MULTI-CRITERIA DECISION MAKING FOR SUSTAINABILITY EVALUATION IN URBAN AREAS: A CASE STUDY FOR KERMANSHAH CITY, IRAN

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Abstract. Sustainable development refers to interactions between different aspects of economic, social and environmental features that are designed to improve the quality of human life. The aim of this study is to evaluate urban sustainability in different urban areas of the Kermanshah city of Iran. An important city in western Iran, Kermanshah faces several social, economic and environmental problems, thus confirming the need for this research. This study was completed using multi-criteria decision making (MCDM) methods, including SAW, ELECTRE and TOPSIS. The results of these three methods indicated that different urban areas in Kermanshah city have different sustainability levels and among the six urban areas, area 4 was designated as first priority. In addition, this paper offers some necessary strategies on the issues relating to the planning and management of Kermanshah city. Furthermore, the results of three methods were compared with each other. The findings of the Friedman Test showed that there is no meaningful difference between the applied methods.
Keywords: *MCDM, sustainable development, SAW, ELECTRE, TOPSIS*

Introduction

Presently, over 50% of the world's population lives in cities. Cities form the core of social, economic, and environmental development and are also the most probable places to suffer setbacks (Connelly, 2007; Oliver, 2008; Varol et al., 2010). The statistics on the urban growth rate in the world show a significant increase in the rate of 3% in 1800 to 50% in 2008. On this basis, it is expected to increase up to 60% and 70% by 2030 and 2050, respectively (Khazaei et al., 2013). These changes have an impact on economic, social, and environmental conditions and can create problems such as social injustice, inappropriate population settlements, and climate change (Rasoolimanesh et al., 2011; Hassan et al., 2015; Huang et al., 2015). In order to face the aforementioned changes, new approaches and solutions, such as sustainable development, environmental justice, modern city lifestyle, and recently, smart development have been introduced (Taghvaei, 2013; Haikio, 2014). Sustainability was introduced for the first time in 1972 at The United Nations

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Conference on the Human Environment held in Stockholm. Also, the Agenda 21 was approved in 1992 among The United Nations Conference on Environment and Development in Rio de Janeiro (Whitehead, 2003). The concept of sustainable development was advanced to solve economic, social, and environmental problems; it is one of the most important debates worldwide, one that sees collaboration from international environmental organizations as well as the United Nations (Rotmansa et al., 2000; Rasoolimanesh et al., 2011; Maleki, 2013). Today, the proposed practical plan considers 21 fundamentals that provide the three necessities of our time, the environmental preservation of water, soil and biodiversity, which our lives are dependent upon (Willis, 2006). There are many definitions of sustainable development. Sustainable development is 'a kind of development by which today's generation can achieve their basic needs without limiting the future generation's resources'. This cannot be achieved till all the factors and criteria have been defined and designed in detail (Leghaee, 1999; Berke, 2000; Jansen, 2003).

Also, the different aspects of sustainable development including, economic, social and environmental should be considered. If any aspects of sustainable development are weak, the system will be unsustainable. Urban sustainable development has the ability to develop the cities and provide the urban future generations and community's needs (Hall, 1993).

Since urban sustainable development comes from the knowledge of the conditions in urban areas, the study and review of the status of such areas is essential. In earlier research, the sustainable development level of Weifang city, of Shandong province, was studied by the AHP method. The result of this study showed that the Weifang sustainability index has been increasing in the last few years due to the environmental infrastructure improvement (Wang et al., 2012). The development of urbanization under the ecological environment restriction in the western region was done by Duan (2012). This study presents the corresponding solutions to increase the urban sustainable development quality. Different methods of multi-criteria decision making (MCDM) systems, such as SAWM, ELECTRE, TOPSIS and PROMETHEE, were used while studying the sustainability of different provinces in India (Sen et al., 2014). Evaluation of urban sustainability in 287 cities in China using TOPSIS-Entropy method has been done. Since, the level of urban sustainability in China was not high and much difference between cities exist, some strategies at urban and regional scale have been proposed (Ding et al., 2016). In another study performed by Zarrabi (2014), the social sustainability of Tehran city in Iran was assessed using factor analysis, and the level of sustainability in each urban area was defined. The same research had been done in Ilam, Iran (2009), Ahwaz, Iran (2013) by Maleki, and Orumieh, Iran (2013) by Mobaraki. Several other studies have also been conducted using MCDM methods (Viteikiene et al., 2007; Rajak et al., 2015; Zhang et al., 2016; Mokhtari Malek-Abadi et al., 2016; Liang et al., 2016; Hsueh et al., 2017).

