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Re-Organizing of Iran's Yazd Province Urban Network Emphasizing on Development Rate

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ABSTRACT

One of the most important aspects of regional developments is to recognize economical and spatial structures of the region. Universal experience has shown that ignoring attention to the role of small and medium cities simultaneously with increasing trend of urbanization will result in country polarization, over all-heading phenomenon, severe imbalance in residence order, inaccessibility of some cities to development trend, and creating gap between urban and rural regions. The purpose of this paper is to re-organize Yazd province urban network focusing on development rate.

The approach to this study is descriptive-analytical and it re-organizes Yazd province urban network based on library information and the statistical data obtained from four censuses (1976, 1986, 1996, and 2006) using spatial analysis models. The result of the study shows that residence order of the province and its urban hierarchy has changed in the last decades apt to the line with social, economical, and political changes. Considering models used in the study, it can be said that Yazd province is the first in Urban Primacy dominant in urban hierarchy; moreover, spatial distribution is unequal in this province. The results achieved using entropy index shows that population distribution in Yazd province urban network and cities between 1976 to 2006 has moved towards imbalance making the process unequal. So that Yazd as the capital of province is the on the top and Nodoshan is the most deprived city in terms of the study indices.

Key words: Urban network, development, tensile, Yazd province.

INTRODUCTION

One of the significant features of spatial development in Iran is regional inequality and absence of regional balance. This gap between different regions is considered as an obstacle for the mentioned regions development. Urbanization extension and increase in the number of cities has resulted in forming inefficient and fractured urban system, as a result of which, significant example is the capital of Iran; Tehran and existence of few large cities in some regions and large number of small cities and villages in the country. The inefficient urban system having fractured urban hierarchy has caused lack of integration and making various difficulties in distributing urban services in all provinces.

High density of population and facility in one or some geographical points is one of the significant features of third world countries in which development of large cities associated with complete discontinuity with medium and small cities has allocated highest level of economic, social, and services to itself.

Development polar strategy and priority of source allocation preference to certain regions in the past have resulted in polarization of spatial development in the country and large volume of population and activities have been allocated to some major polars such as Tehran, Isfahan, Mashhad, Tabriz, and Shiraz. As an example, Yazd city has attracted the population and facilities in its dominant area and caused imbalance in population system of the province. According to census in 2006, above 60 percent of urban population is living in Yazd city and the rest live in 22 other cities of the province. Population of Yazd is above 7 times more than the population of Meybod as a second city of the province; therefore, urban population distribution in the province shows imbalance in population system. At present, this province with one large city is one of the provinces with medium sized urbanization percent in the country in which the urban population exceeds 50 percent. One of the major reasons of high urbanization rate in the province is the existence of the metropolitan city of Yazd, playing the transitional role in Tehran- Bandar Abbas highway and splitting regional networks from this main highway.

Concepts, viewpoints, and theoretical principles

Urbanization system consists of a set of correlative cities forming urban residence order in an area, region, country, and the world. Urbanization system is not only limited to physical collection of urban residencies; but it

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also includes streams and communications among these settling areas. The streams are: population, capital, produce factors, ideas, information and innovation (Azimi, 2002).

Theories about organizing and spatial development of regions mainly describe how to manage space and biological centers hierarchy in areas. Several studies have been done since 1930s in this field. Central Place Theory is the most famous and applicable among all models explaining the spatial residency. The theory tries to discover the relation between Central Place and dominant area and defines Central Place as a living place providing services and population of its dominant area (Maboudi, 2003: 16). Walter Crystaller modeled residency spatial distribution of South Germany to write Central Place Theory and analyzed it in his own theoretical framework. His theory is based on this fact that central place distribution in spatial area is such that each central place supplies commodity and service needed for its lower central places. In fact, Crystaller's main model is depended on marketing which results in establishing hierarchy interrelationship between Central Places (Azimi, 2003).

Brian Barry presenting Systems Theory emphasizes that public investments in infrastructure and medium and small cities is essential. He believes that primary goal of national planning should be investment in order to achieve balanced hierarchy (Eftekhari and Kharameh, 2003).

Beaujeu Garnier inspired by Anglo-Saxon geographical theory concentrates on nature of facilities and extension of attraction space of cities in evaluating urban hierarchy (Misra, 1974).

