International Journal of Agricultural Management and Development
Available online on: www.ijamad.iaurasht.ac.ir
ISSN: 2159-5852 (Print)
ISSN:2159-5860 (Online)
Research Paper

A Comparative Investigation of TOPSIS, Factor Analysis, and Scale Gram Analytical Methods on Rural Development (Case of Islamshahr rural development level)

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Received: 29 May 2018,
Accepted: 15 October 2018

Abstract

Rural areas have always played a significant role in the global economy by providing a variety of foods and raw materials. This role is much more prominent in developing countries. Rural development is also an important part of regional policies, covering agriculture, forestry, natural resource management, land use, and economic diversity in these areas. The present study focused on investigating rural development in rural areas of Islamshar County, Iran. Given the lack of productivity in this region and the fact that this county is so close to two metropolitan cities of Karaj and Tehran, it is necessary to examine the level of development of the villages in this county. Among various methods of ranking, the credit and point of rural development in this research were measured by AHP-based TOPSIS, factor analysis, and scale gram methods. Categorization by TOPSIS and factor analysis revealed close results considering 27 criteria for the evaluation of choices. Scale gram analysis generally confirmed these results. Also, the overall results show that the economic factor derived from the factor analysis method and the agricultural factor derived from the AHP method were acceptable. According to the viewpoint of the research population, many of the rural areas in the studied county were categorized in "deprived" group.

Keywords: ***classification, factor analysis, rural development, scale gram, TOPSIS***

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INTRODUCTION

Since all-inclusive growth of human being comprises the main goal of development, it is essential to find and understand the status of human communities and their needs in spiritual and material dimensions when planning for development (Pourtaheri et al. 2009; Pourtaheri, 2010; Rezvani, 2004). One of the important concerns in developing countries is approaching an acceptable level of development in different dimensions. Rural development is a significant basis for national development in every country (Rezvani, 2002). Approximately half of the world population (56%), two-thirds of developing countries, and most of the deprived world make living through agriculture. In addition, it has been established that most of the poor in the world live in rural areas (two-thirds, i.e. roughly 900 million people). Over the past decades, the greatest part (66% in 1960) of the Iranian population has been made by those living in rural areas and they used to earn money mostly from agriculture. Today, after many ups and downs, villages have succeeded to preserve their credit and find their place in the national economy within which agriculture still plays a key role. Although since the beginning of the recent century and especially since the middle of the century, we have witnessed a gradual decrease in rural population in favor of urbanization, available statistics show that one-third of the Iranians (27% in 2015) still live in rural areas (World Bank, 2015). Furthermore, accounting for 24% of Gross National Product (GNP), 40% of non-oil exports, 30% of labor, and 80% of the country's food needs, the agricultural and rural area sectors still form an important part of Iran's economy (Statistical Center of Iran, 2011).

A deep examination of the matter reveals the high importance of rural areas because, as Tudarou (1991) and Eftekhari et al. (2009) believe, rural areas are responsible for all the problems of underdevelopment such as prevalent poverty, growing inequality, rapid population growth, and rising unemployment. Iranian villages have always had an insignificant contribution to the national development due to their dispersion, and low population density, cultural and ethnic characteristics, and the obstacles against rural integration; as well, irrespective of a high theoretical place, the agricultural sector has failed to practically influence much of the national macro decisions (Ostovar, 2007; Rezvani, 2002).

Some consider the issue of rural development to be obsolete; however, it does not mean that the extent or intensity of rural poverty has been alleviated in undeveloped countries over the recent years, but it is opposite in a major part of the world because the priorities of the governments and the patterns of most helping brokers have been changing in the past 10-15 years (John Barry, 2001). Over the past several decades, development, quality, and infrastructure have been the source of many challenges to the development trend of regions throughout Iran affected by inefficient national planning and the past programs. On this account, the investment policy of the government was set forth for economic regions, sectors, and subsectors aiming at fair distribution and the tackling of the existing imbalances (Rezvani & Sahneh, 2005). Knowing the advantages and disadvantages of regions is essential for providing plans, programs, and policies in such a way that using socio-cultural, economic, contextual, hygienic, etc. indices could be considered as a suitable criterion for the placement of districts and also a significant factor of removing the current difficulties towards a sustainable development (Ghanbari Haft Cheshmeh & Hussainzadeh Dalir, 2005).

According to scientific findings, effective planning with reality-based productive and efficient programs is an important move towards establishing social justice in different regions since the analyses and cause investigations will not be reliable if planning does not go along with resources and circumstances that are currently available in regions

(Pezeshki & Zarafshan, 2008). The experiences of some countries, such as India, South Korea, China, and Malaysia, demonstrate the efforts of central governments to promote the efficiency of socioeconomic life in villages with the purpose of achieving an integrated regional development. For example, India is a pioneer in expectant poverty alleviation programs in rural areas focusing on rural integrated development approach and making non-farming activities diverse, particularly in the development of rural industries. Pointing out to the need for removing regional differences as a basis of growth and development, Prashanth Reddy, a regional planning expert of India, mentioned in an article titled "regional inequality in the state of Andhra Pradesh" that reduced regional inequality in the state of Andhra Pradesh (three coastal regions of Andhra, Rayalaseema, and Telangana) in India over the recent 50 years has caused information technology growth in the regions to increase and rural poverty to decrease (Sharma & Reddy, 2004). Also, regional development and underdevelopment are among the most discussed issues by economists and programmers. In this respect, the regional inequalities and differences that are affected by socioeconomic features, as well as policies and programs, have made programmers develop techniques and methods to identify and analyze the reason(s) of regional inequalities and differences via determining the development and regional ranking (Mohamadi et al., 2016).

