

Situation Analysis of Cities in Ardabil Province in Terms of Health Indicators

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Abstract. Regional planning's and development policy objectives seek to identify the disadvantaged and underdeveloped regions in order to obtain proper national and regional strategies for their development and consequently reduce inter-regional and intra-regional disparities between them; hence, this study aims at analyzing the improvement of the city of Ardabil province in the health sector so that it can be used for planning in the future. Because of the practical purposes and the nature of this study, the type of research that is used here is descriptive-analytic. The data were collected using documentary research and Statistical Yearbook. For organizing and analyzing the mathematics, Analytic Hierarchy Process (AHP) technique is used and the obtained rankings are all based on TOPSIS method. Moreover, using *Williamson's scattering coefficient, the unbalanced distribution of the services was identified and using cluster analysis,* the cities were clustered into three levels of developed, semi-developed, and non-developed with regards to the health care services available for them, and finally for a more efficient representation of them, some maps were drawn. Excel, SPSS, and ArcGIS software's were used in various stages of research. The outcomes illustrate that the city of Ardabil first class in terms of health indicators and Kosar city has ranked last. The results also demonstrate that more than half of the cities in Ardabil province are disadvantaged and in terms of health conditions, indexes are very instable. Finally, it is suggested that development plans based on these cities' level of developments should be executed and non-developed areas should be the first priority in development programs and projects as well.

Keywords: Development · Multiple attribute decision making · Ardabil province · Health indicators

1 Introduction

One of the main symptoms of underdevelopment is inequality in different aspects of a city. In fact, developed countries, in addition to the high economic and social indicators, have a relatively equitable distribution of income and opportunities [6]. In order to solve the problems of regional imbalance, the first step is to recognize and categorize areas in terms of how developed they are in social, cultural, and economic areas [8]. This gives the planners and policy makers a profound and better understanding of

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regional issues, and as a result can suggest policies and preparation of action plans, and thus accelerate the development of disadvantaged areas come into being [14]. Level of development is a way to measure regional development and it shows the difference in spatial, economic, social and cultural areas and distinguishes the status of each region in relation to the other in terms of the level of development measures. By using this, the formation of polar regions will be determined and finally in planning development areas, less developed regions need to be considered and the imbalance between areas will be prevented [3]. Among the different development indicators, health indicator is regarded as the most important indicator of progress in any country and the success of national development programs is largely tied on achieving fulfilling the objectives of this section. If the quality and quantity of health indicators in a society are high, and also they are distributed in a balanced way, there will be a relatively high amount of wealth and welfare in that society [18]. A glance at the country's health indicators over the past decade, on the one hand shows the rapid promotion and process of these indicators and on the other hand, it shows that in different regions and provinces, there are disparities among the indicators [12]. The health sector matters so much that the improvement of health indicators brings about the development of society and the promotion of human and social development in the country [17]. Multiple Attribute Decision Making (MCDM) is one of the most common methods of decision-making. These methods will ensure that the decision making process is a clean, rational and efficient process and improve the quality of decisions and evaluations. Multiple Attribute Decision Making refers to a process in which the evaluation or decision-making is performed based on different indices that might be even antithetic and since they can evaluate integrated index, is considered a useful tool at the disposal of the planners. By using this method, we can distinguish the cities of Ardabil province in terms of health indicators and point out to the differences in these cities and also we can determine each city's status in relation to the other in terms of their level of development. Consequently, in development planning areas, the poor and less developed areas, will receive more attention and it will also prevent the risk of regional imbalance. To this end, we used several methods to analyze the cities of Ardabil on the basis of eight health indicators so we can achieve a balance in the province in terms of health indicators and the areas are prioritized concerning the due attention that needs to be paid for them. In this study, we show that cities in Ardabil province can be ranked according to several health indicators. Besides, due to the geographical nature of these places, most of them are disadvantaged and in serious need of improvement. Using development plans and prioritizing these cities, we can help in the betterment of people's living conditions. It is of great importance in today's world because it addresses one of the major issues in environmental studies and urban planning.

1.1 Research Questions

According to the problem and the descriptive nature of this research, this study does not need any hypotheses and questions below make up the formation of this study.

