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Research Article

Studying the Development of Rural Areas in Kohgiluyeh and Boyer-Ahmad Province Using PROMETHEE Method

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Abstract

Purpose- The cities of Kohgiluyeh and Boyer-Ahmad province are in a deplorable condition in terms of rural development indices. The proper planning for optimal allocation of resources requires the analysis of development indices in the province, so that we can attain balanced and exhaustive development by capitalizing on existing forces and capacities of the cities to bring about prosperity and happiness for all people. In the present study, in order to identify the current status of development in the province and its rural areas, we have used eight effective criteria and 40 items (sub-criteria) to identify and classify rural areas in this city and rural areas.

Design/methodology/approach- This is a descriptive-analytical study with an applied approach that adopts a regional approach to the geographical area. In order to model the level of development, according to the goals of the research, the development indices of the province were collected based on library resources. After identifying and reviewing the study indices, the weight of each index was determined based on the mathematical models used in the PROMETHEE decision making method. Finally, the results were entered in GIS software and the output maps were drawn.

Findings- The results suggest that Boyer-Ahmad city with the highest net output flow is highly developed, followed by Basht and Lande cities.

Originality /Value- This paper is categorized as new rural studies as it investigates 602 villages in Kohgiluyeh and Boyer-Ahmad province using a PROMETHEE decision-making method. The results of this study can have many implications for rural planning researchers.

Key words- Kohgiluyeh and Boyer-Ahmad province, PROMETHEE method, Rural areas, Development indicators, Rural development leveling.

Paper type- Scientific & Research.

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1. Introduction

In the process of planning and development of rural areas, it is necessary to identify and analyze the current status of villages and study their facilities and challenges in various fields in order to guide the planners in setting the development goals and determining appropriate policies and strategies. In this process, determining the levels of rural development and evaluating the strengths and weaknesses of each region in economic, social, cultural and physical areas lay the ground for optimal allocation of resources and facilities for harmonious, integrated and balanced development of villages (Fathollahzadeh & d Mehdizadeh, 2013). There are several ways to classify and rank regions, all of which are intended to alleviate regional inequalities. In addition to natural, economic, and social characteristics, such inequalities are influenced by politics and planning strategies.

The planners have developed several techniques and methods to identify and analyze the causes of inequality and regional differences by exploring the degree of development and ranking of regions (Nazmafar & Ali Bakhshi, 2017). One of these decision-making methods is PROMETHEE, which considering its hybridity and expansion potentials at various national, regional, urban and rural levels, can have multiple applications in assisting and advising the planners and authorities at diverse levels of decision making.

In the present study, in order to identify, analyze and model the development of rural areas in eight cities of Kohgiluyeh and Boyer-Ahmad provinces, 40 effective and accessible indicators were developed based on valid scientific and statistical documents and resources including 2016 population and housing census, statistical yearbooks, and population statistics of villages as well as the resources obtained from the administrative centers and institutions of the province

The cities of Kohgiluyeh and Boyer-Ahmad province are in deplorable conditions in terms of rural development indices. Hence, proper planning for optimal allocation of resources calls for the analysis of the extent of development in provincial regions, so that we can achieve balanced and inclusive development by tapping on existing forces and capacities in the cities and consequently bring prosperity for all people. The main question raised in this study is "What is the level of development of rural areas in cities of Boyer-Ahmad, Kohgiluyeh, Gachsaran, Dena, Bahmaei, Basht, Charam and Lande in Kohgiluyeh and Boyer-Ahmad provinces?"

2. Research Theoretical Literature

2.1. Rural Development and its Characteristics

Rural development describes proper and efficient management and operation of basic, natural, financial and human resources of the rural areas to achieve a suitable and desirable consumption pattern and to employ the technical facilities that meet the demands of the present and future generations (Falsoleiman, Mekaniki & Eghtedari, 2019). Traditionally, rural development has focused on the use of natural land resources such as agriculture and forestry. Anyway, changes in global production networks and growing urbanization have altered the characteristics of rural areas. Tourism, special products, and alternative entertainment, resource extraction and agriculture are the main economic drivers of these areas (Ghaffari & Salehi, 2013).

Development indices are statistical criteria that describe the status of diverse dimensions of development in an abridged but comprehensive manner. Agricultural development, industrial development, services, infrastructure, educational and health indicators are examples of development indices (Kalantari, 2010). In most of previous research, a multi-criteria decision-making model has been used to investigate indicators in various economic, social, cultural, industrial, service, educational, infrastructure dimensions. For each of these indices, separate sub-indices could be defined. In this study, eight main indices and 40 sub-indices have been used as follows:

- Demographic index includes population, literate population, employed and unemployed population;
- Healthcare Index includes health centers and health houses, mortuary, sewage system, veterinarian, physician;
- Business-service index includes cooperative stores, bank, fuel station, bakery, grocery store and kerosene distribution center;
- Cultural-sport index includes rural park, public library, play grounds and gym;

- Infrastructure utilities index includes water, electricity and gas;
- Political-administrative index includes Islamic Council, Dehyari, Agricultural Service Center, police station;
- Scientific-educational index includes kindergarten, primary school, boys middle school, girls middle school, boys high school, girls high school, vocational high school and technical and vocational high school;
- And, communication and transportation index includes access to post office and post boxes, telecommunication office, access to public transport, Internet connectivity, asphalt road, dirt road, rural master plan;

2.2. Rural Development Ranking

Through the ranking of rural areas, it is possible to determine the status of development and deprivation. One of the benefits of this ranking is providing an extended and integrated hierarchy of rural service centers. It provides access to a wide range of functions for a number of people, allowing a comparison of the level of regional development in different areas in order to identify possible causes of underdevelopment (Badri, Akbarian & Jawaheri, 2006). What is meant by ranking is the hierarchical position of villages based on diverse indicators of sustainable development, which merges environmental, social and economic dimensions. In fact, ranking is a type of hierarchical grouping of identical phenomena, which is performed based on a set of criteria or characteristics and evaluates the status of each criterion relative to others. Grouping at the classification is designed as a statistical tool, which is intended to provide a framework for analyzing and presenting a broad range of generalizable data (Ziaian, Firoozabadi & vallahie 2015).

