

Municipal Ranking based on Developmental Indices using PROMETHEE and Factor Analysis (Case study: Kerman, Iran)

M.R. Rahnama¹ and Batool Seyyedi^{2*}

¹ Associated Professor, Ferdowsi University of Mashhad (FUM), Mashhad, Iran

PhD Student in Urban Planning, International College of Ferdowsi University of Mashhad, Mashhad, Iran

* Corresponding author

Abstract

Regarding the necessity of integral regional developmental policies, analyzing development levels in addition to ranking them based on standardized indices, is regarded as the core of any urban planning. Balanced spatial distribution of facilities not only means to dedicating equal cultural spaces but it conceptualizes, in an extended view, the full ability of using unseen potentials in deprived areas. Therefore, it is a significant subject to include deprive diminishing plans for decreasing social inequalities in order to limit their diverse economic and political consequences. In fact, getting a precise insight of different regions due to their different characteristics is considered as the base of a designing a true methodology to gain sustainable development. Application of quantitative criteria for ranking purposes in residential areas results in identifying more suitable locations to live in one hand and is also considered as criteria for construction of plans for decreasing inequalities on the other hand. This papers tries to rank cities located at Kerman province Iran using PROMETHEE methodology as a multi-criteria decision making (MCDM) approach. Results showed that Kerman and Faharaj are ranked as the first and the last developed cities respectively. Factor analysis results (variance coefficient= 0.55) clarified that the difference seen in accessibility levels to facilities is backed to accessibility levels to tools on which stand some developmental signs.

Key words: Municipal Ranking, PROMETHEE, Kerman

Introduction:

Clear regional imbalances as well as unequal distribution of facilities and services are included as inseparable characteristics countries termed as “the third world” among them is included Iran. In developing countries, the quality of people’s lives is directly influenced by these factors (Meysara 2009). Today, a wide range of factors cause a wide network of central locations in residential places affecting their surrounding regions (Nazarian, 1995). Furthermore, regional inequality in all of its forms and levels threatens the objects of humanitarian sustainable

development in addition to facing environmental abilities into different types of dangers (Pacion,

2003). It is completely evident that providing principal social and economic facilities including hygienic water, basic services, psychologically safe environments, etc are regarded as principals for designing sustainable development plans (Ziary, 2001). To gain these aims an integral regional extension through enhanced local conditions is supposed to be the suitable solution. This horizon is accessed by more balanced distribution of economic, social and human capitals throughout different social

locations (Alexander, 2006). The more difference between regions, the more attraction of people's moneys and capitals to richer areas (Khakpour 2006). Therefore, the major objective of governmental policy making plans in the field of future developing maps is to providing a fair pattern of development that covers all social classes (Todaro 1985). Some principal reformations in social, political, administrative and economic structures include some basic requirements for sustainable development (Azkia, 1995). Therefore, increased people's self-confidence, decreased poverty and unemployment coefficient, balanced distribution of economic capitals (incomes and fortunes), increased social welfare, simplified partnership status for people in approved plans, more freedoms, expansion of democratic rules, enhanced humanitarian personalization and, in a summarized term, accompanying of development by social justice, are regarded as inevitable elements of developmental purposes. Firstly, one must explore the current conditions of an area to be able to identify the between development levels in order to be able to take some steps forward for designing for decreasing or eliminating the differences (Hosseinzadeh, 2001). To gain these goals, one must get enough information about distribution pattern of developing indices in different national, regional and local scales (Zanghi abadi, 2011). Sustainable development decreases political unrests and the rate of migration to urban areas on which stand various kinds of urban delinquencies (Harvi, 1997). Ranking different areas based on standardized development criteria is considered as a suitable methodology for evaluating their spatial, economic, educational and environmental conditions. Such an approach provides a deeper insight for polar development in a region regarding the requirements of rich, poor and medium developed areas resulting to justified development in regional scale (Jadidi, 2004). This paper investigates cultural, hygienic,

educational and environmental inequalities among cities geographically located inside politically introduced territories of Kerman province, Iran. Our aim is to identify levels of capital possessing by cities in order to be able in suggesting some development designs for leading their potentials so that some new and clear steps would be taken for enhancing their current condition to a better one.