These studies have been done by various methods and various indicators at different cities with different problems and different conditions. They indicate that there are many differences between areas in a city in terms of social, economic and environmental sustainability indicators and high inequality exist among different urban areas. According to the literatures, the cities have a trouble with legal authority and financial resources to deal with urban problems. These studies have also provided useful information on increasing the sustainable development level of cities and agreed that the urban development should be done by sustainable plans and good management and three

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important objectives should be considered including, social equality, economic development and environmental protection. While, community participation is a key role in promoting quality of urban sustainable environment.

As a country, Iran has consistently struggled with economic, social and environmental issues. Therefore, paying attention to sustainable development is essential for the nation's present and future. Several cities in Iran have developed in unsuitable ways, leading to different issues like pollution and chaos. This is particularly challenging on metropolises, which are usually focal points of population, trade, economy, culture, as well as pollution. Despite being one of the most important cities in western Iran, Kermanshah is highly unsustainable due to rapid population growth, high migration rate and increase in trade and economic activities, all of which lead to different problems. Even with the appropriate facilities, services are unevenly distributed among different parts of the city. This study aims to assess the sustainability of urban areas in Kermanshah by using the SAW, ELECTRE, and TOPSIS methods, as well as explore necessary policies to promote the sustainability level in the different areas.

Materials and methods

The study area

Kermanshah is located between latitudes 33°N and 35°N and longitudes 45°E and 47°E. The city, comprising 1.5% of Iran's total area, is located in the west and has a shared boundary with Iraq. Kermanshah Province is limited by Kurdistan in the north, Lorestan and Ilam provinces in the south, Hamedan in the east, to the country of Iraq in the west. The city of Kermanshah is the capital of the province, with a population of 818,719 people within the area of 9564 km^2 (Statistical Center of Iran, 2011). According to the population and housing census from 1966 to 2011, the population of Kermanshah city has increased from 192,072 people in 1966 to 850700 in 2011, with a positive population growth rate of 3.36%. Despite fluctuations, the city's population has always exhibited a positive growth trend (Zinatizadeh, 2013; Shirazi, 2013). Kermanshah has six urban areas, which are defined in *Table 1* and *Figure 1*.

Table 1. *Specification of each area of Kermanshah city (Statistical Center of Iran, 2015)*

Urban areas	Population	Area (Hectare)
Area 1	80689	1442
Area 2	100900	1135
Area 3	164254	1654
Area 4	151376	1469
Area 5	177408	1711
Area 6	144092	2153