- Concerning the health indicators, are the development of the cities in Ardabil province balanced?
- In relation to health indicators, which cities are developed and which cities are non-developed?

2 Literature Review

Many studies have been conducted throughout the world and in Iran to determine the levels of development of cities and the inequality between them. The most important ones are mentioned here:

Sayehmiri [9] in a study to rank the health situation of the city of Ilam, using numerical taxonomy and principal component analysis, have shown that concerning the health status in Ilam province, the cities of Ilam, Mehran, Darrehshahr and Dehloran are developed cities and Shirvan, Chardavol, Eivan and Abdanan are underdeveloped. Zangiabadi et al. [15] in a study entitled Analysis of the Degree Development of the Cities of East Azarbaijan Province, through TOPSIS and AHP models, have ranked the cities and finally presented strategies to achieve the desired balance. Tofighi et al. [13], in their study Ranking the Cities of West Azarbaijan province and How They Benefit from Structural Indicators of Health, applied Scalogram model in their research and have concluded that as far as the benefits from structural indicators of health are concerned, there is a large gap between the cities of West Azerbaijan province. Kalantari et al. [2] conducted a research study using TOPSIS technique titled Review and Assessment of the Health Care Services in Zabol and noted that the geographical distribution of health care centers in the city is imbalanced and is unable to meet the needs of people. Seydaei et al. [10], in their article The Analysis of Indicators of Health System in Kermanshah used TOPSIS, AHP, and cluster analysis for modeling and mentioned that none of the cities of Kermanshah are developed with regards to the health indicators. In their research to determine the degree of development of Yazd province cities with regards to their access to health care centers, Sarai et al. [19] applied Morris model and concluded that there is an unbalanced distribution in facilities and services in Yazd province. Tavakolinia et al. [20], analyzed the cities of Ardabil province in terms of regional development disparities in the health sector using VIKOR model and have reached the conclusion that concerning the level of development in health indicators these cities are not in a balanced state in such a way that the city of Khalkhal with a final score of 0.0924 (Greatly Developed) and Pars Abad with a final score of 0.9989 (Poorly Developed) ranked respectively the first and last in their study. Literature review shows that although extensive research has been done on the level of development of the cities in Iran including Ardabil province. The present study focuses on a different approach that can be utilized to differently analyze the cities in Ardabil province.

3 Research Method

The purpose of this study is practical and the purpose and method that is used here is descriptive-analytic. The data were collected by means of documentation, library method, officially released data and the press. To measure the development level of the cities in Ardebil province concerning health indicators, TOPSIS technique is used and AHP model is applied for weighting the indices. Moreover, for an uneven distribution of indicators in the cities, Williamson's scattering coefficient is employed and further took advantage of clustering analysis to categorize the cities with regards to their level of development. SPSS software is used to analyze the data and for graphical representation of the data ARC GIS is used. To learn more about the techniques and methods involved in this study, they are briefly introduced here.

AHP Technique. Analytic hierarchy process (AHP) is one of the most extensive multi-criteria decision aids [7]. It is a flexible, robust and simple approach to make decisions more easily in the absence of conflicting decision criteria where choosing between the available options are difficult [1]. This multi-criteria evaluation method was proposed for the first time by L. Saati in 1980 and has had many applications in science [16]. This technique allows us to compare our indices as a couple and measure each index's score in relation to the other [11]. The first step in AH is to create a hierarchy of the subject matter at hand in which the objectives, criteria, sub-criteria, options and the relationship between them is also demonstrated. The next Four steps in the AHP include: measurement of the criteria and sub-criteria, measurement of the options, calculating the final score and evaluating the logical inconsistency of judgments [2].

TOPSIS Techniques. TOPSIS model was introduced in 1981 by Huang and Yoon. This model is used to determine the rankings of one or more options over several criteria. Furthermore, the specified quality weights by the decision maker is normalized into a comparable scale. By defining a near zone coefficient, we can determine the rankings by calculating the distance from both *Positive* (*PIS*) and negative (NIS) ideal *solutions*. According to this method, the best and the worst condition may be determined for each indicator but we should bear in mind that the most appropriate option is the one with the shortest distance from the best condition and maximum distance from the worst condition. This way we can have the best solution for our problem [5]. The advantages of TOPSIS model include [22]:

1. The *simultaneous application* of *quantitative* and *quantitative criteria*;
2. It is a simple and fast method;
3. The *output* of the model *can determine the order of priority options*;
4. It has the criteria and indicators of the initial weighting coefficients;
5. The contrast and the match of the options are considered.