Background

Peter Hall (1992) believes that job making fortunes composes the most important policy of regional economics in order to decreasing inequality levels, declining migration rate and regional development. In his opinion a countries development in achieved through regional (polar) development. In this strategy, cities are allowed to be fully developed either culturally or economically so that their development may either directly or indirectly influence rural development. For example cities may stimulate agricultural products because of huge consumptions of these products in cities. There are satisfying evidences that confirm "policy of development poles" executed in cities could not handle the goals in stimulation of rural areas (Hamsi 1981). The first principal theory indicating the levels of development was formed in 1950s (Badri, 2011). In this view, economists are divided into 2 main categories: 1- the liberalists (e.g. Colin, Clark, Huggins, rabinson, etc.). 2- the socialists (e.g. Morris Dobb, Pole Barons, etc.). Various approaches have been presented about developmental subjects since the beginning of the negotiations including theory of complementary development, reconstruction theory and marxistic approach (2003). Background of these studies dates back to 30 previous years when the principal theories formed (Rezaee 2011).

Methodology:

This study is an applicable research done through descriptive-analytic technics. Necessary data were collected through documentations presented by organizations as well as librarian assays. These information were also collected through the last formal demographic almanac published by Iranian Center for Statistical Information (ICSI) at 2011. Generally, the indices used for ranking cities were confined into 4 main criteria including economic, hygienic, educational and demographic ones gathered in 76 variable pointed in extended detail in table1. These variables were analyzed by PROMETHEE and factor analysis as MCDM and statistical methodologies, respectively.

Principal component analysis (PCA) was used in order to perform factor analysis. It is worth mentioning that two variables (urban and rural accessibility to first aid services) were omitted from FA because of their zero data series variance. We used SPSS statistical software package v.21 and visual PROMETHEE package to conduct FA and PROMETHEE analysis, respectively.

Promethee Methodology:

The Preference Ranking Organization Method for Enrichment of Evaluations and its descriptive

complement geometrical analysis for interactive aid are better known as the PROMETHEE and Gaia methods.

Based on mathematics and sociology, the PROMETHEE and Gaia method was developed at the beginning of the 1980s and has been extensively studied and refined since then.

It has particular application in decision making, and is used around the world in a wide variety of decision scenarios, in fields such as business, governmental institutions, transportation, healthcare and education.

Table 1: variables categorized in four main criteria

Criteria	Variable
Economic	active population, agriculture, fishery, mining, industry, providing of water, gas and power, structure building, business, hoteling and restaurant, transportation, storekeeping, tenements, renting, insurance, hygienic services, banking and financing, economic partnership and unemployment rate.
Hygienic	number of specialists, dentists, psychologists, pharmacists, hospitals, maternities, active hospital beds, hospitalized patients, laboratories, MRI centers, CTSCAN centers, urgency centers, hospitalization rate, rural accessibility to hygienic WC, HIV positive population, ratio of factories under hygienic services, ratio of employees under hygienic services, number of students under insurance services, raw ratio of borne child, ratio of rural and urban dead borne infants, ratio of urban and rural accessibility to first aid

	services, ratio of death among urban and rural child before 1 year and 1 month old, under 2500 gram borne child, ratio of death under parturition, ratio of home-borne, ratio of hospitalized borne infants, vaccination ratio.
Educational	Number and percent of educational center, number and percent of students, density of students per class.
Demographic	Ratio of urbanization, percent of rural population to total population.

Rather than pointing out a "right" decision, the PROMETHEE and Gaia method helps decision makers find the alternative that best suits their goal and their understanding of the problem. It provides a comprehensive and rational framework for structuring a decision problem, identifying and quantifying its conflicts and synergies, clusters of actions, and highlight the main alternatives and the structured reasoning behind.