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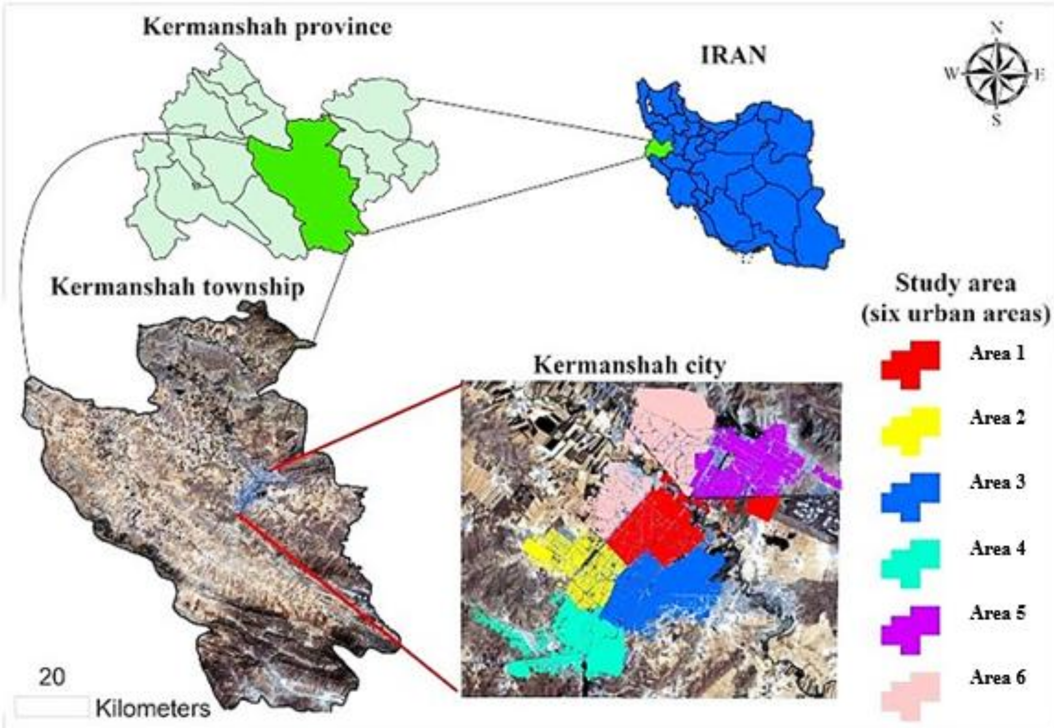

Figure 1. *Location of the study area*

In order to investigate sustainability of six urban areas in Kermanshah, a list of 44 indicators was prepared. The selection of indicators was based on expert opinions, conditions in Kermanshah city, access to the required data, and literature review (Mousavi, 2005; Zakerian, 2010; Jafaei, 2011; Aboubakri, 2012; Bahari, 2012; Raz-Dasht, 2012; Azani, 2013; Saraei, 2013; Saeedi Mafar, 2013; Akbari Nasab, 2014; Mokhtari, 2014; Li-Yin, 2011; Singh, 2009) (*Table 2*). The required data were gathered from different centres viz. province hall, municipality, department of environment, municipal water and wastewater company, waste management organizations, traffic and transportation organizations, renovation and reconstruction organizations, and statistics and information technology center. Additionally, Shannon's entropy method (Shannon, 1948) was used to determine the weight of indicators (*Table 2*).

Table 2. *List of the indicators studied and their weights in Kermanshah city (Social and welfare (1-23) Economic growth (24-31) Environmental protection (32-44))*

Indicator	Weight
(1) Population density	0.002006
(2) Literacy rate	0.000917
(3) Family size	0.008309
(4) Number of Fire station per 1000 people	0.011512
(5) Number of gas station per 1000 people	0.031225
(6) Number of toilets per 1000 people	0.023562