In similar studies, Hou Yu et al. (2010) investigated the development status of the coastal areas of China from 1998 to 2007. To assign weights to the indices, they compared AHP and principal part analysis (PCA) methods. Based on the results, no single method sufficed in assigning weights to the indices because the principal components were a linear combination of primary variables, and AHP considered a better and more efficient method. Zanakis et al. (1998) found that some methods, in addition to the common parameters, have other parameters such as constant coefficient, which affect the ideal solution or final answer. They also stated that adopting different methods to evaluate the choices would entail different results. Accordingly, to elaborate on the issue, they conducted a comparative analysis of a number of multi-attribute decision-making methods including SAW, TOPSIS, and AHP.

Al-Hassan et al. (2007) studied the regional inequalities in Ghana within 1990-2000 using cluster analysis and factor analysis as the main methods. The regions of the country were categorized into privileged, semi-deprived, and deprived areas. In a study on knowledge-based communities, Chu et al. (2007) analyzed the SAW and TOPSIS methods comparatively. The ranking of the studied communities showed similar results from both methods; however, the researchers introduced TOPSIS as a more suitable method of recognition and elaboration of the existing realities. The methodology of Sharma (2004) in his research was composed of determining inequalities and analyzing principal components as well as the constant coefficient.

Wolf et al. (2004) compared AHP and Analytic Network Process (ANP) and used these two approaches together with six criteria and 43 different indices to evaluate forest management. They found that multi-criteria analysis outperformed ANP. In a comparison of a number of multi-criteria decision-making methods, Voogd (1983) found that the results of each method were different from those of the other methods at least in 40% of cases. He maintained that the index weighting differed across the various methods and the process and algorithm of ideal solution determination were different as well. Phillis et al (2002) conducted a study titled "sustainable development, unclear concepts and their evaluation using fuzzy logic". They believe that the definition and measurement of sustainable development is inherently an intricate and vague concept, and fuzzy logic and its systemic method are an accurate and appropriate technical means for unclear subjects for which the common mathematical

methods are not suitable. Therefore, this study used the fuzzy logic method to evaluate development. Soares et al. (2003) presented a categorization method for different regions of Belgium in order to support regional development policy. This ranking was carried out using multi-variable statistical techniques of cluster analysis based on 27 socioeconomic, hygienic and educational indices.

Accordingly, and in line with the subject of this research, the villages near Islamshahr County were expected to have experienced a balanced growth in different economic sections compared to the other rural areas in the region due to the closeness to the capital. However, given the decentralized development activities of the government, these cities have usually been left unnoticed in terms of development needs. Or, the lack of analysis and credit ratings in smaller towns around megacities makes the aforesaid indices difficult to tackle. The present study aims at comparing ranking methods to rank them in terms of efficiency and investigating the performance of the government in organizing development and underdevelopment in the abovementioned regions. Additionally, attempts were made to answer the question as to whether the development has been conducted as a balanced move based on the rated indices or it has been overlooked under the influence of the nearby megacities. This study also makes an attempt to suggest the programmed management as a solution to use the available resources and execute services and projects that can contribute to the development of rural areas.

METHODOLOGY

This is a quantitative study and applied research in terms of purpose. The main design of the study was a survey. Data were collected by three questionnaires as research instruments of library investigation using subject note-taking and the review of studies conducted by other scholars in line with the framework, purposes, and questions of the present research. The questionnaires differed in ranking method. The executive people and beneficiaries in rural development made up the statistical population of the research. The experts and staff of Jihad-e Agriculture Organization of Islamshahr were investigated the state and executive agents factors of the county.

Islamshahr County has an area of 195 km^3 (about 1% of the total area of the province) with a semi-arid climate, an average rainfall of 231 MMS, four rural districts, two districts, and 27 villages. The city has relative advantages of being located near a large consumer goods market in Tehran, Karaj and Robat-Karim, integrated and fertile lands, public and private agribusinesses, active agricultural associations and cooperatives, educated users, and active agriculture graduates.

The sample was taken by the proportionate stratified sampling technique. Given the division of Islamshahr County into two districts, four rural areas, and 27 villages, all personnel (totally 100 individuals) of Jihad-e Agriculture Organization of Islamshahr were questioned. The updated development indices-based statistics were received from the Statistical Center and Jihad-e Agriculture Organization of Islamshahr as well as the Population and Housing Statistics of 2014. The face and content validity of the questionnaires were confirmed by a panel of university professors. In order to estimate the validity and reliability of the AHP questionnaires, the Consistency Rate (CR) was calculated for each matrix and supplied to the relevant expert to review in cases the CR was greater than the allowed limit (more than 0.1) (Madhoushi & Rahimikhah, 2009). This was repeated until the CR of the pairwise comparison matrices fell within the allowed limit and was calculated and tested for every manager. Based on the calculations, the CR of matrices was obtained to be less than 0.1, implying the validity and reliability of the AHP questionnaire.