The basic elements of the PROMETHEE method have been first introduced by Professor Jean-Pierre Brans (CSOO, VUB Vrije Universiteit Brussel) in 1982. It was later developed and implemented by Professor Jean-Pierre Brans and Professor Bertrand Mareschal (Solvay Brussels School of Economics and Management, ULB Université Libre de Bruxelles), including extensions such as GAIA.

The descriptive approach, named Gaia allows the decision maker to visualize the main features of a decision problem: he/she is able to easily identify conflicts or synergies between criteria, to identify clusters of actions and to highlight remarkable performances.

The prescriptive approach, named PROMETHEE provides the decision maker with both complete and partial rankings of the actions.

PROMETHEE has successfully been used in many decision making contexts worldwide. A non-exhaustive list of scientific publications about extensions, applications and discussions related to the PROMETHEE methods was published in 2010.

The applications of PROMETHEE and Gaia to complex multi-criteria decision scenarios have numbered in the thousands, and have produced extensive results in problems involving planning, resource allocation, priority setting, and selection among alternatives. Other areas have included forecasting, talent selection, and tender analysis.

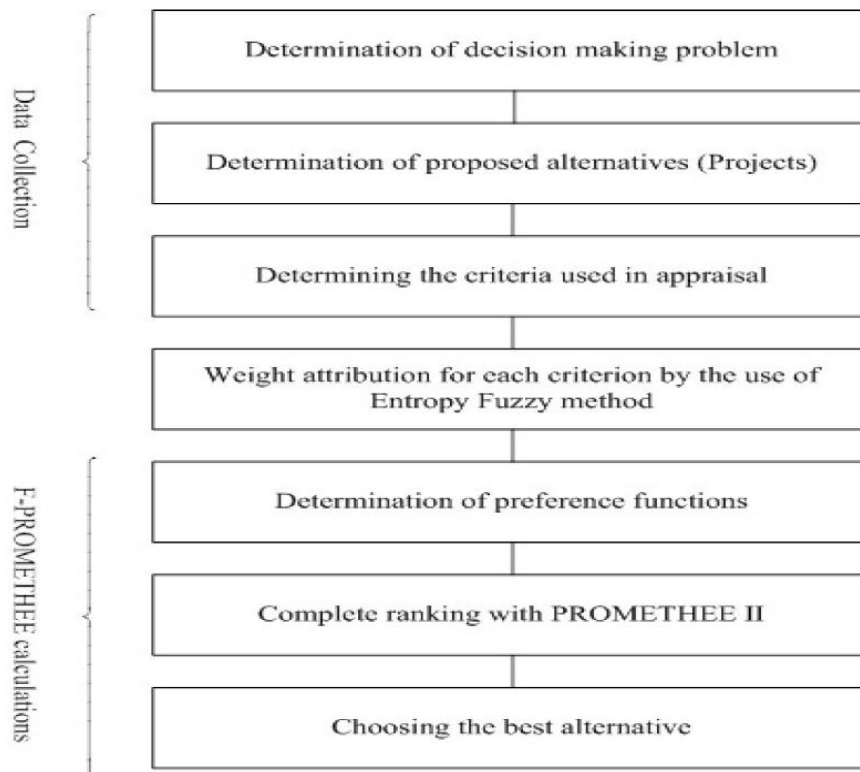


Figure1: PROMETHEE virtual steps

Factor analysis:

Factor analysis is a statistical method used to describe variability among observed, correlated variables in terms of a potentially lower number of unobserved variables called factors. For example, it is possible that variations in four observed variables mainly reflect the variations in two unobserved variables. Factor analysis searches for such joint variations in response to unobserved latent variables. The observed

variables are modelled as linear combinations of the potential factors, plus "error" terms. The information gained about the interdependencies between observed variables can be used later to reduce the set of variables in a dataset. Computationally this technique is equivalent to low rank approximation of the matrix of observed variables. Factor analysis originated in psychometrics, and is used in behavioral sciences, social sciences, marketing, product management, operations research, and other

applied sciences that deal with large quantities of data.

