Original Article

Analyzing and Prioritizing the Factors Influencing the Spatial Distribution of Population in Urban System (Case Study: Sistan Region)

Gholam Reza Miri[1], Mohammad Karim Raisi[2], Abdolali Puor Keikhaei[3]

[1]Assistant Professor, Department of Geography and Urban Planning, Faculty of Humanities, Islamic Azad university, Zahedan Branch, Zahedan, Iran, [2]Instructor Department of Geography, University of Piame Noor, [3]Ph.D Student, Department of Geography and Urban Planning, Faculty of Humanities, Islamic Azad university, Zahedan Branch, Zahedan, Iran

Abstract

Today, the regional imbalances in national space has made it necessary the need to study the urban hierarchy and network and in this way, the spatial pattern of urban population and balance and imbalance in the urban hierarchy system of each region will be discovered. In this regard the goal of this research is analyzing and prioritizing the factors influencing the spatial distribution of population in urban system in Sistan region. The research method is descriptive- analytic based on library, documentary and field studies. AHP and ELCTERE models have been used for analysis of descriptive and inferential data. The results of Analytical Hierarchy Process (AHP) showed that among the factors influencing the spatial distribution of population in the urban system of Sistan, economic factors have played a major role. The results of ELCTERE model also showed that the city of Zabol has accepted a greater impact compared to other cities in the region considering factors influencing the spatial distribution of population.

Key words: Spatial distribution of population, Urban systems, Region, Urbanization, Sistan

INTRODUCTION

Along with the increase in income and production in the world, demand for municipal services was also increased and as a result, towns and cities were growing in number and in terms of population size. Such an increase in size and number of cities has been occurred during the period of rapid urbanization in the early nineteenth century in developed countries and developing countries in the middle of twentieth century but the increase of public wealth was not as much. Complex economic and technical developments which had been formed since the Industrial Revolution caused profound changes in the size of cities, the proportion of their population living in them and in urban growth rate (Ebrehimzadeh and Rafiei, 2009, 123).

The result of this is the inequality in the distribution of population in urban system of countries in the past two centuries (Pumain, 2003, 22). During the historical period, inequality in size of population in the cities has been increasing (Roehner, 1995, 30). Studies show that the spatial distribution population and activity in urban systems in developing countries had been more unbalanced and unequal than the developed countries. Excessive focus of population and activities, mainly in the largest cities in developing countries has attracted a major part of the development potentials of these countries to the cities and as a result, these cities have been relatively much larger than the second and the third city in the country (Zebardast, 2007, 29).

The first geographical analysis of distribution of cities size in urban systems goes back to the early twentieth century (Hekmatnia and Mosavi, 2006, 191). In the second half of the twentieth century, rapid population growth and its increasing concentration in one or more urban points in different countries prompted the most issues in demographic policies. At first, the West theorized this phenomenon and called it as an abnormality leads to an

Corresponding Author: Gholam Reza Miri, Assistant Professor, Department of Geography and Urban Planning, Faculty of Humanities, Islamic Azad University, Zahedan Branch, Zahedan, Iran. E-mail: Gholam_Reza_Miri@yahoo.com

imbalance and inequity in the distribution of opportunities and inefficient of system (Amakchi, 2004, 13). In the meantime, what is known as the urban system shows significant differences in the developed and developing countries. Generally, the study of the number, function and distribution of urban centers and distribution pattern of population of these settlements has a special place in urban and regional studies (Taghvai, 2000, 1).

Considering the inequality in population size will lead inequality in other sectors such as economic, social and political activities and many problems and issues will arise in urban and non-urban settlements. Many scientists in different periods have studied different aspects of the urban system and population distribution pattern in urban system. Some have tried to explain urban system and some of them have also tried to understand how to recognize the balance of the urban system by providing some models and some others have presented some ways to improve and increase its balance. Knowledge of the composition of the population and its distribution in each country play a decisive role in its growth and all-round development and relying on these figures, governments are able to organize micro and macro programs of social, economic, cultural development and even administrative organization of society (Ashofteh Teharani, 2002, 33). In the past half century cities have expanded too fast so that the increase in degree of urbanization and urban population of the city has been an undeniable fact. Iran, as a developing country is not the exception. The main characteristic of the urban system of our country is the development of large cities and the population density So that provincial capitals compared to other cities have a big head or macrocephaly. Excessive concentration of national assets and job opportunities have increased urban attractions and the wave of emigration from small residential centers to superior urban centers and from the small and medium cities and villages to political or regional centers (Tavallai and Khazai, 2006).