The analysis unit in the present study was

the rural district, and in order to find the development degree of these areas, 35 development indices related to agricultural, sociocultural, healthcare, economic, and infrastructure sectors were prepared and analyzed. The data analysis was carried out using MS-Excel, Expert Choice, and TOPSIS analysis. In order to check the development degree in different regions, several steps must be taken including the selection of indices (Patrick, 2002; Miranda, 1999; Wirén, 2000), scale difference settlement between indices (Kalantari, 2003, 2009), and weight assignment to indices (Mousavi & Hekmatnia, 2005; Sheykhbeglou et al., 2012; Mohammadi et al., 2012).

The methods of TOPSIS and factor analysis of Hwang & Yoon (1981) (Render et al., 2000), as well as Scale gram analysis were used to find out the rural development level of the villages of Islamshahr County given their advantages and superiorities over the other techniques.

Analytical Hierarchy Process of the research problem

According to the theoretical framework of the research described above, the first step of problem-solving through AHP method is to determine the hierarchical structure of the problem, where rival criteria and choices are presented. As elaborated in the TOPSIS method, after the data are standardized, it is necessary to assign weights to each index (criterion) and sub-indices in order to be used in the evaluation of rural development.

The procedure of the research was composed of three fundamental steps as follows.

- First step: Identification and ranking of AHP-based rural development evaluation (offer AHP tree) (Figure 1).

First, given the review of the literature and using the ideas of experts, the hierarchical decision-making tree should be prepared to recognize the rural development evaluation. This resulted in 27 effective factors within five principal elements.

- Second step: Weight assignment to principal factors (level 1)

In the second step, to calculate the relative importance (weight) of each principal factor, a questionnaire in line with the AHP questionnaire (pairwise comparison) was prepared and handed out to get opinions of the experts. The questionnaire included a matrix for paired comparison of factors. Hence, there are comparisons equal to the number of factors. Given the five factors in level 1, the number of comparisons or questions is 10. After the questionnaires were filled, the Inconsistency Rate (IR) of each factor was examined separately. Finally, 10 questionnaires were analyzed and the opinions of the participants were joined via the Expert Choice Team. This software has a lot of capabilities to incorporate paired comparison matrices of individuals and integrate matrices of different persons into a single merged matrix where every element is obtained through a geometric mean.

Elaboration on calculations of the above table by Expert Choice

For example, the geometric mean of the entry in the above table was calculated as below:

$$a_{12} = (3 \times .... \times 6)^{\frac{1}{10}} = 1.765$$

Given the reversibility principle in the AHP method, the elements under the matrix diagonal are opposite to those of upper diagonal. For example, the entry is obtained as below:

$$a_{21} = \frac{1}{1.765} = 0.566$$

The other elements of the table were obtained likewise whose results are presented in Table 1.

The weights of Level 1 were calculated as below. Therefore, after the calculation of the geometric mean of opinions of the experts, the problem decision-making matrix was first normalized using the following relationship:

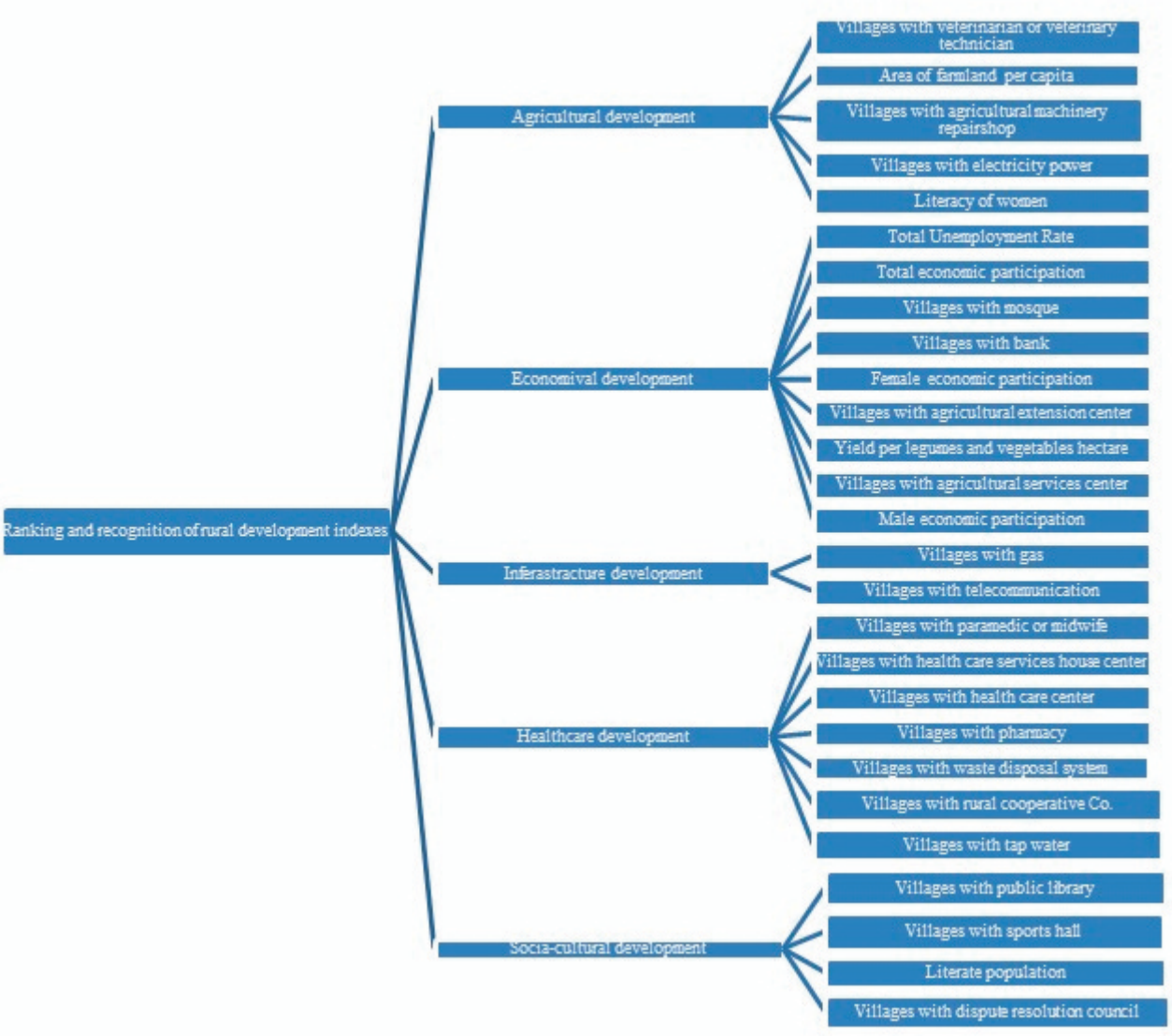
$$r_{ij} = \frac{\overline{a_{ij}}}{\sum^{n} \overline{a_{ij}}}$$