Factor analysis is related to principal component analysis (PCA), but the two are not identical. Latent variable models, including factor analysis, use regression modelling techniques to test hypotheses producing error terms, while PCA is a descriptive statistical technique. There has been significant controversy in the field over the equivalence or otherwise of the two techniques.

Results:

A: Ranking of cities using PROMETHEE methodology:

It is concluded from table 3 that city of Kerman, among 19 cities politically located into Kerman province territory, is positioned at the highest level of development status ($\Phi = 0.355$). Rafsanjan and Sirjan occupy the 2th and the 3th

Using principal component analysis (PCA), we conducted factor analysis in order to categorize 60 criteria into their principal classes. Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were run using SPSS software package in order to test FA satisfactory measure for our set of data (table2).

positions as well ($\Phi = 0.252$ and 0.178 , respectively). According to the results obtained from PROMETHEE analysis, Ravar and Faroj are considered as the most deprived cities ($\Phi = -0.158$ and -0.195 , respectively). It is directly excluded from Φ coefficient calculated by the software in which determines the strongest preference between alternatives based on various variables. Φ ranges from $+1$ to -1 such that the closest the value to $+1$ the more preferred is the alternative and vice versa. Here, cities play the role of alternatives and variables shown on table 1 play the role of the criteria. This is graphically shown in figures 2 and 3 as well. This graph is called "PROMETHEE network". As it is obviously seen, Kerman is at the top and Faroj is at the bottom of the graph indicating the most developed and the least developed cities, respectively.

B: categorization of criteria into main classes using factor analysis:

Table 2: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.785
Approx. Chi-Square		29.416
Bartlett's Test of Sphericity	df	76
	Sig.	.000

Table 3: ranking cities based on Phi coefficient

	cities	Phi	Phi+	Phi-	Variance from Kerman
1	kerman	0.355	0.4858	0.1308	0
2	rafsanjan	0.2527	0.4309	0.1782	0.1023
3	sirjan	0.1728	0.3882	0.2154	0.1822
4	jiroft	0.1145	0.3496	0.2351	0.2405
5	zarand	0.0515	0.3218	0.2703	0.3055

6	roudbar	0.0488	0.2561	0.2073	0.3062
7	bam	0.0393	0.3171	0.2778	0.3157
8	ghale ganj	0.0041	0.1816	0.1775	0.3509
9	kohbanan	-0.0129	0.0942	0.107	0.3679
10	manojan	-0.0163	0.1924	0.2087	0.3713
11	shahre babak	-0.0366	0.2331	0.2696	0.3916
12	kahnoj	-0.04	0.2636	0.3035	0.395
13	baft	-0.0528	0.273	0.3259	0.4078
14	bardsir	-0.1077	0.2432	0.3509	0.4627
15	narmashir	-0.1321	0.0373	0.1694	0.4871
16	anbar abad	-0.1362	0.164	0.3001	0.4912
17	reygan	-0.1497	0.1585	0.3083	0.5047
18	ravar	-0.1585	0.1904	0.3489	0.5135
19	fahroj	-0.1958	0.1104	0.3062	0.5508