Williamson's Dispersion Coefficient: One of the basic methods to obtain local and regional disparities is the dispersion coefficient. Using this method, we can determine how far an indicator is imbalanced distributed among local and regional areas. In other words, to determine the spatial distribution of an index or inequality level of

development between different regions, Williamson's dispersion coefficient method is used. We can calculate this coefficient with the following equation:

$$cv = \frac{\sqrt{\sum_{i=1}^{n} \frac{(X_i - \overline{X})^2}{N}}}{\frac{\sum_{i=1}^{n} X_i}{N}}$$

In that equation, X_i, is the value of a variable in a particular area or region (index value of the area); $\overline{\chi}$ is the average value of the variable (mean index value of the area) and N shows the number of areas and regions. High values of CV represents extreme inequality in the distribution of indicators throughout the areas and regions [24].

Cluster Analysis: It is one of the most widely used quantitative methods in studying an area, in fact clustering is a way of leveling the regions, towns, villages and so on in such a way that the regions at a particular level are very similar to each other and are significantly different from other levels [23].

3.1 Introduction of the Study Area

Ardabil province with an area equal to 17867 km^2 (1.1% of the total area of the country), is located between the northern latitude of 37 45 to 39 42 and eastern latitude of 47 30 to 48 55 of the Greenwich meridian in North West part of Iran. The average height of this province is more than 1400 m above sea level in which the lowest point is in the height of 100 m and is located at ParsAbad and Bilesavar and its highest peak is Sablan with a *height* of 4,811 m above sea level. Ardabil province borders Azerbaijan from north, Gilan province from east, and West Azerbaijan from south. Also, according to the latest national distribution, the province is divided into 10 cities: Ardabil, Bilesavar, Pars Abad, Khalkhal, Sareiyn, Kosar, Meshkinshar, Moghan, Namin and Nir. This province has 29 districts, 26 cities and 71 rural districts (Fig. 1).

3.2 Introducing Variables and Indicators

Variable and indicators are one of the major components of assessing progress towards development [4]. Because not only the development levels of residential areas need an extensive series of indicators but also they are necessary in any scientific study. It should be noted that considering all aspects of scientific research is neither possible nor desirable. Therefore, proper selection of a limited number of indicators could lead us to more actual results [12]. The present study analyzes and evaluates the development level of cities in Ardabil based on 8 health indicator and in 10 cities of the province. The variables that were used in this research, have been turned into indicators and analyzed include the number of: specialist doctors, general practitioners, medical institutions, hospital beds, laboratories, pharmacies, pharmacist, and nurses.

Since the collection of information and data for the analysis of the study should be both official and trustworthy, the indicators that are used here are all accessible through

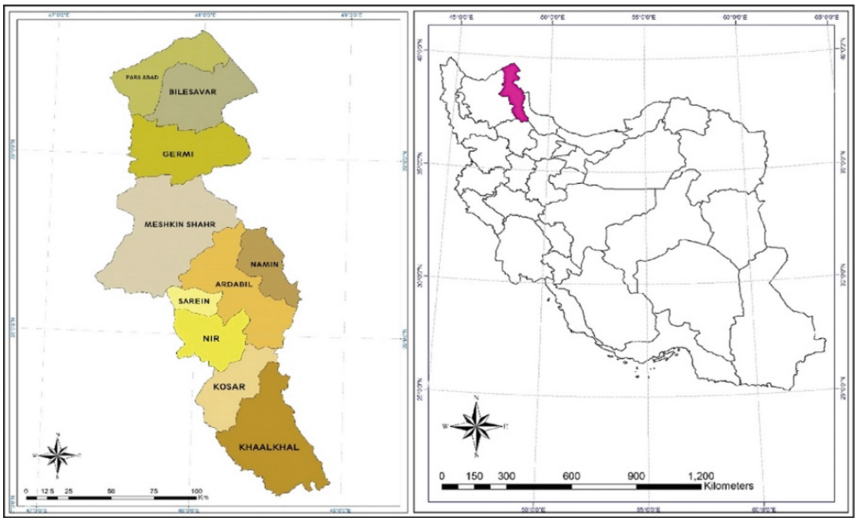


Fig. 1. Distribution of cities in Ardabil province

official statistical agencies. This way the accuracy of the information's presented in this paper is approved. Table 1 contains both the classification and the description of indicators used in this study:

Table 1. Raw data of health indicators for each city in Ardabil Province based on Statistics in 2017

City	Population	No. of specialist doctors	No. of general doctors	Number of medical institutions	Number of medical beds	Number of laboratory	Number of pharmacies	Number of pharmacists	Number of nurses
Ardabil	564365	269	100	174	1416	25	83	9	709
Bilesavar	53768	7	12	3	36	1	4	0	32
Parsabad	173182	41	14	12	224	6	16	1	117
Khalkhal	92332	17	33	9	113	3	7	1	145
Sareyn	18231	2	7	1	0	0	1	0	5
Kosar	26198	2	10	1	0	0	1	0	6
Germi	84267	12	12	5	96	2	6	1	82
Meskinshahr	151156	34	33	20	153	3	13	2	110
Namin	61333	3	29	4	50	1	3	1	22
Nayyer	33656	2	15	1	0	0	1	0	7
Total	1172647	385	265	230	2043	41	135	15	1136

Source: Statistics of Ardabil Province in 2017.

4 Findings

Given that the techniques and processes along with their data are not separately provided here, the steps of the proposed model are explained with the research data so that identifying the level of development and the areas in relation to health indicators will be easy to understand for the readers:

Step 1: Formation of matrix data based on alternative m and indicator n (Table 2). It should be noted that the division of variables and constants results in an appropriate denominator [21]. In this study the appropriate denominator for converting variable into an indicator is considered 10,000.

$$A_{ij} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ . & & & . \\ . & & & . \\ . & & & . \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix}$$

Table 2. Matrix of health indicators in Ardabil (per ten thousand)

City	No. of specialist doctors	No. of general doctors	Number of medical institutions	Number of medical beds	Number of laboratory	Number of pharmacies	Number of pharmacists	Number of nurses
Ardabil	4.77	1.8	3.08	25.1	0.44	1.47	0.16	12.56
Bilesavar	1.3	2.23	0.56	5.7	0.18	0.74	0	5.96
Parsabad	2.37	0.81	0.7	12.93	0.34	0.92	0.05	6.75
Khalkhal	1.84	3.57	0.97	12.24	0.32	0.75	0.1	15.7
Sareyn	1.1	3.84	0.55	0	0	0.55	0	2.74
Kosar	0.76	3.82	0.38	0	0	0.38	0	2.3
Germi	1.42	1.42	0.6	11.4	0.23	0.71	0.11	9.73
Meskinshahr	2.25	2.18	1.32	10.12	0.2	0.86	0.13	7.28
Namin	0.49	4.73	0.65	8.15	0.16	0.49	0.16	3.59
Nayyer	0.84	6.34	0.42	0	0	0.42	0	2.96

Source: Author's calculations for turning data into indicators

Step 2: Standard Matrix Formation Without Scale (Table 3).

$$r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{k=1}^{m} a_{kj}^2}} \quad R_{ij} \rightarrow \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ . & & & . \\ . & & & . \\ . & & & . \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}$$

Step 3: Determining the weight of each indicator by the following equation:

$$\sum_{i=1}^{n} W_i = 1 \rightarrow V_{ij} = \begin{bmatrix} W_1 r_{11} & \cdots & W_n r_{1n} \\ \vdots & \ddots & \vdots \\ W_1 r_{m1} & \cdots & W_n r_{mn} \end{bmatrix}$$