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(7) Number of public parking per 1000 people	0.115307
(8) Number of hotel per 1000 people	0.109761
(9) Number of not-level intersection per 1000 people	0.037687
(10) Number of central post office per 1000 people	0.007423
(11) Number of park per 1000 people	0.014057
(12) Number of police centers per 1000 people	0.028361
(13) Number of intelligent intersection per 1000 people	0.148629
(14) Number of pedestrian bridge per 1000 people	0.031043
(15) Number of Database Disaster Management per 1000 people	0.079185
(16) Number of hospital per 1000 people	0.095756
(17) Number of clinic per 1000 people	0.084947
(18) Number of drugstore per 1000 people	0.024643
(19) Numb9er of university per 1000 people	0.0869
(20) Number of sport centers per 1000 people	0.001686
(21) Number of cultural centers per 1000 people	0.009692
(22) Number of religious places per 1000 people	0.028122
(23) Number of schools per 1000 people	0.01927
(24)Unemployment rate	0.199759
(25) Employed population to 15-year-old population and more	0.208196
(26) Sponsorship rate	0.021259
(27) Number of civil projects per 1000 people	0.017955
(28) Number of shopping centers per 1000 people	0.093252
(29) Number of markets per 1000 people	0.032902
(30) Number banks per 1000 people	0.221543
(31) Number of recreation and tourism centers per 1000 people	0.205136
(32) Percent of Accidents and breakdowns in water and sewage networks	0.021924
(33) Percent of wastewater treated	0.10955
(34) Percent of Population Water network coverage	0.000461
(35) Percent of Population network wastewater coverage	0.000921
(36) Percent of source separation of solid waste	0.216273
(37)Waste production per capita	0.0043
(38) Percent of Semi-mechanized collection of household waste	0.004441
(39) Number of industrial centers per 1000 people	0.191567
(40) Number of database associated with environment per 1000 people	0.14267
(41) Green space per capita	0.111328
(42) Number of traffic jams per 1000 people	0.053538
(43) Percent of travel at peak hours	0.045457
(44) Percent of old area	0.09757

Source: (Mousavi 2005, Zakerian 2010, Jafaei 2011, Aboubakri 2012, Bahari 2012, Raz-Dasht 2012, Azani 2013, Saraei 2013, Saeedi Mafar 2013, Akbari Nasab 2014, Mokhtari 2014, Li-Yin 2011 and Singh 2009)

Following this, the MCDM methods were used for prioritizing the urban areas. The MCDM method is a branch of operations research models which cope with decision problems that have a number of criteria (Pohekar et al., 2004). In this study, one method from each subgroup of the MCDM methods was chosen. The selective methods include Elimination and Choice Expressing Reality (ELECTRE) from the concordance sub-group, the Technique for Order Preference by Similarity to Ideal Solutions (TOPSIS) from the compromising sub-group, and Simple Additive Weighting (SAW) from the scoring sub-group of the MCDM methods. These methods are further described in the following sections.

SAW

The simple additive weighting (SAW) is one of the simplest methods of the MCDM methods (Churchman et al., 1954):

Normalize the decision matrix (N):

According to the *Eq. 1*, the decision matrix is normalized using of linear method.

$$n_{ij} = \frac{a_{ij}}{Max\ aij} \quad i = 1, \dots, m, \quad j = 1, \dots, n \qquad \text{(Eq. 1)}$$

Calculate the weighted normalized decision matrix (V):

The weighted normalized value (v_{ij}) is obtained according to *Eq. 2*.

$$V_{ij} = N_{ij} W_j \quad i = 1, \dots, m, \quad j = 1, \dots, n \qquad \text{(Eq. 2)}$$

Where w_j is the weight of the *i*th indicator.

Select the alternative with the highest overall performance value (A):*

$$A^* = \{A_i Max \sum n_{ij} w_j\} \qquad \text{(Eq. 3)}$$

ELECTRE

ELECTRE was introduced at the end of 1980th (Roy 1968). ELECTRE Is an outranking method based on outranking relation and concordance analysis. So, this method does not necessarily results in ranking the alternatives (Velasquez et al 2013; Taha et al 2013).

Normalize the decision matrix (N):

The normalized value (n_{ij}) is obtained according to the *Eq. 4*.

$$n_{ij} = \frac{x_{ij}}{\left[\sum_{i=1}^{m} x_{ij}^2\right]^{\frac{1}{2}}} \quad i = 1, \dots, m, \quad j = 1, \dots, n \qquad \text{(Eq. 4)}$$

Calculate the weighted normalized decision matrix (V):

The weighted normalized value (v_{ij}) is obtained according to *Eq. 5*.

$$V_{ij} = N_{ij} W_j \quad i = 1, \dots, m, \quad j = 1, \dots, n \qquad \text{(Eq. 5)}$$

Where w_j is the weight of the *i*th indicator.