2.3. Rural Development Models

The adoption of quantitative criteria and methods to rank settlements in the spatial system of regions not only leads to the unraveling of inequalities in settlements, but also serves as a measure of mitigating and eliminating the existing inequality (Ziari, Zanjirchi & Sorkh Kamal, 2010). The wave of adopting quantitative models began during the 1960s, along with the issues related to the level of development, which extended the application of these methods to determining the level of regional development.

Since this decade onward, mathematical models coupled with the application of various quantitative models and different statistical methods and prevalent use of computer software stimulated the desire of politicians, planners and geographers to adopt these techniques in the logical justification of their choices (Badri & Akbarian Ronizi, 2006). Regional ranking based on the level of development is often viewed as a multi-criteria decision-making issue in terms of socio-economic development, which could be addressed in a variety of manners. In these models, the decision maker seeks to choose the best option according to the desired purpose and the characteristics and criteria of the study. These models, which have multiple applications in ranking issues, are also known as ranking models (Akbari & Zahedi Kivan, 2008). With regard to assessing and determining the level of development, there are a variety of methods and techniques to organize and evaluate information, depending on the credibility and trustworthiness of the information and the skill of the programmer (Badri et al., 2006).

2.4. Research Background

Many studies have explored extent of rural development using multi-criteria decision-making models in Iran and other countries. In these studies, various technologies such as geographic information system (GIS), questionnaires, and multi-criteria decision-making models have been used. Some of these studies are as follows.

Lee & Hong (2007) performed a sustainable analysis of Chinese Taipei by selecting 51 indices, concluding that these indices were dissimilar in terms of sustainability. Environmental and social indices move in the direction of sustainability, while economic and institutional indicators are relatively unstable. Soares, Marquês & Monteiro (2003) proposed a method to classify different regions of Portugal in an attempt to support regional development policy. This ranking was based on multivariate statistical techniques of factor analysis and cluster analysis using 33 economic, health, educational and cultural indicators.

In another study identified regional inequalities in Romania using the model of variance analysis and dispersion analysis. They showed that in terms of social and health indices, there were significant differences between Bucharest, the Romanian

capital, and other parts of the country. Polednikova (2014), in a survey of some EU countries using the multi-criteria decision-making method, TOPSIS and sensitivity analysis, illustrated that there was growing inequality between EU countries in terms of urban and rural development indicators, and this inequality was more pronounced in some regions.

In a critical and analytical study based on 14 factors affecting the development of rural areas in the Czech Republic, Straka and Tozova (2016) reported that although there were several indices for identifying and ranking development in rural areas, there were no identical indices to describe rural development. Mosayebi, Barghi, Rahimi, & Ghanbari (2017) investigated the prioritization of development strategies in rural areas by adopting a sustainable development approach to villages in the northwestern region of Isfahan province using four categories of economic, social, physical-spatial, environmental indicators. They also examined the impact factor of these indices by AHP technique and PROMETHEE method. The results suggest that among above indicators, the index of creation and expansion of new jobs, facilities and infrastructure, and adaptability with regional potentials are of the utmost importance. On the other hand, based on these indicators and according to the strategies selected by experts, it turned out that the strategy of tourism development planning and public participation strategy was ranked first among the optimal rural development strategy. (Aliaei and Azizi 2018), used a descriptive-analytical approach to investigate and analyze the level of development of villages in Vakilabad village using 37 indices in three environmental, socio-cultural and economic dimensions through factor analysis and GIS. The results suggest a significant difference between the villages of this village in terms of the level of development, which could be ranked in three groups consisting of high level of development, medium level of development and low level of development.

Sojasi Qeydari, Sadeghloo & Mahmoud (2009) conducted a study based on VIKOR model to rank villages based on bioavailability indicators in Nezamabad rural district of Azadshahr city. They found that the villages of Ghorychai and Haji Nabi had the lowest rank based on 16 biodegradability indices in the studied rural areas, while the villages of Aqchali, Alia and Bahram Sufi had the highest rank.

Development indices are statistical criteria that describe the status of different dimensions of development in an abridged but comprehensive way. Agricultural development, industrial development, services, infrastructure, educational and health indices are examples of development indices (Kalantari, 1998). In most of previous research, a multi-criteria decision model has been used to examine indices in various economic, social, cultural, industrial, service, educational, and infrastructure domains for each sub-indicator.

There are several reasons that corroborate the originality of the present study. With regard to the study of rural planning in Iran, few studies have adopted PROMETHEE decision-making method. In 2013, a special software for this decision-making model called Visual PROMETHEE was introduced. This software has several advantages, which highlight the importance of this decision-making model for planning development in rural areas. Some of these advantages are listed below.

1. Practical features and graphical analyses with specific color schemes;
2. Ability to examine thousands of indices and options;
3. Different analysis features such as GIS and Web, which offer planners a broader view of the area;
4. Possibility of considering the views of all experts up to thousands of experts and questions;
5. Providing access to analyses related to the quality and risk of the project; ability to compare numbers along with quantitative and quantitative weights;
6. Comparison of positive and negative criteria for analysis irrespective of their number; Ability to employ six preference functions for comparison under different conditions and regions;
7. Combining PROMETHEE decision making method and GIS;

Other innovations of this research include studying a statistical population of 277569 people, 602 villages with a population of over 100 people in 45 counties and 8 towns, which is unprecedented in Iran in terms of its large statistical samples.

Kohgiluyeh and Boyer-Ahmad is among the deprived provinces of Iran, and even though most of the natural areas of the province are located in rural areas, rural residents have difficult living conditions. Since a large portion of the province's

resources and services are unequally distributed, it is very important to study the development of rural areas in this province, as it presents a novel dimension that can contribute to proper planning.

