbagh [Maleki & Damanbagh, 2013] concluded that the eight regions of the city of Ahvaz differ in their access to the selected development indicators and that there is a significant relationship between the selected indicators and the trend of sustainable development in the city of Ahvaz. Pourmousavi and Movadt [Pourmousavi & Movadt, 2017] concluded that integrated urban management in the eight regions of the city of Ahvaz differs greatly among the regions in terms of the level of access and shows imbalance and inequality. Rahnama *et al.* [Rahnama *et al.*, 2019] concluded that Region 3 of the city of Ahvaz has the highest level of livability and Region 5 has the lowest level of livability compared with the other urban regions of Ahvaz. Mori and Christodoulou [Mori & Christodoulou, 2012] concluded that creating a new urban sustainability index to evaluate and compare the sustainability performance of cities is necessary in order to understand the global impact of cities on the environment and human life in comparison with their economic contribution. In the future, the urban sustainability index will be able to provide local authorities with guidance toward sustainable paths. Yong [Yong, 2020] concluded that, as global urbanization continues, sustainable urbanization is the key to successful development; Urumqi has suffered from a severe shortage of resources for several decades, and various studies have shown that the condition of this city has been unsustainable. Bounoua *et al.* [Bounoua *et al.*, 2024] concluded that over the past decades Morocco has witnessed considerable urbanization and has faced challenges related to urban sprawl. In this study, which examined urban sustainable development in 27 urban regions of Morocco, only 7 regions showed trends toward sustainable urban development, while the remaining 20 regions had moved away from the sustainability goals. Di Liddo *et al.* [Di Liddo *et al.*, 2025] concluded that urban sustainability has become a central issue in contemporary urban planning and policy-making, reflecting the growing need to address complex environmental, social, and economic challenges. However, the wide range of criteria used to measure sustainability often leads to inconsistency and limits their practical application.

Urbanization is considered a sign of progress in human society. Historically, urbanization has been associated with economic development and improved living

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standards. For example, urban areas usually have better access to essential services such as water supply, sanitation, and electricity, which is directly related to the improved quality of life of their residents [Shamaee *et al.*, 2024].

Cities and their development represent some of the greatest challenges of the twenty-first century [Michalina *et al.*, 2021]. Cities are complex social, economic, and natural systems that play a key role in the development of human civilization. As a result, urban development has emerged as a basic prerequisite for moving along the path of sustainability [Jia *et al.*, 2024]. Cities are considered one of the most important elements in achieving the sustainable development goals [Bąk & Sompolska-Rzechuła, 2024]. The rapid growth of cities and large agglomerations has challenged sustainable urban development with a wide range of environmental, social, and economic impacts [Santos *et al.*, 2021].

Sustainable urban development, as one of the important factors of human social development, directly affects the achievement of the global sustainable development goals [Yan *et al.*, 2024]. Sustainable cities and urban sustainability are defined in various ways and are characterized by criteria that relate to numerous domains according to the specific conditions and needs of cities [Tanguay *et al.*, 2010; Mori & Christodoulou, 2012]. Sustainable urban development is a comprehensive approach that integrates social, environmental, and economic considerations into the dynamic processes of complex systems in order to achieve the sustainability of society for the benefit of present and future generations [Spiliotopoulou & Roseland, 2020].

Today, sustainable development is interpreted as development that meets the needs of the present without compromising the ability of future generations to meet their own needs [Panteleeva & Borozdina, 2022]. Sustainable development is a collective effort that affects the destiny of humanity at the global level and has become a focus of global attention. Sustainable development arose from humanity's widespread concern about environmental issues and problems and from deep reflection on the process of the Industrial Revolution [Jia *et al.*, 2024]. The sustainable development of cities is often defined as the balance among the three basic dimensions of environmental, social, and economic sustainability. Sustainable cities strive to create a healthy and resilient habitat, environmentally, socially, and economically, for existing populations without compromising the ability of future generations to have the same experience. However, many issues in cities require the responsible institutions to address them and, where possible, solve them. That is why it is also necessary to consider a fourth dimension, namely the institutional dimension. With this approach, sustainable urban development can be understood as a synergistic relationship among environmental, social, economic, and institutional factors in each respective city. In addition to these dimensions, a cultural dimension of sustainability can also be found in the existing sources and literature [Michalina *et al.*, 2021]. Achieving sustainable urban development is one of the most important goals of many countries [Hassan & Lee, 2015]. Sustainable urban development is a comprehensive and integrated approach to putting social, cultural, economic, institutional, environmental, and ecological considerations into practice in order to achieve the sustainability of society for present and future generations. Sustainable urban development is the optimal use of the space, resources, and capacities of the city in a way that meets the needs of its citizens in the present without negatively affecting the needs of future residents.