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Formation the concordance matrix set

$$S_{k,l} = \{j \mid Vkj \geq Vij\} \ , \quad j = 1, \dots, m$$

$$S_{k,l} = \{j \mid Vkj \leq Vij\} \ , \quad j = 1, \dots, m$$

Formation the discordance matrix set

$$D_{k,l} = \{j \mid Vkj < Vij\}, \quad j = 1, \dots, m$$

$$D_{k,l} = \{j \mid Vkj > Vij\}, \quad j = 1, \dots, m$$

Determine of concordance matrix (I_{kl})

In this stage, the concordance matrix is calculated using *Eq. 6*. This matrix is an m*m matrix, which diameter of that, does not have any element. The other elements (entries) of this matrix can be calculated via summation of indicator weights that belong to concordance group.

$$I_{kl} = \sum w_j \ , \quad j \in A_{k,l} \qquad \text{(Eq. 6)}$$

Determine of discordance matrix (NI):

In this stage, the discordance matrix is calculated using *Eq. 7*. This matrix is an m*m matrix. The diameter of this matrix does not have any elements and other elements can be calculated from weighted normalized matrix according to *Eq. 7*.

$$NI_{kl} = \frac{Max\left|V_{ij} - V_{lj}\right|, j \in D_{k,l}}{Max\left|V_{ij} - V_{lj}\right|, j \in all\ indicators} \qquad \text{(Eq. 7)}$$

Calculate the effective concordance matrix (H):

To create this matrix, first we need to determine a threshold. If each element of matrix I, be bigger or equal to that, that factor in matrix H, will be equal one, otherwise 0. From the *Eq. 8*, the threshold for the matrix is calculated.

$$I = \sum_{i=1}^{m} \sum_{k=1}^{m} I_{k_l} / m(m-1) \qquad \text{(Eq. 8)}$$

If, $I_{ki} \geq \bar{I}$, $H_{ki} = 1$ *and* *If,* $I_{ki} < \bar{I}$, $H_{ki} = 0$

Calculate the effective discordance matrix (G):

In this stage, the effective discordance matrix can be calculated based on the *Eq. 9*

$$\overline{NI} = \sum_{i=1}^{m} \sum_{k=1}^{m} NI_{k_l} / m(m-1) \qquad \text{(Eq. 9)}$$

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If, $NI_{ki} \geq \overline{NI}$, $G_{ki} = 0$ *and* *If,* $NI_{ki} < \overline{NI}$, $G_{ki} = 1$

Determine the effective final matrix (F):

The effective final matrix can be calculated by combination of effective concordance and effective discordance matrix based on the *Eq. 10*.

$$F_{kl} = H_{kl}G_{kl} \quad \text{(Eq. 10)}$$

TOPSIS

TOPSIS was proposed by Hwang and Yoon in 1981. The basic concept of this method is that, the chosen alternative should have the closest distance from the ideal solution (Velasquez et al., 2013; Taha et al., 2013).

Normalize the decision matrix (N):

The normalized value (n_{ij}) is obtained according to *Eq. 11*.

$$n_{ij} = \frac{x_{ij}}{\left[\sum_{i=1}^{m} x_{ij}^2\right]^{\frac{1}{2}}} \qquad i = 1, \ldots, m, \quad j = 1, \ldots, n \quad \text{(Eq. 11)}$$

Calculate the weighted normalized decision matrix (V):

The weighted normalized value (v_{ij}) is obtained according to *Eq. 12*.

$$V_{ij} = N_{ij}W_j \qquad i = 1, \ldots, m, \quad j = 1, \ldots, n \quad \text{(Eq. 12)}$$

Where w_j is the weight of the *i*th indicator.

Determine of positive ideal solution and negative ideal solution

Positive ideal solution (V_j+) =vector of the best values of each indicator (*V*)
Negative ideal solution (V_j^-) = vector of the worst values of each indicator (*V*)
The best values for the positive indicators are the biggest and for the negative indicators are lowest values.