2. Research Methodology

2.1 Geographical Scope of the Research

Kohgiluyeh and Boyer-Ahmad Province is located in the southwest of Iran with Yasuj as its capital. It is surrounded by Chaharmahal and Bakhtiari province in the north, Fars and Isfahan provinces in the east, Fars and Bushehr provinces in the south and Khuzestan province in the west. With respect to geographical coordinates, this province is located between 30 degrees and 8 minutes and 30 seconds to 31 degrees and 29 minutes and 45 seconds latitude and between 49 degrees and 52 minutes and 35 seconds to 51 degrees and 41 minutes and 22 seconds longitude. With an area of 15504 square kilometers, according to the latest national administrative divisions in 2016, it comprises eight cities (Boyer-Ahmad, Kohgiluyeh, Gachsaran, Dena, Bahmaei, Basht, Charam and Lande) ((Kohgiluyeh and Boyer-Ahmad Provincial Management and Planning Organization, 2014:98). According to the official report, the population of the province in 1996 was 713052 people. As noted in the 2016 General Population and Housing Census, approximately 186,320 households live in the province, of which 103,270 households settle in urban areas and 82,558 households in rural areas and there are 492 non-resident households. According to the latest administrative divisions in the same year, the province consists of 8 cities, 17 towns, 19 districts, 45 villages, 1643 inhabited settlements and 595 uninhabited settlements (Kohgiluyeh and Boyer-Ahmad Provincial Management and Planning Organization, 2017).

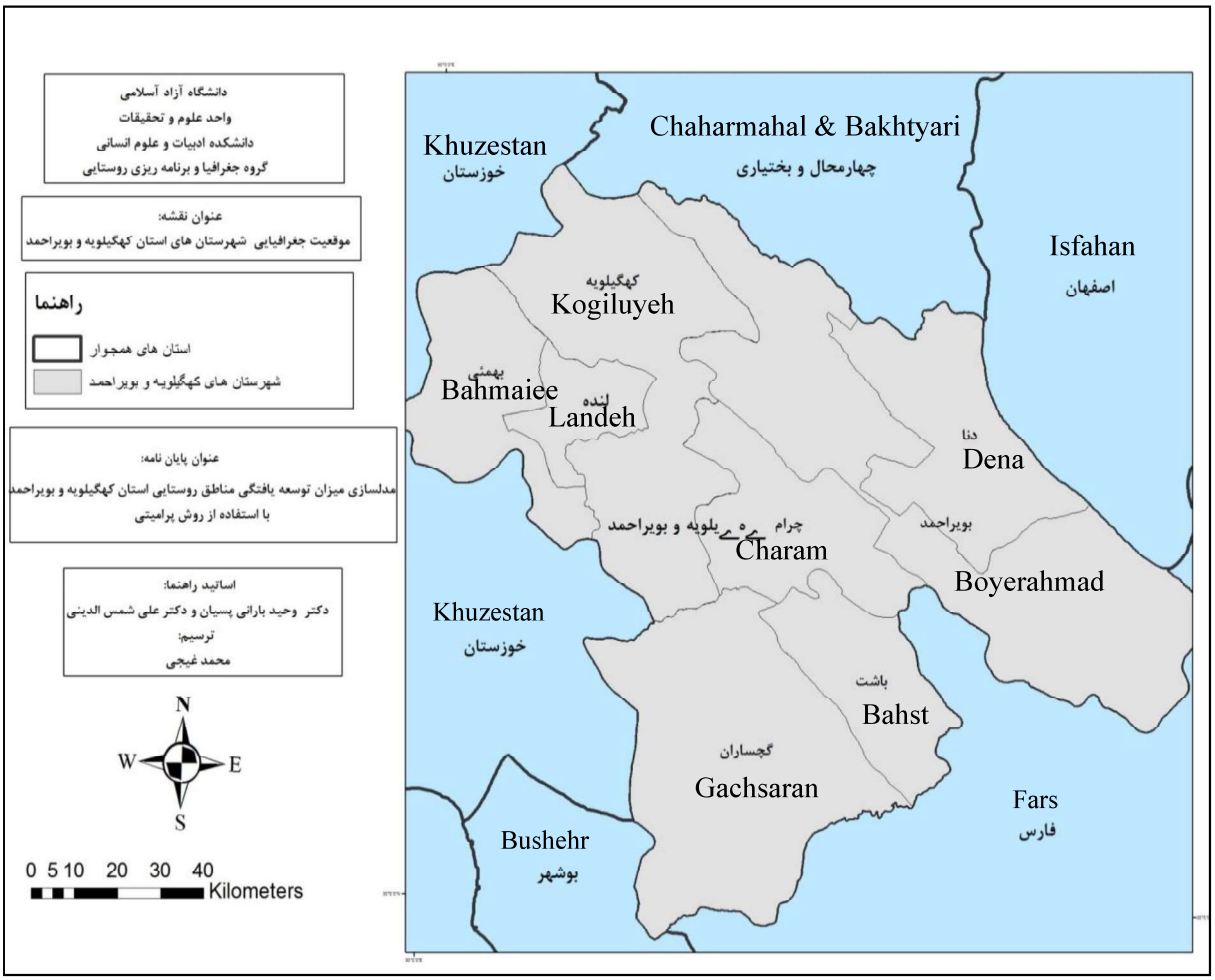

Figure 1. Kohgiluyeh and Boyer-Ahmad province's location map

3.2. Methodology

This is a descriptive-analytical study that falls in the category of applied research in terms its goals. To model the level of development, based on the research objectives, the development indices of the province were collected using library resources. After identifying and reviewing the main indices of the research, we first determined the weight of each index based on the mathematical models used in the PROMETHEE decision making method, and then entered the results to GIS software to draw the output maps.