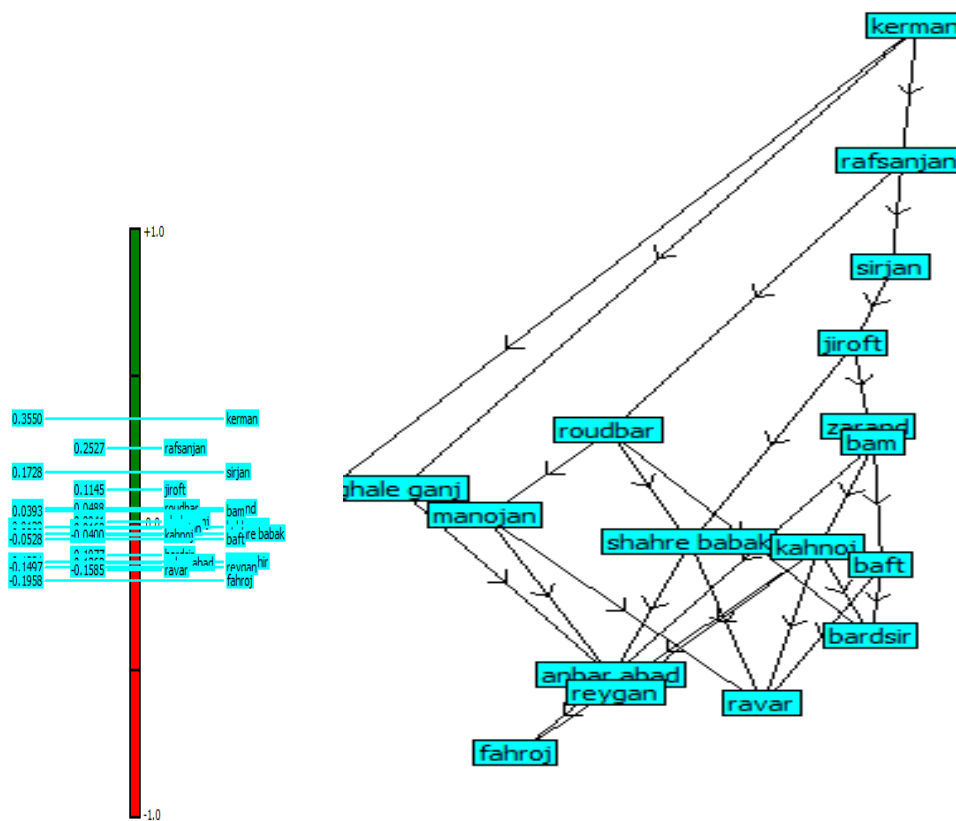


Figure2: graphical ranking of cities presented by Virtual PROMETHEE software (PROMETHEE network)

It deserves mentioning that classes with exactly the same names are different in their indices (table 4). As it is indicated in table 4, 42.2 (DOI: dx.doi.org/14.9831/1444-8939.2014/2-SI/MAGNT-115)

percent of variance is dedicated to hygienic-educational- demographic category (N0.1) of variables in which proves that the variables

included in this category are the most influencing ones for ranking cities. 4.45 percent of variance for the 7th category shows that

percent of rural accessibility to WCs is least influencing factor for ranking cities in Kerman province.