In this regard, Sistan region is not excepted from this development and growth of cities and by increasing urban population, the urban network of the region has changed therefore, the urban network in urban sustainable development approach caused questions such as: What are the most important factors influencing the spatial distribution of population in urban systems of Sistan region?

Therefore, the goal of the present research is the study of the factors influencing the spatial distribution of population in urban system in Sistan region.

The Goal of The Research
- Assessment and recognition of the factors influencing the spatial distribution of population in the city of Sistan

- Providing strategies for planning and balancing spatial distribution of population in Sistan region

THE HISTORY OF THE RESEARCH

Esmaeilzadeh and Motavaseli, (2006) in a research entitled Growth and distribution of population in metropolitan areas of Metropolis Tehran have concluded that the establishment of population in metropolitan area of Tehran is unbalanced and inappropriate and the goals and strategies of urban schemes has not been achieved in some urban areas and settlements and if this process will be continued, the metropolitan area will be faced with more difficulties.

Farhoodi et al (2009) in a research have studied the manner of spatial distribution of population in urban system in Iran during the years of 1956 to 2006. The results of the data obtained in this study from the selected models show that imbalance in the spatial distribution of population and activity in the urban system of the country has been increased from 1956 to 2006. But from 1976 until now, despite the level of inequality, it has been moving towards more balanced and relevant distribution.

Fazel and Baigmohamadi (2012) in a research have analyzed the spatial structure of the population in the city of Isfahan during 1956 -2006. The obtained results indicate that although the system of the city during the last fifty years has been led to little balance. But due to the presence of Isfahan and a dramatic difference in the total population of the next cities, inconsistency and imbalances in the hierarchy of urban and spatial distribution of population of province is evident.

Ivan et al (2002) in a research that have conducted about spatial structure of city and urbanization suburbs in the metropolitan area of Barcelona city with a critical review of elementary research including (Clark in 1961, the Morth in 1969, Mills 1973). They were used to explain patterns of urban spatial structure in metropolitan areas and in addition to density on the variable of access, they have emphasized on distance to the nearest transport axes and the population and have tried to analyze the decentralization of population and employment in the metropolitan area of Barcelona. The studies show that the urbanization of population is much broader than employment and the model of Single-core metropolis has a limited use to describe the metropolitan area of Barcelona. Finally, rising utilities and improvements that have occurred in private transport have provided conditions of employment provided for suburban population.

CONCEPTS OF URBAN SYSTEMS AND RELATED RESEARCHES AND THEORIES

The urban system is a set of interdependent cities that constitute the structure of urban settlements in an area, region, country and world. The urban system is not only limited to physical collection of urban settlements but it will also include the currents and communications between the settlements. These currents are: Population, capital, factors of production, ideas, information and innovation (Azimi, 2002:53). What is known as the urban system shows great disparities in developed countries and developing countries. At the beginning of the industrial revolution in Europe, a wide redistribution in the population of these countries was performed which can be considered as a factor for diversion of urban system of Europe because many of today modern cities were promoted to the higher rank from small cities. The industrial revolution has another important effect by increasing the size of inequality in cities across Europe (mainly through the impact of the transport system). However, it should be reminded that the urban hierarchy in Europe did not disturbed generally as a result of the industrial revolution however, the harmonious development of infrastructure and public welfare with size of cities in these countries during next periods, led to a balance in urban system. The entry of industrial wave to third world countries, from the early twentieth century was led production and income increase, followed by the demand for municipal services. This process increased the number and size of cities in these countries and from the mid-twentieth century it paved the way for imbalance in urban system of these countries. But what happened in developed countries was a peaceful and orderly compatibility among the changes in the spatial structure of urban system and changes in energy and infrastructure resources and this is why urban system in developed countries has had a further order.

Geographical study of urban system was conducted by well-known figures like Felix Auerbach, Lotka, Goodridge and Singer from the beginning of the century. Although Auerbach propounded the law of rank of city size for the first time in 1913 but George Zip proposed the first systematic review and formulation in this field in 1949.

By proposing the law of rank of city size, Zipf the comments to the whole urban system. He claimed that it is in a "homogeneous social, economic system," that the rule of Rank – Size will be true and it is when the urban system of a country will be balanced. Some researchers believe that there is no adequate theory to explain the prime city. But most of them agree that the phenomenon of Prime City often found in developing countries or small industrial countries (Zebardast, 2006,30).