Determine of Euclidean distance to positive and negative ideals:

Euclidean distance of each alternative from positive ideal (d_j^+) and negative ideal (d_j^-) can be calculated based on *Eq. 13* and *14*.

$$d_i^+ = \sqrt{\sum_{j=1}^{n}\left(V_{ij} - V_j^+\right)^2} \quad , \ i = 1,2, \ldots, m \quad \text{(Eq. 13)}$$

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$$d_i^- = \sqrt{\sum_{j=1}^{n}\left(V_{ij} - V_j^-\right)^2} \quad , \; i = 1,2,\dots,m \qquad \text{(Eq. 14)}$$

Determine the relative closeness to ideal solution (CL):*

Determination of relative closeness of each alternative to an ideal solution can be calculated based on *Eq. 15*.

$$CL_i^* = \frac{d_i^-}{d_i^- + d_i^+} \quad , \quad i = 1,2 \;\dots, n, \quad 0 \leq CL_i^* \leq 1 \qquad \text{(Eq. 15)}$$

Ranking the preference order

Alternatives having bigger CL, are better. According to relative closeness of each alternative to an ideal solution, the ranking order of alternatives can be determined and the best alternative is selected.

Results

Based on the data obtained, the sustainability levels of six urban areas were evaluated using three methods under the MCDM, and three aspects of sustainability, including social, economic and environmental.

Urban areas ranking by SAW

The results obtained from SAW in three categories (social, economic, and environmental) are shown in *Table 3*. The best alternative selected is the one where the sum of the weighted normalized values is greater than other values.

Table 3. *Results obtained from SAW method*

Area	Sum of environmental indicators values	Rank	Sum of economic indicators values	Rank	Sum of social indicators values	Rank	Sum of indicators values	Rank
1	0.764	1	0.817	1	0.471	4	2.052	4
2	0.362	5	0.695	2	0.489	3	1.555	3
3	0.538	3	0.547	4	0.626	1	1.711	1
4	0.602	2	0.560	3	0.600	2	1.762	2
5	0.330	6	0	5	0.290	6	0.62	6
6	0.368	4	0	5	0.392	5	0.76	5

According to the results, Area 1, with a value of 2.052, is more sustainable than the others. Three areas (4, 3, and 2) are ranked in the second, third, and fourth place, with

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values of 1.762, 1.711 and 1.555, respectively. Areas 6 and 5 are graded as fifth and sixth, with 0.76 and 0.62, respectively.

Urban areas ranking by ELECTRE

The results of urban area ranking in three categories (social, economic, and environmental) using the ELECTRE method are shown in *Tables 4, 5, and 6*.

Table 4. *The final dominance matrix of social indicators*

Final dominancy	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6
Area 1	-	0	0	0	1	1
Area 2	0	-	0	0	1	1
Area 3	0	1	-	0	1	1
Area 4	0	1	0	-	1	1
Area 5	0	0	.	0	-	0
Area 6	0	0	0	0	1	-

Table 5. *The final dominance matrix of economic indicators*

Final dominancy	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6
Area 1	-	1	0	0	0	1
Area 2	0	-	0	0	0	1
Area 3	0	0	-	0	0	1
Area 4	1	1	1	-	1	1
Area 5	0	1	0	0	-	1
Area 6	0	0	0	0	0	-

Table 6. *The final dominance matrix of environmental indicators*

Final dominancy	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6
Area 1	-	1	1	0	1	1
Area 2	0	-	0	0	0	0
Area 3	0	0	-	0	1	0
Area 4	0	1	0	-	1	1
Area 5	0	0	0	0	-	0
Area 6	0	0	0	0	0	-

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Based on the results, two areas (4 and 1) have the maximum dominance, followed by areas 3, 2, 5, and 6, in that order.