The present study was conducted with the aim of examining and measuring sustainable urban development in the eight regions of the Ahvaz metropolis.

## Methodology

This quantitative analytical research was carried out on data from the city of Ahvaz in 2021 (1400 SH) using the new CORASO ranking technique. The city of Ahvaz, the capital of Khuzestan Province (31° N and 48° E) [Gholami *et al.*, 2023], is considered one of the most extensive metropolises of the country, and this extent results from the horizontal development of the city over the past decades (Figure 1). According to the statistical yearbook, the population of Ahvaz in 2021 was 1,262,580, and the city is divided into 8 urban regions (Chart 1).

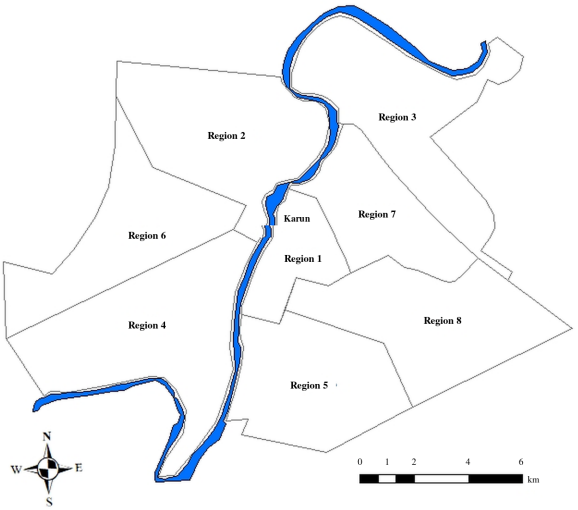


**Figure 1)** Geographical location and regions of the Ahvaz metropolis

The indicators of urban population, employed population, unemployed population, population left without a spouse as a result of divorce, issued building permits, commercial permits, commercial-residential permits, residential permits, single-story building permits, intersections with smart traffic lights,

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video surveillance cameras, traffic violation cameras, neighborhood parks, local parks, district parks, and square green spaces were collected from the statistical yearbook of the city of Ahvaz [Statistical Yearbook of Ahvaz Metropolitan, 2020].

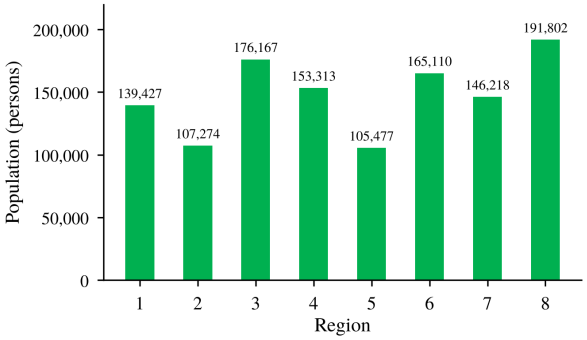


**Chart 1)** Population of the eight regions of the Ahvaz metropolis in 2021

The weights of these indicators were calculated using the entropy model and were used in the CORASO multi-attribute decision-making technique. The CORASO technique, introduced by Adis Puška [Puška, 2025], is one of the multi-criteria decision-making methods whose aim is to rank alternatives according to their closeness to or distance from the ideal solutions. This method uses the normalized decision matrix and the weights of the criteria to calculate the overall value of each alternative and then ranks the alternatives on the basis of their deviation from the best and the worst solutions. The steps of the CORASO technique are as follows [Puška, 2025]:

*Forming the decision matrix:* The first step is to form the decision matrix, in which the various alternatives are placed against a set of evaluation criteria. The values of this matrix can be quantitative and numerical or qualitative, so that each cell of the matrix represents the value of a particular criterion for a particular alternative. A very important point is that the values of the criteria must not be negative; moreover, if a criterion is of the cost type, that is, the lower its value the more desirable it is, its data must not contain a zero value, because in the cost normalization formulas zero causes an error.