By studying the distribution of rank of city size, Brian Berry concluded that normal rank-size distribution (theoretical) will be happened in countries which have a developed economy, have multiple major cities with large populations (e.g., China and India) or in the process of development (e.g., Alsavadvr). The systems of Prime city have quite different features and specifications. Berry's studies also showed that the phenomenon of Prime City may be the result of an incorrect definition of the urban system (Tavfigh, 1994, 4).

By studying the phenomenon of Prime City in Latin American countries, Morris concluded that there is no relation between the Prime city and Colonization. for this reason, theorists' attention was focused on economic mechanisms.

Smith proposed the two issue of the Prime population and the Prime infrastructure as a result of studying the Prime city. He believed that the process of the Prime city development can only be understood historically. The Prime population is correlated with the Prime infrastructure historically. The prime infrastructure is correlated with a specific pattern of link between the government and the economy and the prime population is correlated with the late development, colonial and state capitalist development (Zebardast,2007, 32).

Burne (1975) in a book titled "Urban systems" recognized three different functional level of urban system in the advanced economies inspired by the urban system of Western Canada (Burne, 1975, 18).

Berry (1954) in a book entitled "Cities" has investigated the Urban system in the state of Iowa and has realized two important points which include: settlement pattern of this state is echelon and other processes that has been happened is the process of contraction in the city's network caused by development of telecommunications and electronic technology that it has made the cities of urban network closer together. Thus, the urban systems in terms of space-time have been shrunk (Rehnomai et al, 2011, 88).

James Vanz the geographer of University of Berkeley studied the issue with historical geography perspective and by following a meandering path of settlements development concluded that growth hierarchy of residence sometimes acts from top to bottom (According to Christaller model) (Tahmasebi, 2005:30).

David Harvey believes that the contemporary metropolises bring a very complex economy. In this hierarchical economy, local centers dominate on its sphere of influence and more important metropolises dominate on smaller

centers. He knows this economic construction as a result of economic possession and surplus extraction (Harvey, 1997:318).

The formation of hierarchical settlements and their expansion is a function of the demand for centers of specialized applications and transportation technology (Shokohi, 1997: 318). Mark Jefferson the Inventor of "theory of Prime city model" believes that the city which leads a country or region is integrated and large in total that represent national characteristics of people of that country. He also believes that densely populated cities of urban systems are often not compatible with any model and the population size of the first to the eighth city of country is usually more than what it is expected (Jefferson, 1993, 48).

In his view, if three largest cities of a country with ratios of 100, 30, 20% of the population respectively it will mean that the second city has 1/3 and the third city has 1/5 of the first city. It can be said that this country has the pattern or the model of the Prime city (Amlek Hosseni, 1999:31).

AREA OF STUDY

Sistan region with an area of 15,197 sq km in the geographic range between 30°C and 5 minutes to 31 degrees 28 minutes' latitude and 60 degrees 15 minutes to 61 degrees 50 minutes' longitude in southeastern Iran and the northern part of the province Sistan and Baluchestan by about one eighth of the total area allocated to the province. Average annual rainfall in the region 6/59 mm, mean annual temperature of 22°C and the average annual relative humidity is 38.

METHODS OF THE DATA ANALYSIS

The research method is descriptive- analytic based on library, documentary and field studies. AHP and ELCTERE models have been used for analysis of descriptive and inferential data.

DISCUSSION AND CONCLUSIONS

Factors Influencing the Spatial Distribution of Population

spatial distribution of population is one of the most important issues in population geographical studies. Identifying factors influencing the spatial distribution of population is one of the important tools in economic, social, political, and military and security planning.

In present research, analytical Hierarchy Process (AHP) was used for weighting the indices and for determining
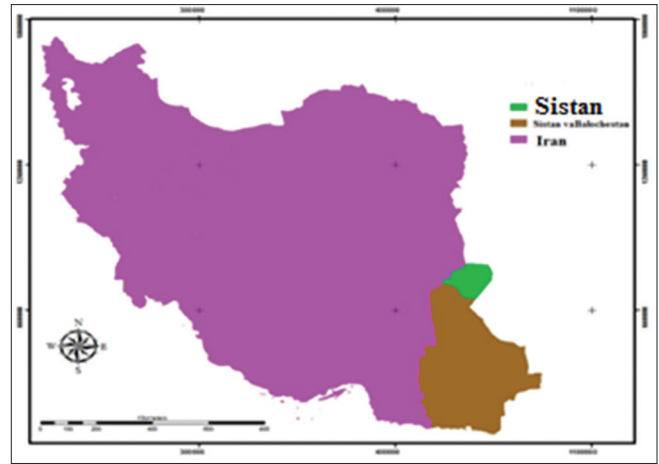