For example, to get entries and in the normalized matrix, we went ahead as below. First, all the entries of the first column in the merge matrix were summed up:

$$\sum_{i=1}^{5} \overline{a_{i1}} = 1 + 0.566 + 0.420 + 0.285 + 0.166 = 2.437$$

Then, the entry from the merged (geometric) matrix was divided into the total number of the first column. $\sum_{i=1}^{n} \overline{a_{ij}}$

$$\overline{a_{11}} = \frac{1}{2.437} = 0.410$$



Figuer 1. AHP tree of rural development evaluation factors

The other remaining elements of the normalized matrix were calculated via the above formula. Following normalization of the group decision-making matrix, now it was the turn to assign weights to the components of Level 1 which was calculated using the row mean method as below:

$$W_j = \frac{\sum_{i=1}^{n} w_{ij}}{n}, \; j = 1,2,\ldots, n \qquad , \sum_{i=1}^{n} W_j = 1$$

For example, in order to calculate the weight of A, all elements of the first line in the normalized matrix were first summed up and, then, they were divided into the number of all principal factors i.e. 5. Accordingly, we had:

$$\frac{\sum_{j=1}^{n} w_{ij}}{n} = \frac{0.410 + 0.431 + 0.447 + 0.373 + 0.262}{5} = 0.385$$

Therefore, other remaining weights were calculated as above whose results are demonstrated in Table 1.

Calculation of matrix consistency rate (CR)

Group decision-making

To ensure the reliability of the ranking of rural development evaluation, Inconsistency Rate (IR) of paired comparison matrix should be identified. The steps to calculate the IR are as follows:

- First stage: Calculation of Weight Sum Vector (WSV)

$$WSV=D\times W$$

- First, the paired comparison matrix *D* (Table 4-5) is multiplied by relative weight vector (*W*):

$$WSV=\begin{bmatrix}1 & 1.765 & 2.380 & 3.512 & 6.012\\ 0.566 & 1 & 1.319 & 2.426 & 6.261\\ 0.420 & 0.758 & 1 & 2.203 & 5.863\\ 0.285 & 0.412 & 0.454 & 1 & 3.817\\ 0.166 & 0.160 & 0.171 & 0.262 & 1\end{bmatrix} * \begin{bmatrix}0.387\\ 0.251\\ 0.207\\ 0.114\\ 0.041\end{bmatrix} = \begin{bmatrix}1.970\\ 1.276\\ 1.051\\ 0.578\\ 0.211\end{bmatrix}$$

- Second stage: Calculation of Consistency Vector (CV)

The elements of WSV are divided into relative weight vector (*W*), and the resulting vector is called consistency vector (CV):

$$CV=\begin{bmatrix}1.970\\ 1.276\\ 1.051\\ 0.578\\ 0.211\end{bmatrix} \div \begin{bmatrix}0.387\\ 0.251\\ 0.207\\ 0.114\\ 0.041\end{bmatrix} = \begin{bmatrix}5.089\\ 5.085\\ 5.079\\ 5.072\\ 5.138\end{bmatrix}$$

- Third stage: Calculation of the largest special value of paired comparison matrix (λ_{max}):

$$\lambda_{max}=\frac{5.089+5.085+5.079+5.072+5.138}{5}=5.093$$

- Fourth stage: Calculation of inconsistency index (II):

$$II=\frac{5.093-5}{5}=0.019$$

Table 1

Inconsistency Random Index (IRI)

N	1	2	3	4	5	6	7	8	9	10
I.R.I	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.51

(Saaty, 1980)

$$IR=\frac{II}{IRI}=\frac{0.019}{1.12}=0.02\leq 0.1$$

IRI is the value which is extracted from the relevant table. This value is 1.12 for a matrix with the dimension of n=5. Finally, the IR of the desired matrix amounts to IR=0.02. Considering the fact that the value is less than 0.1 (*IR≤0.1*), then, there is a consistency in the paired comparisons.