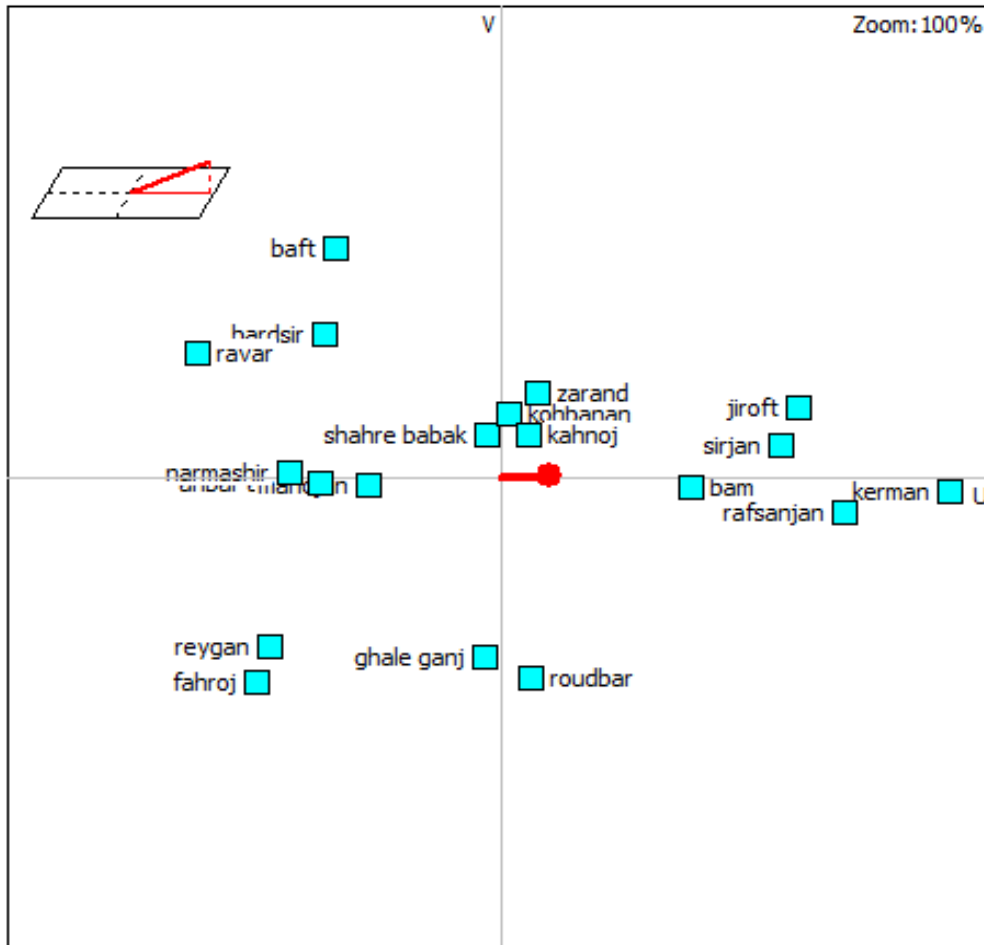


Figure2: graphical ranking of cities presented by Virtual PROMETHEE software (Gaia presentation)

Table 4: variables categorized into 7 principals

NO. of the class	variables	Eigen value	Percent of variance	Cumulative percent of variance	Principal name
1	Number of HIV positive people, percent of employees under hygienic services, percent of students under hygienic services, percent of students at pre-university class, number of students at pre-university class, percent of schools for pre-university classes, percent of students at primary classes, percent of schools for primary classes, number of schools for primary classes, population of cities, number of CTSCAN centers, number of MRI centers, number of physiotropical centers, number of radiology centers, number of pharmacies, number of laboratories, number of hospitalized people, number of active hospital beds, number of hospitals and maternities, number of mortalities of less than one year old per 1000 birth in urban regions, sex ratio at birth, density of student in primary classes, number of students in primary classes, percent of classes in primary schools, number of classes in primary schools, number primary schools, percent of primary schools, ratio of rural life style.	32.893	42.171	42.171	Hygienic-educational-demographic
2	Number of employees under hygienic services, raw birth ratio, number of psychologists, number of pharmacists, number of dentists, number of specialist doctors, number of physicians, ratio of hospitalization, number of urgency centers, under one year mortality ratio per 1000 birth, ratio of child vaccination.	10.314	13.224	55.395	hygienic
3	Ratio of fresh water accessibility in rural regions, percent of factories under hygienic services, desity of students in primary schools, percent of primary schools, rural mortality at birth, ratio of rural child mortality under one year old per 1000 birth, ratio of urban child mortality under five years old per 1000 birth, percent of at home birth.	10.065	12.904	68.299	Hygienic-educational
4	Number of factories under hygienic services, density of students in pre-university classes, density of students in primary schools, percent of primary schools, percent of urban mortalities, number of child mortalities under one month old per 1000 birth, ratio of pregnancy, number of rural child mortality under 5 years old per 1000 birth, percent of hospitalized birth, ratio of rural life style, ratio of urbanization.	9.215	11.814	80.113	Hygienic-educational-demographic