Table 3. Standardized matrix of health indicators for cities in Ardabil

City	No. of specialist doctors	No. of general doctors	Number of medical institutions	Number of medical beds	Number of laboratory	Number of pharmacies	Number of pharmacists	Number of nurses
Ardabil	0.72	0.16	0.81	0.7	0.58	0.59	0.53	0.48
Bilesavar	0.19	0.2	0.14	0.18	0.24	0.29	0	0.23
Parsabad	0.35	0.7	0.18	0.35	0.45	0.36	0.16	0.26
Khalkhal	0.28	0.32	0.25	0.34	0.42	0.3	0.33	0.6
Sareyn	0.16	0.35	0.14	0	0	0.22	0	0.1
Kosar	0.11	0.34	0.1	0	0	0.15	0	0.08
Germi	0.21	0.12	0.15	0.31	0.3	0.28	0.4	0.37
Meskinshahr	0.34	0.2	0.34	0.28	0.26	0.34	0.43	0.28
Namin	0.07	0.43	0.17	0.22	0.21	0.19	0.53	0.13
Nayyer	0.12	0.57	0.11	0	0	0.16	0	0.11

Source: Author's Calculations

As mentioned earlier, in the present study AHP technique is used to calculate the weight of each indicator. Table 4 shows the obtained weights of the indicators.

Table 4. Indicators' weight investigated in this study

Indicator	No. of specialist doctors	No. of general doctors	Number of medical institutions	Number of medical beds	Number of laboratory	Number of pharmacies	Number of pharmacists	Number of nurses
Weight	0.089	0.061	0.111	0.194	0.182	0.35	0.25	0.08

Source: Research findings

After calculating the weight of each indicator, standard values are multiplied in their weight and weighted matrix is formed. (Table 5).

Table 5. Weighted matrix without scale

City	No. of specialist doctors	No. of general doctors	Number of medical institutions	Number of medical beds	Number of laboratory	Number of pharmacies	Number of pharmacists	Number of nurses
Ardabil	0.064	0.01	0.089	0.133	0.104	0.021	0.133	0.038
Bilesavar	0.017	0.012	0.015	0.034	0.43	0.01	0	0.018
Parsabad	0.031	0.043	0.02	0.066	0.081	0.013	0.04	0.021
Khalkhal	0.025	0.019	0.027	0.064	0.076	0.01	0.082	0.048
Sareyn	0.014	0.021	0.015	0	0	0.008	0	0.008
Kosar	0.01	0.021	0.011	0	0	0.005	0	0.08
Germi	0.019	0.007	0.016	0.059	0.054	0.01	0.1	0.03
Meskinshahr	0.03	0.12	0.037	0.053	0.047	0.012	0.107	0.022
Namin	0.006	0.026	0.019	0.042	0.038	0.007	0.132	0.01
Nayyer	0.011	0.035	0.012	0	0	0.006	0	0.009

Source: Research findings

Step 4: To determine distance i from the highest performance of any indicator which is shown by A is determined as follows (Table 6):

Table 6. Calculation of the highest and lowest performance of any indicator

	Number of nurse	Number of pharmacists	Number of pharmacies	Number of laboratory	Number of medical beds	Number of medical institutions	General practitioner	Specialist doctors
A^*	0.048	0.132	0.021	0.104	0.133	0.089	0.043	0.064
A^-	0.006	0	0.006	0	0	0.011	0.007	0.006

Source: Research findings

$$A^* = \{(\max v_{ij} \mid j \in J), (\min v_{ij} \mid j \in J') \mid i = 1, 2, \ldots m)\} = \{v_1^*, v_2^*, \ldots, v_j^*, \ldots, v_n^*\}$$

Step 5: To determine the lowest performance of any indicator which is shown by (A^-) is determined as follows:

$$A^- = \{(\min v_{ij} \mid j \in J), (\max v_{ij} \mid j \in J') \mid i = 1, 2, \ldots m)\} = \{v_1^-, v_2^-, \ldots, v_j^-, \ldots, v_n^-\}$$

Step 6: To determine the criteria of distance for the minimum and maximum alternative, the following formula is used:

$$s_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^-\right)^2} \qquad s_i^* = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^*\right)^2}$$

For each of the cities in Ardabil, the distance criteria for the maximum and minimum alternatives were calculated (Table 7).