2.3. Data Analysis Method

The PROMETHEE decision-making method was first introduced by two Belgians, Jean-Pierre Brans and Bertrand Mareschal, in 1982 at a conference at Laval University (shojaeian, , Omidypour & Moradi, 2014:185). Among the main advantages of this method are its simplicity, clarity and reliability of the results. This method can apply the evaluation process to a limited set of restricted alternatives, as a partial or complete ranking. It contains the obvious effect of each criterion and its weight on answers, the high efficiency of the algorithm adopted in this method despite its simplicity and reliance on the positive (Max) or negative criteria (Min), as well as positive and negative prioritization or net ranking flow, which are known as optimal and non-optimal solutions, or similarity index in models such as fuzzy TOPSIS and TOPSIS (Shojaeian & Moradi, 2015). Various models of this method have been proposed to investigate decision-making problems, including the partial ranking of options, complete ranking of options, ranking based on a sustainable range for continuous modes and resolving decision problems with constraints, which are labeled as sensitivity analysis in the tool (Daripoor & Moradi, 2017). One feature of this model is calculating copious views and criteria relative to each other. Features such as spider web analysis (GAIA Web) constitute other features of the software. Despite PRO map analysis, this model does not suffer from drawbacks such as qualitative or quantitative criteria so that the decision maker is able to quantitatively and qualitatively compare some criteria in a matrix by assigning a weight of 1 to 9 in the AHP model and Expert Choice software or a weigh of 1 to 5 in the TOPSIS model, regardless of the quantitative or qualitative nature of criteria. Another feature that distinguishes this model is passivity of using Yes and No weighting for the comparison of indices (Shojaeian & Moradi, 2019).

4. Research Findings

The PROMETHEE method requires a generalized criterion be linked to each index fj (j = 1,2,3,…,k). To do so, a set of six instances of generalized criteria are presented to the decision maker, which are numbered from I to VI. Therefore, an effective choice is obtained through the interaction of the decision maker and the analyst's agreement on understanding the degree of preference (Shojaeian et al., 2014:26). In this method, six generalized criteria for the preference function are suggested to the decision maker, which include Usual, U-shape, V-shape, Level, Linear, and Gaussian criteria (Daripoor & Moradi, 2016). In the PROMETHEE model, options are ranked based on paired comparison in each index. The comparison is made on the basis of a predefined preference function in the range of [0, +1]. The P preference function is used to compare options a and b in terms of index j (Daripoor & Moradi, 2017:114).

$$P_j(a,b) = P_j[d_j(a,b)]$$

e

Step 1. In the first step, we need to differentiate each of the options based on the following relationship.

$$(a,b) = f_j(a) - f_j(b)$$

Step 2. The preference of each option over other options: after calculating the difference of options, the value of $PP_j(ab)$ is obtained.

Step 3. Total balanced preference of options:

$$\pi(a,b) = \sum_{j=1}^{k} w_j\, p_j(a,b)\ , \qquad (\sum_{j=1}^{k} w = 1)$$

Step 4. Obtaining a positive and negative ranking flow: Options can be ranked with a positive or negative flow.

Positive ranking flow or output flow: It indicates the priority of option A over other options. The largest $\phi^+(a)$ reveals the best option.

Negative ranking or input flow: It indicates the priority of other options over option A. The smallest $\phi^+(a)$ represents the best option.

$$\phi^{+}(a)=\frac{1}{n-1}\sum_{x\in A}\pi=(a,x)$$

$$\phi^{-}(a)=\frac{1}{n-1}\sum_{x\in A}\pi=(a,x)$$

Step 5. Calculating Ranking Net flow: This indicates a balance between positive and negative ranking flows with a higher net flow showing a preferred option.

Step 6: Complete ranking of PROMETHEE II. In this method, a balance is established between positive and negative external ranking flows. The net flow indicates a preferred choice. The complete ranking of options (PROMETHEE II) is defined as follows and the preferred (P) relations and partial ranking of options are determined (Daripoor, Moradi & Mansouri, Z. 2016:28). The most important output of the PROMETHEE method is shown in Table (1). In this figure, the software automatically normalizes all the data and statistical information extracted in the form of eight indicators and forty sub-indicators or items. In this ranking, which was performed for eight cities by comparing 40 indices, Boyer-Ahmad city obtained the highest net output flow and the lowest negative output flow. The city of Lande also had the highest negative output flow and the lowest positive output flow. This ranking was based on the net flow of the city or option (Boyer-Ahmad, Kohgiluyeh, Gachsaran, Dena, Bahmaei, Charam, Basht and Lande).

Table 1. Net, positive, negative and output ranking flows for Kohgiluyeh and Boyer-Ahmad province
(Source: Research Findings, 2020)

Level of development	Negative output flow (Phi-)	Positive output flow (Phi+)	Net output flow (Phi)	Town	Development rank
Very developed	0.0788	0.9113	0.8325	Boyer-Ahmad	1
Developed	0.2118	0.7488	0.5369	Kohgiluyeh	2
	0.3842	0.5813	0.1970	Gachsaran	3
Moderate	0.3793	0.5369	0.1576	Dena	4
Deprived	0.5271	0.3793	-0.1478	Bahmaei	5
	0.6355	0.2562	-0.3793	Charam	6
Very deprived	0.6552	0.1872	-0.4680	Basht	7
	0.8822	0.0936	-0.7291	Lande	8

According to Table (1), Boyer-Ahmad has the highest level of development with a net output flow of 0.832, followed by Kohgiluyeh (0.336), Gachsaran (0.719), Dena (0.157), Bahmaei (-0.147), Charam (-0.379), Basht (-0.468) and Lande (-0.729). This decision-making method has other features, including the comparison of each sub-index with eight cities and provision of the output flow separately.