Reconstruction Patterns of Population Center Theory presented by UN emphasizes on reconstruction of population centers and points such as population distributions integration, creating regional balance, improving medium and small sized cities to increase living possibility, paying attention to environment, and providing services and facilities in downstream(Ziari,2004: 204). Baptiste believes that difference between industrial and developing countries is in their hierarchy system in economic structure. This structure in former is introverted and in later is extroverted (Baptiste and Darz,1998).

David Harvey believes that current metropolises have a type of complex economy. In this hierarchic economy, local centers are dominant over their dominated area and more important metropolis over smaller centers. He ascribes this economic structure as a result of excessive possession and surplus of economy (Harvey,1997). Shokoii ascribes forming hierarchic residencies and their spread-out as a submission of level of demands for specific function of centers and transportation technology (Shokoii, 1995).

Mark Jefferson, founder of Urban Primacy Theory, believes that a leading city of a country or region is totally large and integrated expressing national properties of people. In his idea, if three large cities of a country have 20, 30, and 100 percent of population ratio respectively, it means that second city has a population of 1.3 and third city 1.5 of the population of first city. It can be said that this country follows Urban Primacy Pattern (Malekhossieni, 1999).

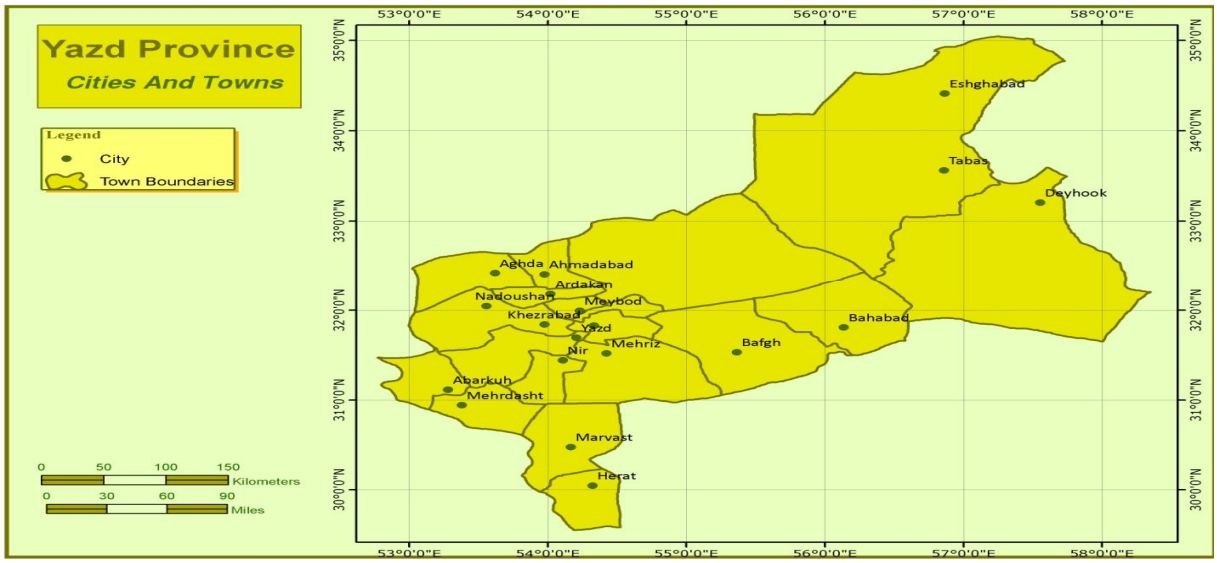
RESEARCH METHODOLOGY

A combination of survey, descriptive, and analytical methods were used to reach the purpose of this research. In this step documentary method has been used to set research theoretical framework and reviewed previous researches. Finally, quantitative models were used to analyze data.Statistical data from 1976, as a statistical basic year, were collected in a form of statistical series including 4 periods. Statistical society of the research is cities of Yazd Province in the year 2006 census.

An introduction to the priphery of the studied region

Yazd province having an area about 131575 square kilometers is located in central area of Iran plateau. The province lies on 29 degree and 35 minutes to 35 degree 7 minutes north latitude and 52 degrees 50 minutes 58 degree 16 minutes east longitude and on dry belt of northern hemisphere.