Figure 1: Map of the study area, The reference: the research findings

Table 1: Dimensions and indices influencing the spatial distribution of population in urban system

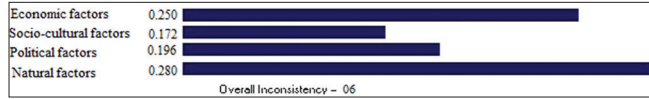| Dimensions	Indices
Natural factors	Climate
	Topography and geology
	Water and Soil
Socio-cultural factors	Emigration
	Identity
	Diversity of cultural goods
Political factors	Proper political space
	Informing and knowledge
	the freedom
Economic factors	Occupation
	Welfare
	Market

The reference: The research findings

relative importance factors to evaluate and analyze factors influencing the spatial distribution of population in the city of Sistan. In this study, the groups decision-making were elite and urban-regional managers and political leaders. After formation of hierarchical structure to determine the weight of each element of decision-making, the pairwise comparisons between elements was conducted.

After completing the questionnaires, Expert Choice software was used to analyze that acts based on the Analytical Hierarchy Process (AHP). Thus, geometric mean was taken for each criterion in each level of expert opinions then the mean was entered to Expert Choice software and a final table at each level was obtained that shows the prioritization of criteria at the same level. It is always possible to calculate the adaptation rate of decision in AHP. If the incompatibility index is greater than 0/1, incompatibility level of ranks will be unacceptable and rankings should be repeated. Finally, the software calculates the final weight of each item from the revised judgments.

Table 2: Preferred size to compare paired

Intensity of importance	1	3	5	7	9	2-4-6-8
Definition	Equally preferred	Moderately preferred	Strongly preferred	Very strongly preferred	Extremely preferred	Intermediate values

The reference: the research findings

Economic factors	0.250
Socio-cultural factors	0.172
Political factors	0.196
Natural factors	0.280

Overall Inconsistency – 06

Figure 2: Weighted index based on the method AHP

The next step, Electre technique has been used in Sistan region for ranking and prioritizing the factors influencing the spatial distribution of population in urban systems. The model of ELECTRE - TRI is a family of multi-criteria of ELECTRE for ranking that Yu presented it for the first time in 1992 and it was developed it in later years. This method is the classification method for MCDM (Multi Criteria Decision Making) that classifies options based on pre-determined intervals. The classification is obtained as a result of comparing each option with profiles that represent the class boundary in ELECTRE - TRI Model.

In this model it is assumed that the utility of each indicator is monotonically increasing or decreasing. Problem with this approach, which involves the seven steps in the next section we will refer to these steps. Table (3) matrix evaluation and decision criteria assessed in the study in the citys of Sistan region ELECTRE model shows.

Our standard every 4 criteria are qualitative. Quality criteria for very low, low, medium, high, very high and the "positive" were considered. Then convert qualitative and quantitative indicators to assess and decide on their placement in the matrix of the "dipole distance scale" are used, which are as follows:

This scale is based on qualitative criteria measured were converted to quantitative criteria that results in a table (5) is reflected.

Obtained after a decision matrix table (Table 5), and the various steps ELECTRE method was performed as follows:

Step One: Normalizing of Decision Matrix (N)
There are several methods of Normalizing the Decision Matrix, which is one of the methods of Normalizing vector.

Normalizing this type of decision-making matrix element squared sum of the squares of each column is divided. In this way, all the columns of the decision matrix are the same units and can easily compare them together.