Table 2. Output flow ranking of commercial-service index in Kohgiluyeh and Boyer-Ahmad Province
(Source: Research Findings, 2020)

Negative output flow (Phi-)	Positive output flow (Phi+)	Net output flow (Phi)	City	Development rank
0000/0	0000/1	0000/1	Boyer-Ahmad	1
2041/0	6735/0	4694/0	Kohgiluyeh	2
3469/0	6122/0	2653/0	Gachsaran	3
3061/0	4694/0	1633/0	Dena	4
5714/0	2245/0	3469/0-	Bahmaei	5
5714/0	2041/0	3673/0-	Charam	6
6531/0	1020/0	5510/0-	Basht	7
6939/0	0612/0	6327/0-	Lande	8

Table 2, which compares cities of this province in terms of commercial-service indices, lists the number of villages with cooperative stores, banks, fuel stations, bakeries, grocery stores, and the kerosene distribution centers. This ranking is based on the net flow of the cities (Boyer-Ahmad,

Kohgiluyeh, Gachsaran, Dena, Charam, Bahmaei, Basht and Lande). Accordingly, Boyer-Ahmad city is the most developed city in the province.
In this ranking, the status of Bahmaei and Charam cities has changed compared to the final ranking. The fact that highlights the importance of this research is the comparison of the province's counties in terms of rural areas or villages, and the nature of relationships between options (towns and counties). Table (3) shows the positive, negative, and net output flows for rural areas in five categories.

Table 3. The degree of development of rural areas in Kohgiluyeh and Boyer-Ahmad provinces
(Source: Research Findings, 2020)

Rank	Negative flow	Positive flow	Net flow	County	Town	Degree of Development
1	051/0	858/0	806/0	Sarrud Jonubi	Boyer-Ahmad	Very development
2	045/0	846/0	801/0	Pataveh	Dena	
3	051/0	840/0	789/0	Dehdasht Sharqi	Kohgiluyeh	
4	062/0	778/0	710/0	Imamzadeh Jafar	Ghachsaran	
5	102/0	738/0	636/0	Sarrud Shomali	Boyer-Ahmad	
6	113/0	726/0	608/0	Lishter	Ghachsaran	
7	113/0	721/0	608/0	Sadat Mahmoudi	Dena	
8	125/0	704/0	579/0	Dasht-e Rum	Boyer-Ahmad	
9	113/0	693/0	579/0	Dehdasht Gharbi	Kohgiluyeh	
10	187/0	608/0	420/0	Behmaei Garmsiri Jonubi	Bahmaei	Developed
11	221/0	522/0	301/0	Sepidar	Boyer-Ahmad	
12	221/0	517/0	295/0	Tayebi Sarhadi Gharbi	Kohgiluyeh	
13	267/0	528/0	261/0	Boyer Ahmad Garmsiri	Ghachsaran	
14	255/0	488/0	233/0	Behmaei Garmsiri Shomali	Bahmaei	
15	255/0	483/0	227/0	Taybi Sarhadi Sharghi	Kohgiluyeh	
16	272/0	465/0	193/0	Tutnade	Dena	
17	238/0	420/0	181/0	Zilaei	Boyer-Ahmad	
18	318/0	443/0	125/0	Bahmaei Sarhadi Sharqi	Kohgiluyeh	
19	227/0	386/0	113/0-	Margon	Boyer-Ahmad	Moderately developed
20	306/0	352/0	045/0-	Cheram	Cheram	
21	329/0	335/0	011/0-	Dena	Dena	
22	403/0	358/0	045/0-	Babuei	Basht	
23	403/0	329/0	073/0-	Ludab	Boyer-Ahmad	
24	369/0	289/0	079/0-	Sarasyab Yousefi	Bahmaei	
25	406/0	380/0	079/0-	Bibi Hakimeh	Ghachsaran	
26	397/0	284/0	113/0-	Bahmaei Sarhade Gharbi	Kohgiluyeh	
27	437/0	301/0	113/0-	Alaghchin	Cheram	
28	437/0	244/0	193/0-	Kabgiyan	Boyer-Ahmad	Deprived
29	443/0	238/0	204/0-	Rock	Kohgiluyeh	

Rank	Negative flow	Positive flow	Net flow	County	Town	Degree of Development
30	406/0	221/0	238/0-	Tayebi Garmsiri Shomali	Lande	
31	471/0	233/0	238/0-	Doshman Ziyari	Kohgiluyeh	
32	465/0	215/0	250/0-	Chin	Boyer-Ahmad	
33	500/0	238/0	261/0-	Sarfaryab	Cheram	
34	573/0	243/0	329/0-	Talkhab	Basht	
35	534/0	170/0-	363/0-	Chenar	Boyer-Ahmad	
36	551/0-	153/0-	397/0-	Kafshkanan	Bahmaei	
37	642/0	142/0	500/0-	Poshte Zilayi	Cheram	
38	619/0	108/0	511/0-	Kuhe Mara Khami	Basht	
39	647/0	136/0	511/0-	Ali Tayeb	Lande	
40	647/0	079/0	568/0-	Kakan	Boyer-Ahmad	
41	676/0	051/0	625/0-	Tayebi Garmsisi Jonubi	Kohgiluyeh	Very deprived
42	681/0	045/0	636/0-	Ajam	Kohgiluyeh	
43	738/0	068/0	670/0-	Sarabiz	Basht	
44	761/0	045/0	715/0-	Shitab	Lande	
45	795/0	014/0	784/0-	Vahdat	Lande	

According to Table (3) and the net output flow presented in the table, the ranking of rural areas of Kohgiluyeh and Boyer-Ahmad Provinces can be obtained as follows:

Very developed villages: Sarrud Jonubi (0.806), Pataveh (0.801), Dehdasht Sharqi (0.789), Imamzadeh Jafar (0.710), Sarrud Shomali (0.636), Lishter (608) / 0), Sadat Mahmoudi (0.608), Dasht-e Rum (0.579) and Dehdasht Gharbi (0.579)

Developed villages: Bahmaei Garmsiri Jonubi (0.420), Sepidar (0.301), Taybi Sarhadi Gharbi (0.295), Boyer Ahmad Garmsiri (0.261), Bahmaei Garmsiri Shomali (0.233), Taybi Sarhadi Sharghi (0.2277), Tutnade (0.391), Zilaei (0.181) and Bahmaei Sarhadi Sharghi (0.125)