*Normalizing the decision matrix* (the first formula for criteria of the benefit type; the second for criteria of the cost type):

$$n_{ij} = \frac{x_{ij}}{\max x_j} \text{ (benefit criteria)}$$

$$n_{ij} = \frac{\min x_j}{x_{ij}} \text{ (cost criteria)}$$

*Determining the weighted normalized values of the alternatives:*

$$v_{ij} = w_j \cdot n_{ij}$$

*Calculating the aggregate value of each alternative:*

$$S_j = \sum_{i=1}^{n} v_{ij}$$

*Calculating the deviation from the ideal solutions:*

$$R_j = \frac{S_j}{S_{j\ \max AS}}; \qquad R'_j = \frac{S_{\min AS}}{S_j}$$

*Calculating the final index of each alternative:*

$$Q_i = \frac{R_j - R'_j}{R_j + R'_j}$$

*Ranking the alternatives:* The alternatives are ranked according to their $Q$ values. A higher $Q$ value indicates a better quality of the alternative.

## Findings

The indicators of the unemployed population and the population left without a spouse as a result of divorce were negative, and the other indicators were positive (Table 1).

**Table 1)** Weights of the sustainable urban development indicators in the eight regions of the Ahvaz metropolis in 2021

| Indicator | Nature | Weight |
|---|---|---|
| **Demographic, economic, and social** | | |
| Population | + | 0.0021 |
| Employed population | + | 0.0564 |
| Unemployed population | – | 0.0312 |
| Divorce | – | 0.0019 |
| **Residential and physical** | | |
| Building permits | + | 0.1455 |
| Commercial permits | + | 0.1206 |
| Commercial-residential permits | + | 0.0544 |
| Residential permits | + | 0.1167 |
| Single-story building permits | + | 0.0345 |
| **Smart transportation** | | |
| Intersections with smart traffic lights | + | 0.1041 |
| Video surveillance cameras | + | 0.1773 |
| Traffic violation cameras | + | 0.1241 |
| **Urban management and urban services** | | |
| Neighborhood parks | + | 0.0058 |
| Local parks | + | 0.0044 |
| District parks | + | 0.0149 |
| Square green spaces | + | 0.0063 |

The highest values of the normal matrix of the sustainable urban development indicators belonged to Region 8 for the indicators of population, employed population, building permits, residential permits, single-story building permits, neighborhood parks, and local parks; to Region 1 for commercial permits, commercial-residential permits, intersections with smart traffic lights, video surveillance cameras, and district parks; to Region 3 for district parks and square green spaces; and to Region 2 for traffic violation cameras, the unemployed population (negative), and divorce (negative). The weighted normal matrix of the sustainable urban development indicators was calculated using the Shannon entropy model (Table 2).

The highest aggregate value of the sustainable urban development indicators in the eight regions of the Ahvaz metropolis in 2021 belonged to Region 1 (0.8076), and the highest deviation from the ideal solutions of each alternative also belonged to Region 1 (4.5560). Regions 1, 2, 8, 4, 3, 6, 7, and 5, respectively, were placed in ranks

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**Table 2)** Normal matrix and weighted normal matrix of the sustainable urban development indicators in the regions of the Ahvaz metropolis in 2021