Urban areas ranking by TOPSIS

For the current study, the relative closeness of each alternative to the ideal solution, in three categories (social, economic, and environmental), was calculated (*Table 7*).

Table 7. *Relative closeness of each alternative to an ideal solution*

Alternatives	Social indicators	Economic indicators	Environmental indicators	Overall closeness to ideal solution
Area 1	0.437	0.52	0.627	1.594
Area 2	0.437	0.349	0.207	1.083
Area 3	0.575	0.578	0.449	1.602
Area 4	0.537	0.913	0.579	2.029
Area 5	0.197	0.557	0.21	0.964
Area 6	0.319	0.196	0.361	0.876

According to the results obtained by this approach, Area 4, with a score of 2.029, is in better condition when compared to the others. Three urban areas (3, 1, and 2) are ranked second, third and fourth, with scores of 1.602, 1.594 and 1.083, respectively. The remaining areas (5 and 6), with scores of 0.964 and 0.876 scores, are ranked fifth and sixth grade, respectively.

Final ranking of urban areas

The final ranking result is based on the average of the ranks obtained from different methods (Momeni 2013). Accordingly, the final rankings of the six urban areas are shown in *Table 8*.

Table 8. *Final ranking results*

Area	MCDM methods			Averaged rank
	SAW	ELECTRE	TOPSIS	
Area 1	1	2	3	2
Area 2	4	4	4	4
Area 3	3	3	2	2.6
Area 4	2	1	1	1.3
Area 5	6	5	5	5.3
Area 6	5	6	6	5.6
Area 4 > area 1 > area 3 > area 2 > area 5 > area 6				

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Discussion

Based on this study, it is evident that different urban areas of Kermanshah city have different sustainability levels. Area 4 is listed as the first priority, followed by areas 1, 3, 2, 5 and 6, respectively. Due to the centrality of area 4, more social and public services, including health, culture, education, entertainment, sports, as well as city infrastructure and administrative buildings are located here. Area 1, which is predominantly occupied by the wealthy, is characterized by high economy; collaboration on environmental projects receives particular attention in this area (due to the location of the administrative section), and it is therefore more sustainable. In comparison, in two areas (2 and 3), the disorganized structure of streets and alleys leads to traffic problems, water and sewage-network-related accidents and difficulties in municipal waste management. Furthermore, Areas 5 and 6 are not well-developed due to rural migration, cheap land price and semi-rural structure. Overall, the main factors contributing to unsustainable conditions in six urban areas of Kermanshah are high unemployment rate, high solid waste production, unequal distribution of city services and infrastructures, the old structure of the city, inefficient public transportation system, lack of attention to renovation projects in older areas and social discrepancies.

Based on these limited factors, particular strategies need to be considered. These include the provision of basic services, decentralization, promoting public participation in urban planning, infrastructure establishment for proper development, building recreation and tourism centers in the city, enhancing relationship with Iraq, improving economic prosperity and reducing marginal jobs. It is further important to draw the attention of local, regional, and national planners towards creating a special economic zone in Kermanshah province, which can create various employment opportunities, and assist in the development of waste management programs and wastewater treatment plants, as well as improve public transportation, and increase green spaces across the city.

In the present study, the results from SAW, ELECTRE, and TOPSIS methods were compared using the Friedman test. Based on the sig (0/93) value, no meaningful difference was found among the methods. As seen in *Table 8*, areas 5 and 6, with the lowest sustainability levels are ranked similarly in all three methods. Areas 1, 3, and 4, with comparably superior sustainability levels were ranked high in all methods, while area 2 in ranked fourth in all of the methods. In the other words, all three applied methods have resulted in similar rankings.