Medium villages: Margon (-0.113), Charam (-0.045), Dena (-0.011), Baboui (-0.045), Lodab (-0.073), Sarasyab Yousefi (079) 0), Bibi Hakimah (-0.07.09), Bahmaei Sarhadi Gharbi (-0.113) and Al-ghachin (-0.113)

Deprived villages: Kabgian (-0.391), Rock (-0.204), Tayebi Garmsiri Shomali (-0.238), Doshman Ziyari (-0.238), Chin (-0.250), Sarfaryab (06.261), Talkhab (-0.329), Chenar (-0.363) and Kafshkanan (-0.397)

Very deprived villages: Posht-e Zilaei (-0.500), Kuhe Mare Khami (-0.511), Aali Tayeb (-0.511), Kakan (-0.568), Tayebi Garmsiri Jonubi (-0.625), Ajam (-0.636), Sarabiz (-0.670), Shetab (-0.715) and Vahdat (-0.784)

4.1. Final Ranking of Options

In this study, step four is presented as positive ranking flow (Phi +) or negative ranking flow (Phi-) and step five is presented as the net output flow (Phi). Figure (2) compares cities with a network of nodes and edges. In this figure, as depicted by the ranking of indices, Boyer-Ahmad is ranked first in terms of the level of development with the highest phi + and the lowest phi-. As we move down in the list of top options, the importance of that option declines with the city of Lande obtaining the last priority.

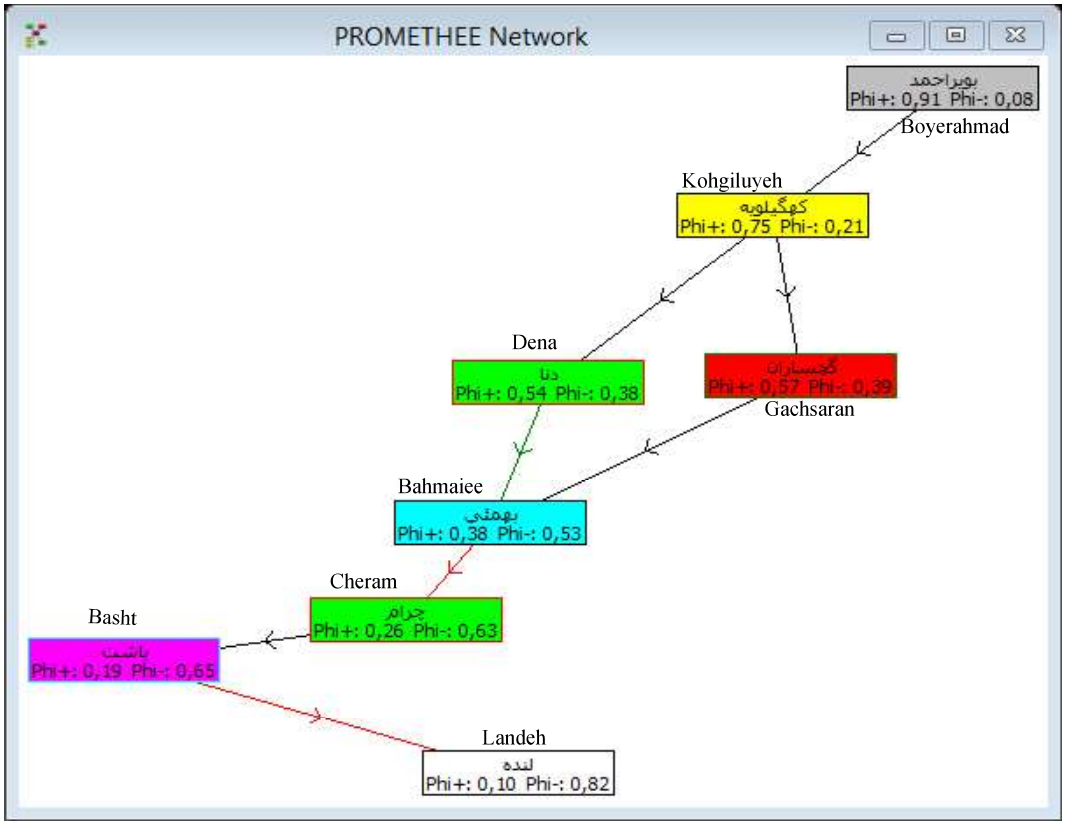

Figure 2. Network modeling of the degree of development in Kohgiluyeh and Boyer-Ahmad provinces
(Source: Research Findings, 2020)

To improve the efficiency of the PROMETHEE method, it is recommended to use the GAIA (geometrical analysis for interactive aid) method with a special modeling technique. In the analysis of multi-criteria problems, it is of utmost important to help the decision maker with the opposing indices and the effect of each index's weight on the final results. GAIA's special modeling method provides such analyses, which are based on PROMETHEE, and add graphic and descriptive analyses to this method. In this method, the set of options can be presented with n points in the next K space. Since there are more than two indices, it is impossible to get a clear picture of the n-dimensional space, and so the analysis of the original composition will correspond to the two-dimensional analysis of options. In this method, options that are in line with the pragmatic decision axis are recommended by PROMETHEEII (Shojaeian et al., 2014).

GAIA and GAIA Web analytics are the most important software analyses of the PROMETHEEII model. The most important feature of this analysis is the level of risk and accuracy or validity of the project. This analysis, which resembles alpha analysis in SPSS software, evaluates expert opinions automatically and assigns a weight in the range of 0 to 100% to the output analysis. A higher weight of outputs (above 70) exhibits the higher level of the project. According to the diagram below, the alpha coefficient and quality of this study is 87.3%, which reflects high reliability of the research and its procedure.