- Third step: Calculation of weight of elements in level 2 (local weights)

The third move is to calculate the weight of subsidiary factors affecting each subgroup.

- Fourth step: Final weight of elements

The final weight of elements in each group equals to the product of local weight of elements in the weight of their group head (principal factors). Then, ranking of each rural development evaluation factor is identified. The results of this phase are demonstrated in Table 2.

- Fifth stage: Calculation of inconsistency rate (IR):

Table 2
Ranking of Rural Development Evaluation Factors Based on the AHP Method

Principal factors	Weight of principal factors	Subsidiary factors	Local weight of subsidiary factors	Final weight	Rank (Priority)
Agriculture development (A)	0.387	A1	0.293	0.113	1
		A2	0.193	0.074	4
		A3	0.143	0.055	7
		A4	0.104	0.040	12
		A5	0.113	0.044	10
		A6	0.091	0.035	13
		A7	0.062	0.024	15
Economic development (B)	0.251	B1	0.379	0.095	2
		B2	0.301	0.075	3
		B3	0.178	0.045	9
		B4	0.091	0.023	16
		B5	0.051	0.013	21
Infrastructure development (B)	0.207	C1	0.335	0.069	5
		C2	0.275	0.057	6
		C3	0.209	0.043	11
		C4	0.107	0.022	17
		C5	0.075	0.015	20
Healthcare development (D)	0.114	D1	0.458	0.052	8
		D2	0.231	0.026	14
		D3	0.172	0.020	18
		D4	0.084	0.009	23
		D5	0.054	0.006	25
Socio-cultural development (E)	0.041	E1	0.381	0.016	19
		E2	0.252	0.010	22
		E3	0.171	0.007	24
		E4	0.117	0.005	26
		E5	0.079	0.003	27

RESULTS

The results in Table 2 indicate the following ranking in terms of important factors: villages with a center for agriculture jihad services with the relative weight of 0.113 were ranked the 1st, villages with a bank with the relative weight of 0.095 were ranked the 2nd, villages with economic male participation rate with the relative weight of 0.075 ranked were ranked the 3rd, villages with an agricultural machinery repair shop with the relative weight of 0.074 were ranked the 4th, villages with a telecommunication center with the relative weight of 0.069 were ranked the 5th, villages with a gas station with the relative weight of 0.057 were ranked the 6th, villages with a veterinarian or veterinary technician with the relative weight of 0.055 were ranked the 7th, villages with a healthcare center with the relative weight of 0.052 were ranked the 8th, villages with a total unemployment rate with the relative weight of 0.045 were ranked the 9th, villages with yield per rice hectare with the relative weight of 0.044 were ranked the 10th, villages with gas with the relative weight of 0.043 were ranked the 11th, villages with arable land per capita with the relative weight of 0.040 were ranked the 12th, villages with yield per grains hectare with the relative weight of 0.035 were ranked the 13th, villages with pharmacy with the relative weight of 0.026 were ranked the 14th, villages with

yield per legumes and vegetables hectare with the relative weight of 0.024 were ranked the 15th, villages with female economic participation rate with the relative weight of 0.023 were ranked the 16th, villages with electricity power with the relative weight of 0.22 were ranked the 17th, villages with health care services house with the relative weight of 0.020 were ranked the 18th, villages with pitch and sports hall with the relative weight of 0.016 were ranked the 19th, villages with drinking water with the relative weight of 0.015 were ranked the 20th, villages with total economic participation rate with the relative weight of 0.013 were ranked the 21th, villages with literate population with the relative weight of 0.010 were ranked the 22th, villages with waste disposal system with the relative weight of 0.009 were ranked the 23th, villages with mosque with the relative weight of 0.007 were ranked the 24th, villages with paramedic or midwife with the relative weight of 0.006 were ranked the 25th, villages with library with the relative weight of 0.005 were ranked the 26th, and villages with dispute resolution council with the relative weight of 0.003 were ranked the 27th.

A) TOPSIS-based ranking of villages

After weight assignment to the indices and sub-indices, the rural areas of Islamshahr were ranked by the TOPSIS method. For this purpose, the standardized matrix of data was first prepared. Then, following AHP-obtained weights multiplied by the normalized values, the positive and negative ideal values were derived from the balanced matrix. Now, the distance of each rural area within each index from positive and negative ideal values could be earned. Finally, the rural areas were ranked based on C_i^+ values. Accordingly, the villages of Islamshahr were examined using C_i^+ values and were ranked with respect to the scale incorporated into Table 3 in terms of rural development.

Table 3
Rural Development Situation Scale

Development degree	Deprived	Underdeveloped	Less developed	Developing	Developed
Point	0-0.20	0.21-0.40	0.41-0.60	0.61-0.80	0.81-1

Source: Feyzpoor and Abadi (2012)

Ranking of the villages of Islamshahr in terms of rural development indicated that the villages of Shatereh, Chichaklu, Ahmadabad Mostofi, and Firuz Bahram were the highest among others in terms of development. On the contrary, the villages of Qaleh Abrik and Hussainabad Siah Ab were the lowest in development ranking with the points of 0.027 and 0.021, respectively. Therefore, out of the 27 villages of Islamshahr, four villages were evaluated to be less-developed and 23 were identified to be underdeveloped.