It is probable that due to the use of a single method for weighting (Shannon’s entropy), the results achieved from all three methods were similar. This suggests that in the process of alternatives prioritization, the weight of indicators is more important than the method being used (Janic et al., 2002; Zareie et al., 2011). On the other hand, the three methods applied in this study belong to compensatory MCDM methods. These refer to methods where trade-offs between the indicators are allowed (XU et al., 2001); that is, a decline in one indicator's attributes is acceptable if it is compensated by an increase in another indicator's attribute. Thus, one of the characteristics of compensatory methods is the closeness among the rankings (Ebrahimi et al., 2014). Many previous studies have shown similar results in final rankings with the use of different MCDM methods, which corresponds to the current study (Chu et al., 2007; Hoshyar et al., 2011; Momeni et al., 2011; Shirouyehzad et al., 2011; Bordbar, 2013).

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Despite the similarity between the results obtained from the three different methods, the authors propose TOPSIS as the most suitable and practical method. This selection is based on the advantages and characteristics of this method as compared to the rest. The benefits of TOPSIS are listed below - (Srdjevici, 2004; Falsoleiman et al., 2013; Kolios et al., 2016):

- It is capable of merging several quality and quantity indicators simultaneously.
- The method is characterized by simplicity and high speed.
- The system function is desirable and acceptable.
- The desirability of applied indicators in solving a problem can be steadily increasing (or decreasing).
- The method allows changing the primary data, and subsequently, changing the functions and outcome.
- Prioritizing in this method is done based on similarity to the ideal solution, such that the final option will be close to the ideal answer and far from the wrong answer.
- In case some of the indicators are not desirable and need to be decreased, or some others are desirable and can be increased, TOPSIS can easily calculate the ideal solution through a combination of the best values obtained from all criteria.
- TOPSIS considers the best and the worst answers simultaneously, based on closeness to the ideal solution.
- The outcomes can express the priorities quantitatively.
- *Table 9* compares the specifications for the different methods.

Table 9. *Comparison of characteristics of methods (SAW, ELECTRE, and TOPSIS)*

No	Feature	TOPSIS	SAW	ELECTRE
1	Compared data type	Quality and quantity	Quality and quantity	Quality and quantity
2	Stability of the results	+	+	+
3	Simplicity	*	***	**
4	Intelligibility	*	*	**
5	Creditability	**	*	**
6	Flexibility	**	*	**
7	Applicability	*	*	**
8	Provide better results	*	*	**
9	Calculation precision	*	*	**
10	Providing details	*	*	**
11	Regarding the decision-maker	*	*	*
12	Sensibility to the weighting	***	*	*
13	Ability in pair comparison	+	-	-
14	The ability to analyze a large number of data	+	+	+
15	Ability to manage low quality input data	+	-	-
16	Computing speed	*	***	**

*(+ = have, - = does not have, * = low, ** = medium, *** = high)*
Source :(Duckstein et al., 1982; Goicoechea et al., 1982; Hobbs, 1986; Hobbs 1992; Srdjevici, 2004; Cavallaro et al., 2005; Caterino et al., 2008; Nikolic et al., 2009; Azar et al., 2010; Achilas et al., 2011; Aruldoss et al., 2013; Amoushahi et al., 2015; Falsoleiman et al., 2013; Hatami Marbini et a. 2013; Herva et al. 2013; Mohammadi Zanjirani et al., 2013)

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Conclusion

Multi-criteria decision making methods were applied to assess the sustainability of urban areas in Kermanshah city. In this research, the authors applied the ELECTRE, TOPSIS and SAW methods for the evaluation of sustainability of urban areas using 44 indicators at three social, economic and environmental aspects. In addition, The Friedman test showed there is no significant difference between these MCDM methods. The results showed that among the six urban areas, areas 4, 1 and 3 are more sustainable than the other areas. Totally, Kermanshah city is not at good condition and is far from sustainability. Therefore, in order to achieve sustainability, especially in more deprived areas, some strategies should be done such as creating jobs, more attention to economic in undeveloped areas, cultural solution and collaboration of people in environmental issues. Equal distribution and decentralization of services and allocating funds to poor areas must be considered. The study also pointed out the advantages and disadvantages related to the application of the selected methods and the TOPSIS method was preferred due to its advantages over the other methods.

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