| Indicator | Matrix | Region 1 | Region 2 | Region 3 | Region 4 | Region 5 | Region 6 | Region 7 | Region 8 |
|---|---|---|---|---|---|---|---|---|---|
| **Population** | Normal | 0.7269 | 0.5593 | 0.9185 | 0.7993 | 0.5499 | 0.8608 | 0.7623 | 1.0000 |
| | Weighted normal | 0.0015 | 0.0012 | 0.0019 | 0.0017 | 0.0011 | 0.0018 | 0.0016 | 0.0021 |
| **Employed population** | Normal | 0.7424 | 0.6253 | 0.9998 | 0.7948 | 0.5365 | 0.8354 | 0.7187 | 1.0000 |
| | Weighted normal | 0.0419 | 0.0353 | 0.0564 | 0.0448 | 0.0303 | 0.0471 | 0.0405 | 0.0564 |
| **Unemployed population** | Normal | 0.8782 | 1.0000 | 0.5546 | 0.7702 | 0.9860 | 0.6880 | 0.6757 | 0.5963 |
| | Weighted normal | 0.0274 | 0.0312 | 0.0173 | 0.0240 | 0.0307 | 0.0214 | 0.0210 | 0.0186 |
| **Divorce** | Normal | 0.6440 | 1.0000 | 0.5361 | 0.6235 | 0.8911 | 0.6184 | 0.7009 | 0.6029 |
| | Weighted normal | 0.0012 | 0.0019 | 0.0010 | 0.0012 | 0.0017 | 0.0012 | 0.0013 | 0.0011 |
| **Building permits** | Normal | 0.9391 | 0.9487 | 0.6218 | 0.5769 | 0.2853 | 0.5769 | 0.2885 | 1.0000 |
| | Weighted normal | 0.1366 | 0.1380 | 0.0905 | 0.0839 | 0.0415 | 0.0839 | 0.0420 | 0.1455 |
| **Commercial permits** | Normal | 1.0000 | 0.6923 | 0.5385 | 0.8462 | 0.0769 | 0.0769 | 0.2308 | 0.8462 |
| | Weighted normal | 0.1206 | 0.0835 | 0.0649 | 0.1020 | 0.0093 | 0.0093 | 0.0278 | 0.1020 |
| **Commercial-residential permits** | Normal | 1.0000 | 0.7375 | 0.0208 | 0.2500 | 0.0833 | 0.7500 | 0.0625 | 0.3750 |
| | Weighted normal | 0.0544 | 0.0238 | 0.0011 | 0.0136 | 0.0045 | 0.0408 | 0.0034 | 0.0204 |
| **Residential permits** | Normal | 0.8127 | 0.9329 | 0.6572 | 0.5548 | 0.2968 | 0.4982 | 0.2862 | 1.0000 |
| | Weighted normal | 0.0948 | 0.1088 | 0.0767 | 0.0647 | 0.0346 | 0.0581 | 0.0334 | 0.1167 |
| **Single-story building permits** | Normal | 0.4207 | 0.3379 | 0.1586 | 0.1655 | 0.0690 | 0.2000 | 0.1379 | 1.0000 |
| | Weighted normal | 0.0145 | 0.0116 | 0.0055 | 0.0057 | 0.0024 | 0.0069 | 0.0048 | 0.0345 |
| **Intersections with smart traffic lights** | Normal | 1.0000 | 0.6154 | 0.3077 | 0.6154 | 0.2308 | 0.3846 | 0.2308 | 0.0769 |
| | Weighted normal | 0.1041 | 0.0641 | 0.0320 | 0.0641 | 0.0240 | 0.0400 | 0.0240 | 0.0080 |
| **Video surveillance cameras** | Normal | 1.0000 | 0.6667 | 0.1111 | 0.1111 | 0.1111 | 0.3333 | 0.1111 | 0.0556 |
| | Weighted normal | 0.1773 | 0.1182 | 0.0197 | 0.0197 | 0.0197 | 0.0591 | 0.0197 | 0.0098 |
| **Traffic violation cameras** | Normal | 0.0714 | 1.0000 | 0.4286 | 0.2857 | 0.0714 | 0.0714 | 0.4286 | 0.0714 |
| | Weighted normal | 0.0089 | 0.1241 | 0.0532 | 0.0355 | 0.0089 | 0.0089 | 0.0532 | 0.0089 |
| **Neighborhood parks** | Normal | 0.9000 | 0.4000 | 0.9500 | 0.7500 | 0.5500 | 0.4000 | 0.6000 | 1.0000 |
| | Weighted normal | 0.0052 | 0.0023 | 0.0055 | 0.0044 | 0.0032 | 0.0023 | 0.0035 | 0.0058 |
| **Local parks** | Normal | 0.5000 | 0.6250 | 0.6875 | 0.6875 | 0.6250 | 0.4375 | 0.3750 | 1.0000 |
| | Weighted normal | 0.0022 | 0.0028 | 0.0030 | 0.0030 | 0.0028 | 0.0019 | 0.0017 | 0.0044 |
| **District parks** | Normal | 1.0000 | 0.8000 | 1.0000 | 0.2000 | 0.6000 | 0.2000 | 0.4000 | 0.5000 |
| | Weighted normal | 0.0149 | 0.0119 | 0.0149 | 0.0030 | 0.0090 | 0.0030 | 0.0060 | 0.0075 |
| **Square green spaces** | Normal | 0.3333 | 0.5000 | 1.0000 | 0.8333 | 0.3889 | 0.7778 | 0.5556 | 0.6667 |
| | Weighted normal | 0.0021 | 0.0031 | 0.0063 | 0.0052 | 0.0024 | 0.0049 | 0.0035 | 0.0042 |