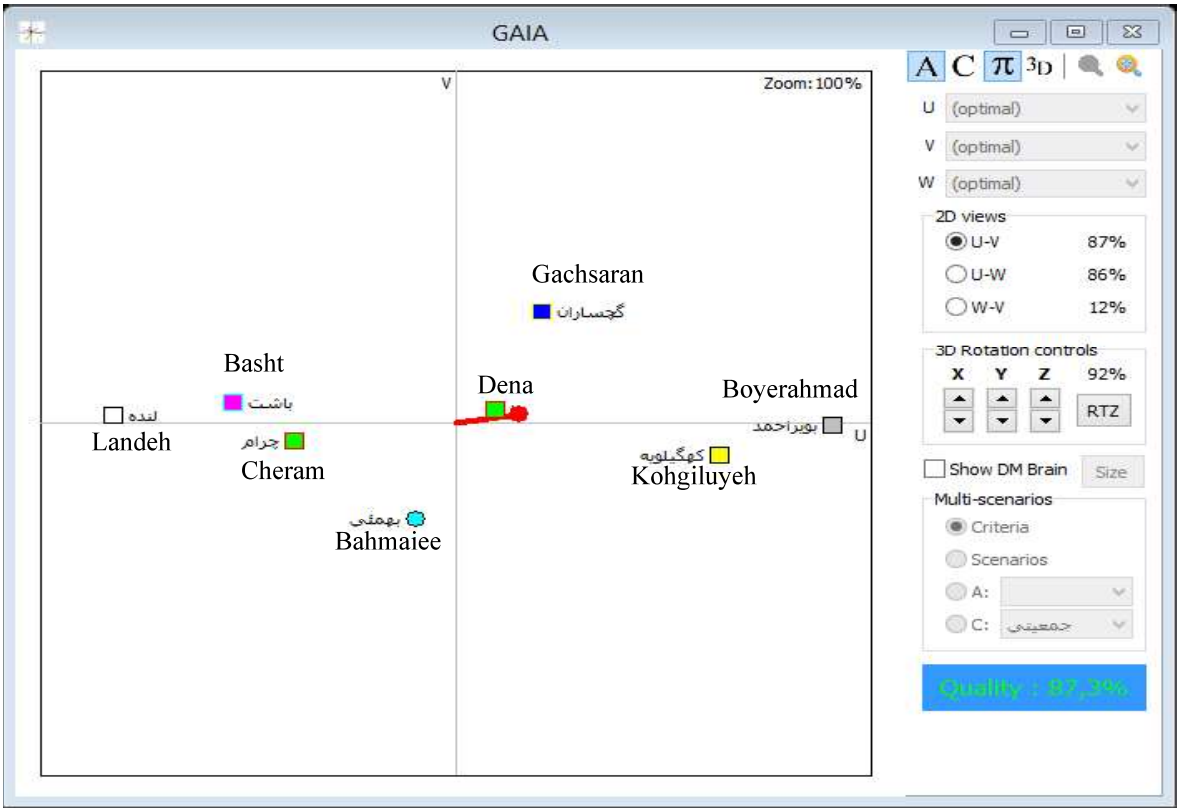

Figure 3. Development modeling with GAIA analysis of Kohgiluyeh and Boyer-Ahmad Provinces
(Source: Research Findings, 2020)

In the PROMETHEEII method, a specific weight is assigned to each criterion, and the classes of each criterion in the input map can assume different weights, as do criteria themselves. This method is highly compatible with the weighting method of the hierarchical process. There are many models for assigning weight to criteria, the most important of which are rating or ratio weighting methods and analytic hierarchy process (AHP).

After determining the final weight of each criterion, these weights are merged in the GIS to assign a weight to each layer and then overlay them in the GIS. Finally, for each of the desired criteria, based on the number of effective layers and the impact of these layers, the appropriate area is identified for prioritizing cities with respect to the level of development.

In this method, different classes are assigned to different weights and flexible combinations are derived from maps, which cover a range of numbers. Overlay logic is divided into two union and intersection types. Union overlay is a method where all layers and their components are visible in a single layer, but in intersection overlay, the existing layers are intersected to find the appropriate location that meets all project conditions. The type of overlay used for positioning is intersection. In this paper, the union overlay has been used. After obtaining the final weights of the net output flow, we need to prepare and draw the final maps. At this stage, the researcher prepares the output map based on the routing procedure. To do so, primary maps are revised based on the latest administrative divisions and converted into Raster files for normalization. In the next stage, the maps of research area, i.e. the cities of Kohgiluyeh and Boyer-Ahmad Province, are merged based on the output weights, which is the net output of the PROMETHEEII method, to prepare the final map. As shown in the outline map (4), Boyer-Ahmad is classified as very developed, and Kohgiluyeh and Gachsaran are classified as developed. They are highlighted in yellow in the map. Dena has a medium level of development (in blue). Bahmaei and Charam fall in the category of deprived areas (in green). Finally, Basht and Lande are classified as very deprived regions.