B) Factor analysis-based ranking of villages

Prior to conducting the factor analysis, it is essential to meet the following assumptions.

Sampling adequacy (KMO)[1]

In order to investigate the adequacy of samples and ensure the appropriateness of the collected data for factor analysis, the Kaiser test (KMO, 1961) was used.

Bartlett's Test of Sphericity

A significant Chi-Square statistic in Bartlett's Test of Sphericity is the least requirement for conducting the factor analysis. In this test, the rejection of the null hypothesis implies that the correlation matrix has significant data, and the least requirement for factor analysis is met (Sarmad et al., 2004).

[1] Kaiser Meyer Olkin

Exploratory factor analysis using analysis of principal components and varimax rotation for rural development indices demonstrate that KMO value of 0.890 and Bartlett's Test of Sphericity at 0.01 is significant. Therefore, given the sampling adequacy and significance of Bartlett's Test, the correlation matrix related to rural development indices is suitable for factor analysis.

The factor analysis model was implemented in this study using 34 indices related to 27 rural areas in Islamshahr out of which five factors were identified with the net value of higher than 3. These five factors account for totally 93.197% of rural development variance. Also, the indices with a factor loading of 0.5 and higher were considered to be the constituent elements of each factor.

Table 4
Net Value and Variance Percent Captured By Each Factor

Factor No.	Total	Variance %	Cumulative variance %
1	9.655	25.409	25.409
2	7.828	20.600	46.008
3	7.620	20.053	66.061
4	7.264	19.115	85.176
5	3.048	8.021	93.197

Now, given the current correlation of each index with every factor, it is possible to adopt a suitable name or names for each factor.

First factor: This factor holds a net value of 9.655 and can explain solely 25.409% of the total variance. This factor with 11 loaded indices, given the type of accumulated indicators in it, could be called economic index.

Second factor: This factor holds a net value of 7.828 and can account for 20.600% of the total variance. This factor with nine loaded indices, given the type of accumulated indicators in it, could be called healthcare index.

Third factor: This factor holds a net value of 7.620 and can capture 20.053% of the total variance. This factor with six loaded indices, given the type of accumulated indicators in it, could be called socioeconomic index.

Fourth factor: This factor holds a net value of 7.264 and can explain solely 19.115% of the total variance. This factor with five loaded indices, given the type of accumulated indicators in it, could be called agriculture index.

Fifth factor: This factor holds a net value of 3.048 and can explain solely 8.021% of the total variance. This factor with two loaded indices, given the type of accumulated indicators in it, could be called infrastructure index (Tables 4 and 5).

Following identification of the number of factors and that each index was loaded in which it was possible to rank the villages using the factor points of each settlement relevant to the indices under study. Finally, the development degree of different villages was calculated considering the obtained factor points and identified based on the standards of Table 6.

According to the information already described on the ranking of villages of Islamshahr using the exploratory factor analysis method, it is evident that all the villages were identified to be underdeveloped.

A) Comparison of TOPSIS and factor analysis

The comparison of ranking of the villages of Islamshahr in terms of rural development via the methods of TOPSIS and factor analysis demonstrated that some of the villages held similar places in both methods, while others had different places. Accordingly, the villages

Table 5
Rotated Factor Matrix of Rural Development Index

Principal Index	Subsidiary Index	Factor				
		1	2	3	4	5
Economic	Female Unemployment Rate	0.968				
	Male Unemployment Rate	0.966				
	Total Unemployment Rate	0.898				
	% of total economic participation	0.893				
	% of villages with mosque	0.863				
	% of villages with bank	0.861				
	% of female economic participation	0.856				
	% of villages with agricultural extension center	0.804				
	yield per legumes and vegetables hectare	0.790				
	% of villages with agricultural services center	0.657				
	% of male economic participation	0.582				
Healthcare	% of villages with paramedic or midwife		0.904			
	% of villages with health care services house center		0.898			
	% of villages with social worker		0.887			
	% of villages with health care center		0.837			
	% of villages with pharmacy		0.818			
	% of villages with waste disposal system		0.737			
	yield per rice hectare		0.715			
	% of villages with rural cooperative Co.		0.689			
	% of villages with tap water		0.404			
Socio-cultural	% of villages with public library			0.939		
	% of villages with sports hall			0.933		
	% of literate population			0.911		
	% of villages with dispute resolution council			0.886		
	% of villages with mailbox			0.882		
	% of literacy of men			0.862		
	yield per grains hectare			0.571		
Agriculture	% of villages with veterinarian or veterinary technician				0.792	
	Area of farmland per capita				0.779	
	% of villages with agricultural machinery repair shop				0.740	
	% of villages with electricity power				0.809	
	% of literacy of women				0.856	
Infra-structure	% of villages with gas					0.659
	% of villages with telecommunication					0.592

Table 6
Determining Standard of Rural Development Degree

Developed	x_i> mean + 2sd
Developing	Mean + sd < x_i < mean + 2sd
Less developed	Mean – sd < x_i < mean + sd
Underdeveloped	Mean – 2sd < x_i < mean – sd
Deprived	x_i < mean - 2sd