Equation (1)

Table 3: Matrix of assessment and decision criteria used

Indicators centers	Socio-cultural factors	Economic factors	Political factors	Natural factors
Zabol	Average	Much	Average	Much
Zahak	Average	Much	Low	Average
Hirmand	Low	Low	Low	Much
Hamoon	Average	Average	Low	Low
Nimrooz	Low	Low	Low	Average

The reference: The research findings

Table 4: Matrix of the "dipole distance scale"

0	1	2	3	4	5	6	7	8	9	10
	Very Low		Low		Average		much		very much	

The reference: the research findings

Table 5: Matrix assessment and decision making (Quantitative)

Indicators centers	Socio-cultural factors	Economic factors	Political factors	Natural factors
Zabol	5	7	5	7
Zahak	5	7	3	5
Hirmand	3	3	3	7
Hamoon	5	5	3	3
Nimrooz	3	3	3	5

The reference: The research findings

Table 6: Scale of assessment and decision-making matrix using Norm

Indicators centers	C1	C2	C3	C4
A1	3.17	3.54	2.20	3.54
A2	3.17	3.54	1.74	2.61
A3	2.20	1.81	1.74	3.54
A4	3.17	2.20	1.80	2.20
A5	2.20	1.01	1.72	2.72
Σ	13.91	12	9.10	14.61

The reference: The research findings

$$n_{ij} = \frac{a_{ij}}{\sqrt{\sum_{i=1}^{n} a^2_{ij}}}$$

The Two, Step is to Obtain the Amorphous Matrix Weighted Scale (V)
For this purpose, we use the method of entropy weight parameters using this method to equation (2) and Table (7) to obtain:

Equation (2)

$$P_{ij} = \frac{aij}{\sum_{i=1}^{n} a_{ij}}$$

To obtain the value of k from equation (3) is used:

Equation (3)

$$k = \frac{1}{\ln(m)} = \frac{1}{\ln 3} = 0/91$$

Equation (4)

$$d_j = 1 - E_j$$

Equation (5)

$$w_j = \frac{d_j}{\sum_{j=1}^{n} dj}$$

The weighted version of the Scale Matrix can be acquired, in order to scale the amorphous matrix square matrix (wn * n) the main diagonal elements of the weights of indicators and other elements is zero, we multiply. In this matrix, the matrix is called a weighted version of Scale (V). The following equation is obtained:

Equation (6)

$$V = N \times Wn \times n$$

Step Three to Seven
Set of coordinated and uncoordinated.

At this point, all options should be evaluated with respect to all indices. The matrix is composed of a set of coordinated and uncoordinated. Harmonized set of indicators which include an option another option is desirable. To find the utility must decide on the type of index terms having positive and negative attention. This matrix is calculated by the following equation:

Table 7: Harmonic scale matrix (V)

Indicators centers	C1	C2	C3	C4
A1	0.227	0.295	0.241	0.242
A2	0.227	0.295	0.191	0.178
A3	0.158	0.150	0.191	0.242
A4	0.227	0.183	0.197	0.150
A5	0.158	0.084	0.189	0.186

The reference: The research findings

Equation (7)

$$I_{kl} = \sum w_j, j \in S_{kl}$$

S_{KL} criterion a measure of the relative importance of S_K compared to S_L. This measure is a numerical value between zero and one, and everything indicates that this value S_K is greater than the S_L is more preferred, and vice versa. The next step is to determine the heterogeneity of the matrix based on the matrix V is obtained using the following formula:

Equation (8)

$$NI_{ki} = \frac{\max |v_{kj} - v_{ij}|, j \in D_{ki}}{\max |v_{kj} - v_{ij}|, j \in \sum A}$$

The continuous criterion, K and I set the whole discrepancy indices to measure. Then create an effective matrix H should first set a threshold and if each element of the matrix is greater or equal to i, the elements of the matrix H, takes on a value of zero is otherwise.

Equations (9)

$$I = \frac{Total\ of\ Harmonic\ Matrix\ Values}{Number\ of\ Harmonic\ Matrix\ Values}$$

According to the obtained threshold values in the Harmonic matrix of the effective coordination number is greater than zero; it will be a smaller amount. According to the obtained threshold values in the matrix of the effective coordination number is greater than zero; it will be a smaller amount. Matrix composition and matrix inconsistent with the efficient coordination of the overall matrix is achieved and the resulting matrix to prioritize the options:

This work is done as a result of comparing options with profiles that represent the class boundary. The results of the ELECTRE model showed that Zabol is ranked in first place, the cities of Zahak and Hamoon are jointly in second place and cities of Hirmand and Nimrooz are located in the next places based on the studied indices. Thus, according

Table 8: Final ranking based on the studied indicators

Indicators centers	Socio-cultural factors	Economic factors	Political factors	Natural factors	Rank
Zabol	1	1	1	1	1
Zahak	1	1	0	0	2
Hirmand	0	0	1	0	3
Hamoon	1	1	0	0	2
Nimrooz	0	0	0	0	4

The reference: The research findings

the factors affecting the spatial distribution of population in the urban system of Sistan region, Zabol has the upper hand compared to other cities and is open to the greater impact.