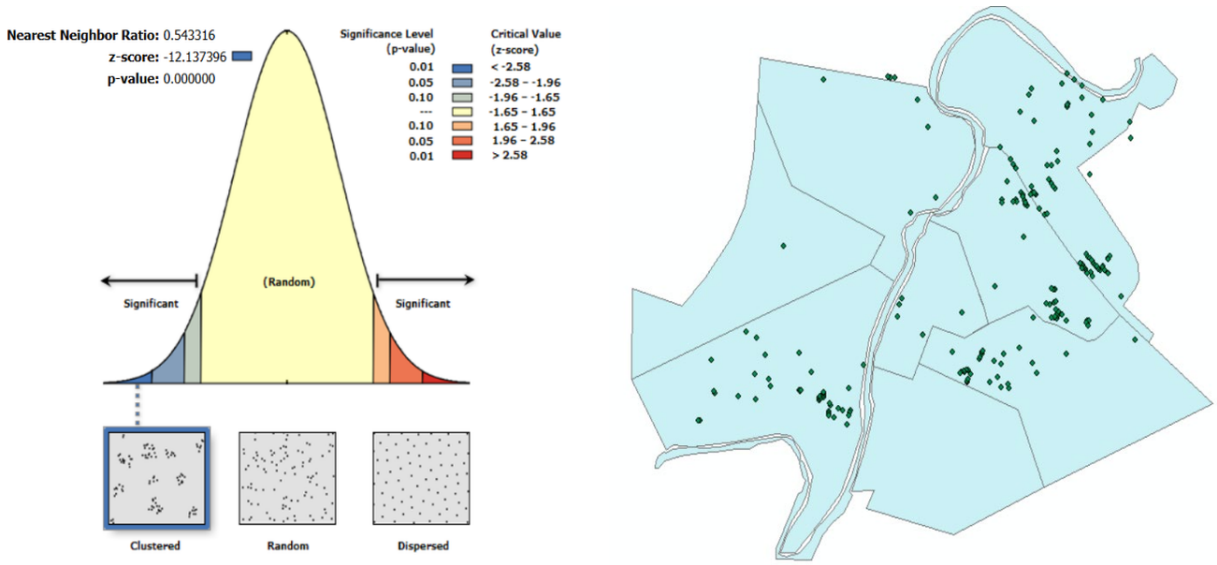


**Figure 2)** Spatial distribution of parks and urban green spaces based on the average nearest neighbor in the eight regions of the Ahvaz metropolis in 2021

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1 to 8 on the basis of the final CORASO score (Table 3).

**Table 3)** Ranking of the regions of the Ahvaz metropolis based on the final CORASO score

| Region | Aggregate value ($S_j$) | $R_j$ | $R'_j$ | Final score ($Q$) | Rank |
|---|---|---|---|---|---|
| **Region 1** | 0.8076 | 4.5560 | 0.0013 | 0.9994 | 1 |
| **Region 2** | 0.7618 | 4.2976 | 0.0013 | 0.9994 | 2 |
| **Region 3** | 0.4500 | 2.5385 | 0.0023 | 0.9982 | 5 |
| **Region 4** | 0.4765 | 2.6883 | 0.0021 | 0.9984 | 4 |
| **Region 5** | 0.2261 | 1.2754 | 0.0045 | 0.9930 | 8 |
| **Region 6** | 0.3906 | 2.2039 | 0.0026 | 0.9976 | 6 |
| **Region 7** | 0.2874 | 1.6211 | 0.0035 | 0.9957 | 7 |
| **Region 8** | 0.5459 | 3.0796 | 0.0019 | 0.9988 | 3 |

The spatial distribution of parks and urban green spaces in the eight regions of the Ahvaz metropolis (nearest neighbor ratio = 0.543316; Z-score = −12.137396; significance level = 0.0000001) was clustered (Figure 2).