5	Ratio of rural accessibility to hygienic waste excretion, number of rural populations under hygienic services, ratio of hospitalized patients, percent of child vaccinations under 1 year old, percent of child under 2500 g of weight at birth.	6.358	8.151	88.264	hygienic
6	Ratio of pregnancy, percent of child under 2500 g of weight at birth.	5.681	7.283	95.548	hygienic
7	Percent of rural accessibility to WC.	3.473	4.452	100	hygienic

Conclusion:

This paper provides some evidences in which proves that the more we get further from the center (capital) of the province, the more highlighted the inequalities get in every economic, social and cultural dimensions because a huge volume of capitals are centralized into Kerman city as the capital of Kerman province. Therefore, it is evidently concluded that the theory of dynamic developing poles is not only successful in diminishing of inequalities in developing countries, but more accelerates the subject. In this paper, using PROMETHEE model as an MCDM methodology, we ranked 19 cities of Kerman province for their developing conditions based on 60 indices categorized into 7 classes by factor analysis as a statistical method. Results obtained from this study may help policy makers, managers and decision makers for better dealing with their taxes on which inequalities and imbalances could be removed or at least weakened.

Based on the results, Kerman, Rafsanjan and Sirjan are ranked as the first to the third developed cities and Fahroj is considered as the least developed one. This showed that the more nearest a city is to Kerman, the more developed it is. Therefore, the dominant developmental model for Kerman province is a center-ward one in which the gaps between cities get deeper by distance of the capital city (Kerman). However, it is inevitable to consider deprived regions in integrated management plans in order to accelerate regional developmental engine.

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References

- 1- Azkia. M, Ghafari. G, 2005, sociological debates on development, Keyhan press, 5th edition.
- 2- Badri. S.A, Abarian Rounizi. S.R, Javaheri.H, determination of development level of rural region (case study: Kamyaran), Journal of geographical researches, 2005, 825
- 3- Jadidi Miandashti. M, 2003, balanced distribution of financial capitals using LRD method, journal of economic researches, volume12.
- 4- Hossein Zadeh Dalir.K, 1995, regional planning, SAMT press, Volume 1
- 5- Khakpour. B, 2007, evaluation of Shivan city development in order to set a regional planning, journal of geography and regional extention, volume 7, 133-145
- 6- Ashkari. SH, 2007, principals for regional planning, Payame-nour press, volume 3
- 7- Rezvani.MR, 2005, taxonomic evaluation of Iranian provinces for their developmental levels, journal of agricultural sciences, volume 51, 459-474
- 8- Rahnama.M, 2001, ranking municipal systems and regional planning (case study: Korasan Razavi province, Iran).
- 9- Alexander.E.R,)2006(Evaluation in Planing,Evaluation and Prospects Ashgate publishing
- 10- Azkid,Mostafa,1985,An Introdction to Sociology of Countries Development Information Publiation Tehran

- 11- Todaro Micheal,1985,Economy Development in Developing Countries,Translator:Qolam
- 12- Ali Farjadi,Ferst Eiditon Publication of Planing and Budget Dpertement,Tehran
- 13- M.Pacion.(2003)Urban geography a Global Perspective ,Zth,London,Routledge
- 14- Taghavi,Neamatolah,1999,Sociology of Countries,Fourth Edition Publication of Payam-e-Nor University.
- 15- Hadder,r(2000)Development Geography Routledge,London,New York P3
- 16- United Nation Dvelopment Program(2005)Human Development Report 2005,New York.
- 17- Hamasi,Mohammad,1981 Discussion Based on Effetive Factors of Man Power Migration in Iran,Iranin Geography Association Publication (Review),Ferst Period,NO3.
- 18- Hall Peter 19992,Urban Regional Planning,3rded.Landon and New York.
- 19- SabagKermani,Majid2001,Local Economy Samt Publication,Tehran.
- 20- Noor bakhsh ,F(2000)Human Development and Regional Disparities in India. Ceter for Development Studies Department of Economics University Glasgow
- 21- Kline,P,1994,An Easy Guidie to Factor or Analysis,Routledge, London