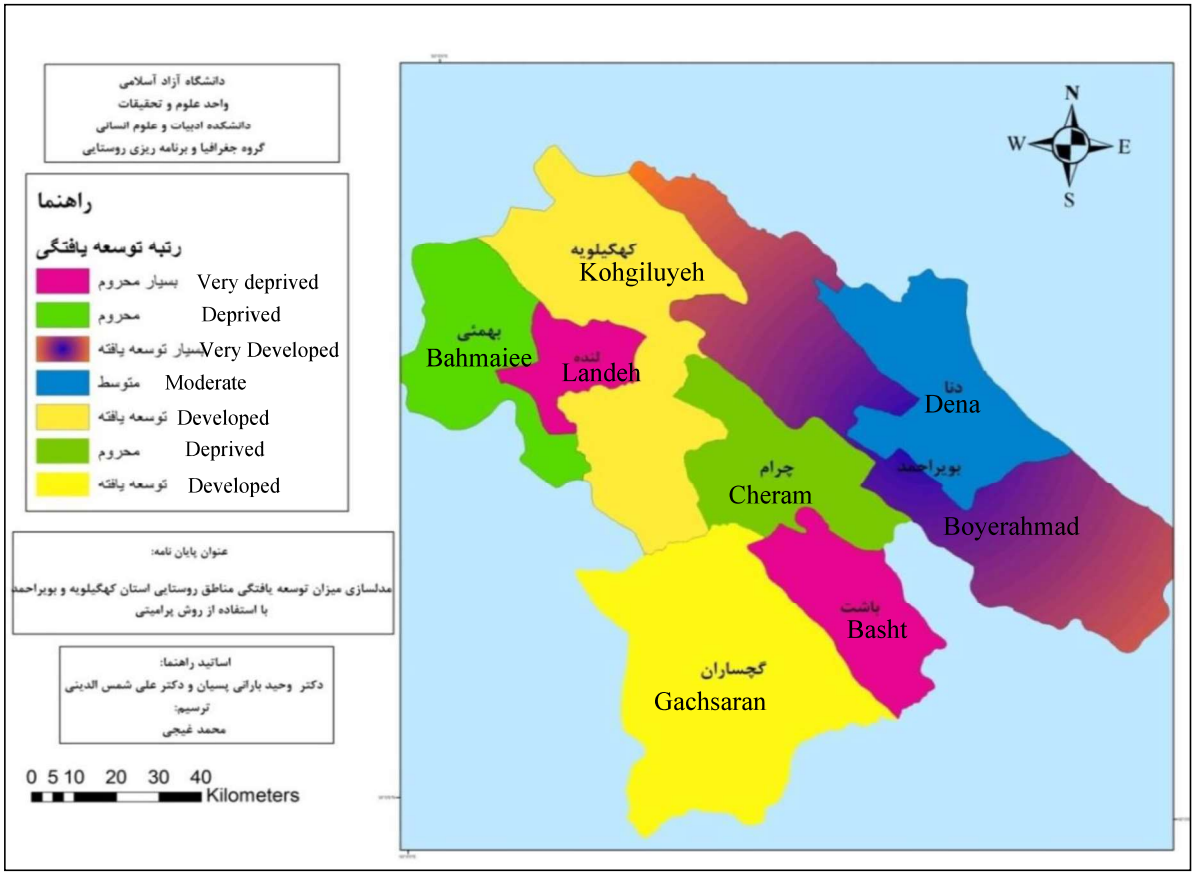

Figure 4. Final map of the development rate of Kohgiluyeh and Boyer-Ahmad cities
(Source: Research Findings, 2020)

5. Discussion and Conclusion

In most developing countries, there are often few regions with a high level of development in terms of public services and economic and social prosperity. These areas play a key role in generating revenue and prompting national production, which comes at the expense of backwardness in other regions and widening inequality between regions across the country. Similarly, in Iran, regional disparities and inequalities are alarmingly on rise. This situation has given rise to serious problems such as migration from deprived areas to more developed areas.

In the process of this research, PROMETHEEII method was used and based on eight indices and 40 items, which are consistent with the definitions of development indices, the development rank of rural areas in Kohgiluyeh and Boyer-Ahmad province were determined. According to the results and development rankings of cities based on 40 indices in the PROMETHEEII decision-making method, the main research question was answered.

In the study area, Boyer-Ahmad is the most developed city in this province; Accordingly, Boyer-Ahmad is the most privileged and developed city of the province with a net output flow of 0.832. Kohgiluyeh and Gachsaran with a net output flow of 0.336, and 0.79, respectively, are ranked among the developed areas. Dena with a net output flow of 0.157 is ranked as moderately developed, and Bahmaei and Charam with a net output flow of -0.147 and -0.379, respectively, are ranked as deprived areas. Finally, Basht and Lande with a net output flow -0.468 and -0.729 are ranked as very deprived areas, respectively.

What justifies the importance and necessity of this research is the growing divergence in the directional development of cities and villages in the cities of the province, which has generated a gap between the residential areas in this province. For this purpose, it is important to study and analyze the status of regions in terms of rural development as a basis for future planning. By determining the quantitative and qualitative status of various indices under the current conditions based on their fundamental capabilities, a

promising future can be envisioned. Furthermore, the assessment of rural indices in terms of the level of development can offer an overview of the geographical conditions of the region in terms of the level of development and stabilization of the population in rural areas, which ultimately contributes to rural development in this province.
Climate diversity, strategic geographical location, abundant tourist attractions and mineral resources are just some of the potentials of Kohgiluyeh and Boyer-Ahmad Province, each of which is sufficient to transform the socio-economic indices of this province. In view of this, the following suggestions can be made:

- Prioritizing the basic needs of villagers including provision of drinking water, improved quality of people's access to bakery and high-quality flour, the need for health services and facilities, access to fuel and energy (gas piping), which are essential for the development of rural life.
- Providing welfare facilities in the villages (e.g., health facilities, sports facilities, proper communication roads, proper residential facilities, etc.) will pave the way for building accommodation in the villages, which will preclude migration to the cities.
- Giving priority to deprived and very deprived rural areas in rural development plans and programs, especially the rural areas of Bahmaei, Charam, Basht and Lande counties.
- Making bottom-up planning and placing a premium on public participation of target groups in regional planning
- And establishing and strengthening service centers in the central villages and counties and striking a balance in the distribution of infrastructure in all villages across the province.

As far as the authors are concerned, this is the first study to examine the rural areas of Kohgiluyeh and Boyer-Ahmad province using a decision-making method. By indexing and weighting the factors affecting rural development, the present study offers a new model for ranking villages, regions and geographical locations in Iran in general. Also, the use of PROMETHEEII model in this research can be a guide for researchers and academic circles or planning organizations of Iran. At the provincial levels, it can also be consulted as a reference for the allocation of resources and credits and fostering the development of cities in Kohgiluyeh and Boyer-Ahmad Province, while recognizing the weaknesses of rural development in each city and their capabilities.

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