## Discussion

In this study, 16 indicators related to sustainable urban development were selected for the application of the CORASO technique, of which 14 have a positive (benefit) aspect and 2 indicators, the number of unemployed people and the number of divorces, have a negative (cost) aspect. The weights of the indicators related to sustainable urban development were calculated through the Shannon entropy model and used in the CORASO multi-attribute decision-making technique; the various steps of the CORASO model were estimated using the data of the decision matrix, and the necessary tables and charts were presented.

The final CORASO scores of the eight regions of the Ahvaz metropolis show inequality and imbalance in access to the sustainable urban development indicators. The results show that the highest final scores of the CORASO model belong to Regions 1 and 2, and in this respect the lowest final CORASO score belongs to Region 5.

The results of this study are consistent with those of Maleki and Damanbagh [Maleki & Damanbagh, 2013]. In that study, Maleki and Damanbagh concluded that the eight regions of the city of Ahvaz show imbalance and inequality in terms of access to the selected urban development indicators. The results of applying the VIKOR model in that study show that the eight regions of this city differ in their access to the selected development indicators, such that Region 2 in the social indicator, Region 1 in the urban services indicator, and Region 4 in the physical indicator had the highest levels of access. In terms of deprivation, Region 6 in the social and physical indicators and Region 5 in the urban services indicator were identified as the most deprived regions.

The results of this study are consistent with those of Pourmousavi and Movadt [Pourmousavi & Movadt, 2017]. Pourmousavi and Movadt concluded that integrated urban management in the eight regions of Ahvaz differs greatly among the urban regions in terms of the level of access, such that the mean human development index was 0.566. Regions 7, 1, 5, and 6 are above the mean in terms of average access and urban management in the studied index compared with the other regions. Overall, the results and findings of that study show imbalance and inequality in the city of Ahvaz.

The results of the study are consistent with the research of Rahnama *et al.* [Rahnama *et al.*, 2019]. The results of the study by Rahnama *et al.* show that Region 3 of the city of Ahvaz has the highest level of livability and Region 5 has the lowest level of livability compared with the other urban regions of Ahvaz. Overall, the results and findings of that study show that three regions of the city were in a desirable condition, one region was semi-desirable, and four regions were in an undesirable condition. Therefore, balanced planning among the regions and attention to the condition of the regions in an undesirable condition should be at the top of the duties of the responsible officials.

The results of the present research are consistent with Yong [Yong, 2020], who believes that, as urbanization continues throughout the world, sustainable urbanization is the key to successful development, and that the city of Urumqi has suffered for several decades from severe resource shortages and various inequalities. On the basis of various studies, the condition of the city of Urumqi is unsustainable in various urban indicators, and urban inequality and imbalance exist. The results are also consistent with Bounoua *et al.* [Bounoua *et al.*, 2024]. They report that in past decades Morocco has experienced rapid and uncontrolled urbanization, that the result of rapid urbanization has been numerous urban problems and challenges, and that the sustainable urban development indicators in 20 urban regions of Morocco are unsustainable and far from the sustainability goals, which indicates inequality and imbalance in Morocco.

One of the limitations faced by this research is the lack of access to statistics and information in Iranian cities, including the Ahvaz metropolis. The indicators involved in sustainable urban development are diverse and numerous, so that by referring to the documents and sources in Latin script we encounter a diversity of sustainable urban development indicators; however, when we refer to the yearbooks, statistical reports, and official and secondary data in our country, Iran, we encounter specific data, and in this respect the hands of researchers are tied to some extent and we are forced to use specific data for estimation in quantitative models and techniques. Finally, to strengthen the sustainable urban development indicators in the Ahvaz metropolis, strengthening the sustainable urban development indicators in Regions 5, 6, and 7 is suggested.

## Conclusion

According to the results of the CORASO technique,

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sustainable urban development in the eight regions of the Ahvaz metropolis is characterized by inequality and imbalance.

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