Table 7
Guide to Determine Provincial Indices Nationwide

Index	Positive	Neutral	Negative
% of literate population	25.65	25.65-23.3	23.3
% of literacy of men	89.6	86.16-89.6	86.16
% of literacy of women	13.85	10.41-13.85	10.41
total economic participation rate	60.66	57.3-60.66	57.3
rate of male economic participation	28.9	27.1-28.9	27.1
rate of female economic participation	2185.1	1572.7-2185.1	1572.7
Reverse unemployment rate	779.1	540.3-779.1	540.3
Reverse male unemployment rate	231.1	159.3-231.1	159.3
Reverse female unemployment rate	5.64	3.44-5.64	3.44
% of villages with public library	14.3	8.4-14.3	8.4
% of villages with pitch and sports hall	88.2	51.8-88.2	51.8
% of villages with mosque	60.27	35.3-60.27	35.3
% of villages with agricultural services center	719.9	365.5-719.9	365.5
-% of villages with agricultural extension center	107.6	77.4-107.6	77.4
% of villages with dispute resolution council	130.8	99.4-130.8	99.4
% of villages with rural cooperative Co	729.4	514.8-729.4	514.8
% of villages with electricity power	252.7	173.9-252.7	173.9
% of villages with gas	69.75	50-69.75	50
% of villages with drinking water	275	177.9-275	177.9
% of villages with health care center	353.7	249.3-353.7	249.3
% of villages with pharmacy	1190.9	855.9-1190.9	855.9
% of villages with health care services house	91.7	61.3-91.7	61.3
% of villages with paramedic or midwife	2889.6	2005.8-2889.6	2005.8
% of villages with social worker	556.8	318.4-556.8	318.4
% of villages with waste disposal system	4268.6	2932.6-4268.6	2932.6
% of villages with bank	2013.7	1497.1-2013.7	1497.1
% of villages with agricultural machinery repair shop	1701.5	1174.3-1701.5	1174.3
% of villages with gas station	82	58-82	58
% of villages with mailbox	138.8	84.8-138.8	84.8
% of villages with telecommunication	621.2	310.7-621.2	310.7
% of villages with veterinarian or veterinary technician	131.32	94.98-131.32	94.98
Area of farmland per capita	11.6	8.6-11.6	8.6
yield per rice hectare	2701.1	1865.1-2701.1	1865.1
yield per grains hectare	1406.4	940.4-1406.4	940.4
yield per legumes and vegetables hectare	2074.1	1442.9-2074.1	1442.9

of Shattered, Firuz Bahram, and Chichaklu, securing ranks of 1 to 3, had the highest levels of development respectively whilst the village of Hussainabad Siah Ab held was ranked the lowest in terms of development based on TOPSIS and factor analysis methods.

B) Investigation of rural development indices in Islamshahr based on Scale gram (cluster analysis) method

In this study, to investigate the rural development indices in the villages of Islamshahr, the different indices proposed in earlier methods (TOPSIS and factor analysis) were considered.

In the next step, the mean and standard deviation were calculated for each index whose results are presented in Table 1. Also, the situation of every index, based on the relation M-1/4S (values less than this hold negative sign) and M+1/4S (values higher than this hold positive sign), was calculated where the positive sign shows the effectiveness of the index in the related village while the negative sign represents that the village suffers from problems in that index. The neutral situation here reflects the ineffectiveness of the index in the development of the village (Table 7).

In order to categorize the provinces based on the indices, each index was given two points for the positive sign, zero points for the negative sign, and one point for the neutral sign (Table 8). According to this categorization, the number of positive, negative and neutral signs were identified.

Table 8
Situation of Development Indices Based On the Cluster

Index	Situation	Number	Percent
Socio-cultural indices	+	45	36.6
	0	27	20.8
	-	58	44.6
economic indices	+	103	29.4
	0	114	21.9
	-	119	48.7
agricultural indices	+	88	30.8
	0	56	19.6
	-	102	49.6
infrastructure indices	+	32	30.8
	0	8	16.3
	-	54	51.9
health indices	+	48	30.8
	0	34	24.8
	-	74	47.4
	-	104	53

Also, in order to rank the villages, the range of variation (R) of the points was first extracted for each cluster in Table 1. Then, the distance of classes was obtained after dividing into the number of classes. The points were derived using the formula $R=X_n-X_1$ and the distance between the classes was calculated based on the formula of A=R/K. Here, *K* is the number of classes given the development degree of 5. The primary number was also considered to be 2 given the smallest number in the table. Therefore, the rural areas of Islamshahr were categorized into five groups (Table 9) in terms of development.

Table 9
Ranking of Rural Areas in Terms of Development

Group	Class distance	Development degree	Number of villages	%
First	8-30.4	Very deprived	8	38.46
Second	30.4-52.8	Deprived	16	19.23
Third	52.8-75.2	average	3	3.85
Fourth	75.2-97.6	developed	-	23.08
Fifth	97.6-120	Very developed	-	15.38

Considering the above results and categorization of the villages in terms of development, a significant difference was observed between the villages in meeting the indices under study in rural development. According to the results, all villages were grouped into three classes of very deprived, deprived, and average.