CONCLUSIONS

Urban system consists of a series of towns and cities related to each other that creates the structure of urban settlements in a region or a country. Spatial distribution of the population is one of the most important issues in urban system. Since the spatial distribution of population in the urban system, on the one hand caused by various factors and on the other hand, it influences on various economic, social and managerial factors, it is worthy of discussion and careful consideration.

In this regard the goal of this research is analyzing and prioritizing the factors influencing the spatial distribution of population in urban system in Sistan region. The research method is descriptive- analytic based on library, documentary and field studies. AHP and ELCTERE models have been used for analysis of descriptive and inferential data. The results of Analytical Hierarchy Process (AHP) showed that among the factors influencing the spatial distribution of population in the urban system of Sistan, economic factors have played a major role. The results of ELCTERE model also showed that the city of Zabol has accepted a greater impact compared to other cities in the region considering factors influencing the spatial distribution of population.

SUGGESTIONS

- Creating the necessary backgrounds for geographic dispersion of investments in the surrounding region.
- Strengthening small and secondary towns and regional growth poles of the urban hierarchy.
- Providing special services and facilities in small and medium-sized cities of region.

REFERENCES

Abdin Darkosh S., 2004, A look at the urban economy, Centre of Academic Publication.

Amakchi H, 2004, Intermediate cities and their role in national development frameworks, Tehran, Center for Architecture and Urban Studies, Tehran.

Ashofteh tehrani A, 2002, Demography and analysis of population, Tehran: Gostareh publications

Azimi N, 2002, Scanning the fundamentals of urbanization and urban systems, Nika publications, Mashhad

Behfroz F, 1995, The dominant fields of human geography, Tehran, Tehran University Press.

Bourne L.S and Simons J.W. 1978, Systems of Cities: New York, Oxford University

Ebrahimzadeh I, Rafiei Gh, 2009, Analysis of the model of physical -spatial expansion of the city of Marvdasht Using the Shannon and Holdren entropy models and presenting a desirable model for future expansion, human geography studies, No. 69.

Esmaeilzadeh H, Motavseli M.M, 2006, Growth and distribution of population in metropolitan areas of metropolis of Tehran, Journal of Urban Management, No.18, Shahid Beheshti University.

Farhoodi R, Zanganashaherki S, Saedmocheshi R, 2009, The manner of spatial distribution of population in urban system in Iran during the years 1956 to 2006, Human Geography Research Journal, Volume 42, Number 68.

Fazel S, Baigmohamadi H, 2012, Analysis of the spatial structure of the population in urban systems in Isfahan province during the years 1956- 2006, Journal of Environmental Planning, Volume 5, number 19.

Harvey D, 2000, Social justice and city, translated by F. Hesamian, Haeri.m and Monadizadeh. B, processing enterprises and urban planning publications.

Hekmatnia H, Moavsavi M, 2006, Application of model in geography with an emphasis on urban and regional planning, Elme Novin publications, Yazd, first edition, Yazd.

Ivan M, Ana G, Miguel A, 2002, urban spatial structure and suburbanisation, universitat autonoma de barcelona.

Jefferson M, 1939, The Law of the Primate City, Geographical Review,29.

Pumain D, 2003, Scaling laws and urban systems, p22.

Roehner B. M., 1995, Evolution of urban systems in the Pareto plane, Journal of Regional Science, 35, 2.

Shokohi H, 2000, new views of the urban geography, Fourth Edition, SAMT publications.

Taghvai M, 2000, Application of Rank - size model in the recovery and balancing urban system in Iran, Faculty of Literature and Humanities of Isfahan University, pp 22-23.

Tahmasebi Sh, 2005, Techniques and methods of analysis of urban and regional issues, Management and Planning Organization of Hamedan province.

Tavalai S, Khazai O, 2006, The spatial distribution pattern of population in urban system of Mazandaran province (1976-2006), geography (Journal of the Geographical Society of Iran), a new era, the fourth year, No 10.

Tavfigh F, 1993, A framework for analyzing and integrating regional indices, Abadi Journal, the third year, No.10.

Zebardast E, 2007, Study of developments, the prime city in Iran, Fine Arts publication, No. 29, Spring, Tehran