Table 7. The determined distances from the maximum and minimum alternatives and their difference from these alternatives

City	S_i^*	S_i^-	City	S_i^*	S_i^-
Ardabil	0.034	0.24	Kosar	0.239	0.014
Bilesavar	0.201	0.058	Germi	0.134	0.131
Parsabad	0.142	0.122	Meskinshahr	0.126	0.134
Khalkhal	0.119	0.138	Namin	0.151	0.145
Sareyn	0.237	0.017	Nayyer	0.214	0.029

Source: Research findings

Step 7 and 8: At this stage a coefficient which is equal with the division of minimum and maximum alternative is obtained. In other words, a relative vicinity of (Ai) to (A*) was calculated as follow: $C_i^* = \frac{S_i^-}{S_i^- + S_i^*}$

After calculating the distance criteria, priority coefficient (C_i^*) for each city were calculated (Table 8). The value of C_i^* fluctuated between zero and one. In this regard $C_i^* = 1$ represents the maximum alternative and $C_i^- = 0$ represents the minimum alternative.

Table 8. Calculation and rankings of the cities based on the results from TOPSIS technique

City	c_i	Rank	City	c_i	Rank
Ardabil	0.876	1	Parsabad	0.462	6
Khalkhal	0.537	2	Bilesavar	0.224	7
Meskinshahr	0.504	3	Nayyer	0.119	8
Germi	0.494	4	Sareyn	0.067	9
Namin	0.49	5	Kosar	0.055	10

Source: Research findings

According to the final coefficient of each city concerning their level of development of health indicators, it is revealed that the cities of Ardabil, Khalkhal, Meshgin Shahr ranked respectively first to third and the cities of Nir, Sarein and Kosar had the lowest rankings. Figure 2 is a geographical demonstration of these information's.

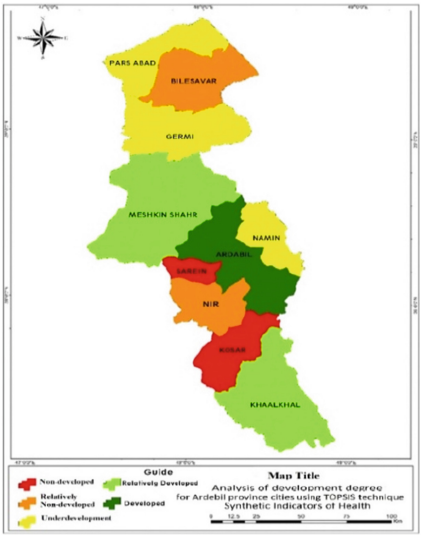


Fig. 2. The rankings of cities in Ardabil based on health indicators

Also, the output from Williamson's dispersion coefficient shows 0.159. As noted, this coefficient is an indicator that determines to what extent an indicator is imbalanced distributed between regions or areas. The indicators are between zero and one. If the obtained number tends to be closer to zero, it shows a reduction of regional disparities

[24] and in the case of our research it also shows the balance and relative equality of the cities in Ardabil concerning their development of health indicators.

Furthermore, the classification for the cities in terms of homogeneity in developed or non-developed health care services and standard score variables, cluster analysis was used. The results obtained from cluster analysis in SPSS software shows the cities in three separatecategories. These categories are shown in Fig. 3.