DISCUSSION AND CONCLUSION

In the categories derived from the factor analysis, the economic factor was the highest. An important indicator of the economic factor is the unemployment rate of women and men, which indicates a high unemployment rate and, so, the weakness and deprivation of people in these areas. The business environment as an important economic factor is, in fact, more important to broad indicators of rural development than it is to the narrower economic measure**s** of income. Improving the ease of doing business in this area may well be the single most important and achievable action the country can take to increase wealth, equality and human development in rural and urban areas alike. Sirčo et al. (2013) showed that the correlation between ease of doing business ranking and IHDI extended from the countries with the best business environment to those with the worst, with a very high correlation coefficient of 67%. This is even stronger than the link between democracy and income, and the inequality-adjusted human development index correlates more strongly with ease of doing business than does the human development index (63%), the gender inequality index (59%) or gross national income (57%).

The results of the research showed that, the healthcare, socio-cultural, agricultural and infrastructure factors were located in the next development levels of rural in the Islamshahr County, respectively.

The results of hierarchical analysis also show that the main factor driving these villages towards development is the agricultural factor. There are also economic, infrastructure, healthcare, and socio-cultural factors.

According to the results derived from the Scale gram analysis and the classification of the villages in terms of developmental level, the following hypothesis test was possible. The research hypothesized that There is a significant difference between the studied villages in meeting the indices of rural development. Based on the results, all villages were classified into three levels of "very deprived", "deprived", and "moderate".

According to the extracted results, in terms of development indicators, 8 villages were in a very deprived area, 16 villages in the deprived group and 3 villages in moderate development. According to the research done by Moradi et al. (2015) the findings of the TOPSIS revealed that the villages of the research district, with regards to the development coefficient (Ci+) can be categorized into three levels: developed, developing and less developed (deprived).

Due to the proximity of these villages to the

two metropolises of Tehran and Karaj, officials should be involved at different levels of decision-making and implementation to solve this problem.

Also, the results of the three applied methods demonstrated that the application of only a single method fails to represent all dimensions of rural development ranking and we need to use other adaptive and complementary methods to gain more reliable results. These results are consistent with Chu et al. (2007), Gose et al. (2000), Hosseinpur et al. (2016), Hou Yu et al. (2010), Voogd (1983), Wolf et al. (2004), and Zanakis et al. (1998). The comparison of TOPSIS and factor analysis methods, also, showed that some villages were ranked similarly by the aforesaid methods, while others held different ranks in terms of rural development. According to the results, all the villages were categorized into three groups of very deprived, deprived, and average. The results revealed that the applied methods differed slightly yield similar coefficients in determining the development degree, so they can be used for adaptive methods.

Implication policy

Some suggestions can be drawn from the results described above to improve the development trend of the villages of Islamshahr and reduce inequality among them.

In order to find the development differences in various regions, one must first investigate the current situation of each area to be able to find causes of the differences in the next move and to cut or remove them via regional planning. Recognition of capabilities and facilities in every area enables the planners to decide and set forth suitable development approaches in line with the needs and circumstances of the region (Sheykhi & Shahivandi, 2012). Following the analysis and evaluation of rural development in the villages of Islamshahr, an executive suggestion is proposed below to improve the rural development in the region.

The results of the evaluation of rural development in the villages of Islamshahr revealed that rural settlements have experienced imbalanced development and have suffered from serious challenges and barriers. Therefore, to solve the problem and make a developing situation in villages, the responsible bodies are expected to conduct planning and policy makings with a particular focus on rural areas.

The investigation of the development in the villages of Islamshahr in terms of health, sociocultural, agriculture, economic and infrastructure indices indicate inequalities in the rural areas. Hence, to bring balance into the development of the region and promote it, the development interventions are expected to reduce the inequalities. Taking the current situation of settlements into consideration and defining priorities in different issues are of high importance to achieving suitable intervention practices and equitable distribution of services and resources in rural areas.

Every measurement of village development needs having settlement hierarchy system organized of which the rural ranking is the first step. Therefore, it needs to offer the required capacities and develop economic relationships within the deprived and less developed areas to relieve the regional imbalance. Accordingly, to set up a hierarchy of rural settlements with satisfying performance and function, it is inevitable to see a village not only as a population hub but as a set of active elements that comprise a comprehensive system and to communicate concurrently with its surrounding environment including other villages and cities.

Sociocultural and economic developments, as well as project-based planning, have caused unbalanced spatial system within the rural areas of Islamshahr. On the other hand, the implemented plans to organize properly the rural areas have focused more on physical development, leaving social, cultural and economic dimensions less noticed. Thus, every approach to developing the villages under study entails a fundamental change in the

policies and attitudes of the relevant authorities and taking sustainable development principles into deeper consideration.

Due to the limited financial resources, it is suggested to identify and use those incentives and opportunities which encourage investments towards a significant development in the area and put them at the core of future budgeting and plans.

ACKNOWLEDGMENTS

The following organizations contributed cash and/or in-kind funding to the project: Islamshahr branch of Islamic Azad University, Agricultural Ministry of Tehran province and Agricultural Management Organization of Islamshahr Township. Particular thanks to the members of the project group who provided links into the community and critical comment on results. Thanks to anonymous reviewers for their helpful comments on an earlier version of this paper.

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How to cite this article:
Dehyouri, S. (2019). A comparative investigation of TOPSIS, Factor analysis, and Scale Gram analytical methods on rural development (Case of Islamshahr rural development level). *International Journal of Agricultural Management and Development, 9*(2), 89-106.
URL: http://ijamad.iaurasht.ac.ir/article_664819_504f320fa1918938719aa8160cb9d11f.pdf