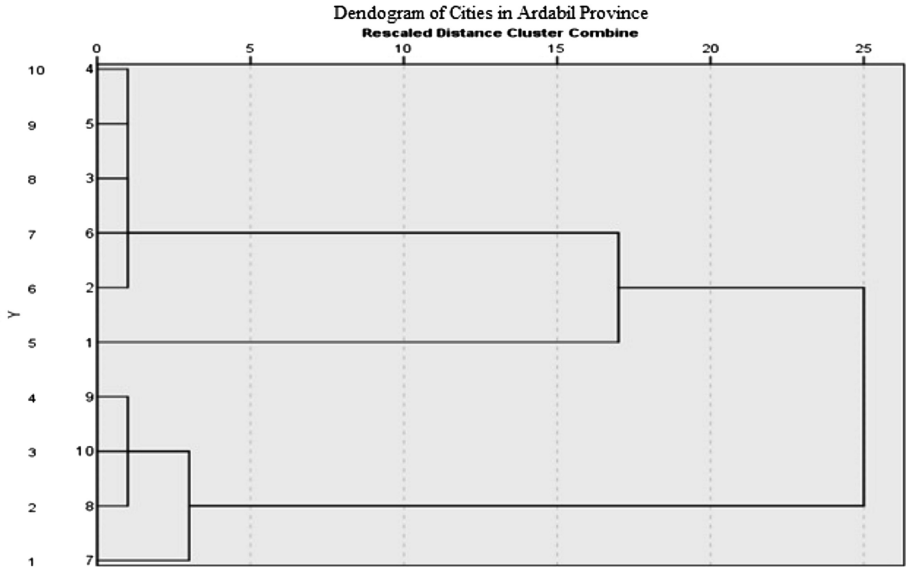


Fig. 3. Tree diagram of cities in Ardabil based on cluster analysis

Tree diagram (dendrogram) demonstrates the classification of cities in Ardabil concerning their homogeneity in their development of health indicators and in this regard the cities of Bilesavar, Nir, Sareyn and Kosar are in the first cluster (non-developed) and the city of Ardabil alone is in second cluster (developed). Khalkhal, Pars Abad, Meshgin Shahr, Namin and Germi are in the third cluster (relatively-developed). Using GIS software, the results of these clusters and their level of development are shown in Fig. 4.

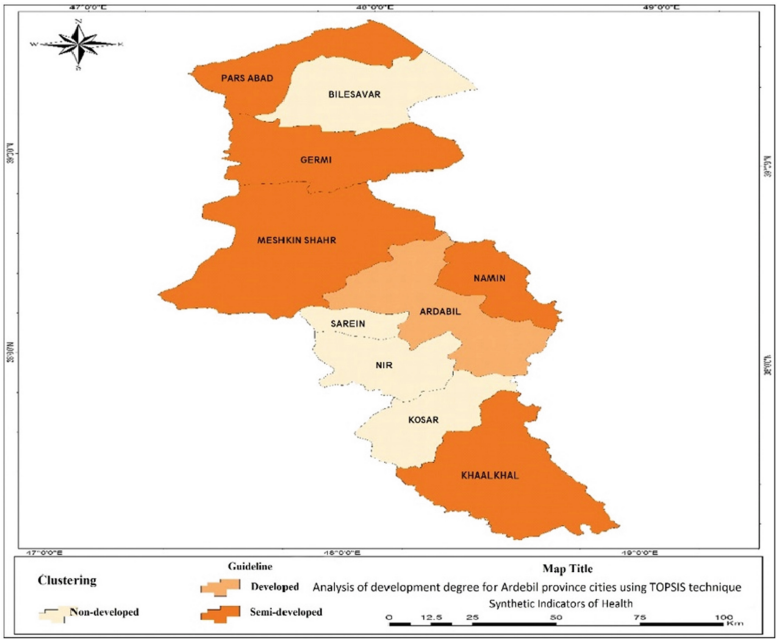


Fig. 4. City clustering in Ardabil

5 Conclusion

Scientific and efficient decision making with regard to prioritization of regional issues, increases the success rate of regional initiatives and policy development programs and using the multi-criteria decision-making models can facilitate the decision-making process.

Desirable access of people of different regions to the facilities and health services are considered important indicators in increasing the quality of life and sustainable development of human societies. Moreover, improving the health status of citizens in each city or region is one of the major reasons of human development. Hence, the present study aimed to assess the state of health indicators, analyzed 8 indicators in Ardabil province using AHP and TOPSIS model and then the inequality rate in the distribution of health services were determined through the dispersion coefficient and with the help of cluster analysis which is one of the methods for identifying homogeneous areas, the current situation of the cities was analyzed. The results (based on the dispersion coefficient analysis) indicates that in terms of the level of development of health indicators, the cities in Ardabil province are relatively balanced. In addition, the results from TOPSIS model shows that with regards to health indicators the city of Ardabil with a final score of 0.876 and the city of Kosar with a final score of 0.055 are respectively highly developed and non-developed areas in the province. Also, the results of cluster analysis showed that the cities of Bilesavar, Kosar, Sarein, as well as Nir are the most non-developed areas and all are placed in a homogeneous category.

Due to the dramatic improvements in health care services on the one hand and increased demand for health services and lack of balance between the needs and the provision of services on the other hand, the priority was to invest in the provision of essential health services. In this regard, the four cities of Bilesuar, Kosar, Sareyin, as well as Nir should be the top priority of developmental programs of health indicators in the province.

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