Yazd province having 18.2 percent of deserts of country is on the second place next to the Sistan and Baluchestan province.The province is neighboring with Isfahan and Semnan Provinces from north, Khorasan Province from east, Kerman Province from south, and Isfahan and Fars from west (Hekmatnia,2009:45). According to last country divisions in 2007, Yazd province has 10 cities, 23 towns, 20 counties, and 51 villages (Yazd province statistical yearbook, 2008: 29). Map (1) shows the location of towns of province. The province having 1.4 percent of population of the country (1035753) and occupying 8 percent of country area is the fourth largest province in Iran located in central plateau.



Map1: Yazd province political division. Source: Author

Yazd Province Urban Network Analysis

Urban network and urban residence distribution analytical models were used to analyze urban hierarchy system of Yazd province aiming at understanding balance or imbalance of the system. These models are as below:

Class Discrepancy Resolution Model

Urban hierarchy of Yazd province has been evaluated based on 4 statistical periods: 1976, 1986, 1999, and 2006 using population parameter. As it is observed in tables 1, 2, 3, and 4, we see big gap in studied periods and this serious flux grows as time passes. In 1976 class discrepancy was 2 classes but in 1986 and 1999 becomes 3 and in 2006 comes to 4, maximum discrepancy in all periods.

Table 1: Urban hierarchy nomination using Class Discrepancy Resolution Model in 1976.

	Population	Number of Cities	Percent	City
1	105752-135925	1	10	Yazd
2	75579-105752	-	-	-
3	45406-75579	-	-	-
4	15233-45406	2	20	Ardakan-Meybod
5	6177-15233	7	70	Others
Total		10	100	

Source: Author's Calculation

Table 2: Urban hierarchy nomination using Class Discrepancy Resolution Model in 1986.

	Population	Number of Cities	Percent	City
1	184761-230483	1	7.1	Yazd
2	139039-184761	-	-	-
3	93317-139039	-	-	-
4	47595-93317	-	-	-
5	1873-47595	13	92.9	Others
Total		14	100	

Source: Author's Calculation

Table 3: Urban hierarchy nomination using Class Discrepancy Resolution Model in 1999.

	Population	Number of Cities	Percent	City
1	261813-326776	1	6.3	Yazd
2	196850-261813	-	-	-
3	131887-196850	-	-	-
4	66924-131887	-	-	-
5	1961-66924	15	93.7	Others
Total		16	100	

Source: Author's Calculation

Table 4: Urban hierarchy nomination using Class Discrepancy Resolution Model in 2006.

	Population	Number of Cities	Percent	City
1	352541-423006	1	4.3	Yazd
2	282076-352541	-	-	-
3	211611-282076	-	-	-
4	141146-211611	-	-	-
5	70681-141146	-	-	-
6	216-70681	22	95.7	Others
Total		23	100	

Source: Author's Calculation

Determining Tensile Rate of Cities in Yazd Province

One of the models used for determining city's ability to attract population is determining elasticity rate or ability to attract population. Based on this model, if tensile rate of one city is above 1, it shows high tensile of the city; and if it is lower than 1, it shows stagnation of development of the city. Related equation is:

$$E_{(t,t+10)} = \frac{r_v(t, t+10)}{r(t, t+10)}$$

E= tensile coefficient in time interval t and t+10

Rv= annual urban population growth rate

r= annual total population growth rate

Computing population growth rate and city tensile rate in Yazd province in 2006 (Table 5 and Diagram 1) show that Yazd, Shahedieh, Bafgh, Bahabad, Harat, Hamidia, and Meybod had high tensile rate rather than other cities and Nir, Zarch, Abarkouh, Mehriz, Taft, and Marvast had lowest tensile rate. Tabas and Ashkezar had relative balance and the rate was around 1 continously.

Table 5 : Computing population growth rate and tensile rate

Year / City	1996	2006	Population Growth Rate	Tensile rate
Ardakan	44398	51349	1.46	0.8
Bahabad	4826	7199	4.08	2.3
Bafgh	25068	30867	2.1	12
Taft	15115	15329	0.14	0.07
Nir	1960	1567	-2.2	-1.2
Mehriz	25239	26364	0.43	0.23
Yazd	326776	423006	2.6	1.4
Shahedieh	11115	14374	2.6	1.4
Hamidia	13100	27611	7.7	4.3
Zarch	12377	9979	-2.1	-1.17
Meybod	38061	58295	4.35	2.4
Abarkouh	19164	20994	0.9	0.5
Ashkezar	11413	13800	1.9	1.05
Harat	8687	10795	2.1	1.2
Marvast	6934	7585	0.9	0.5
Tabas	25722	30681	1.7	0.9

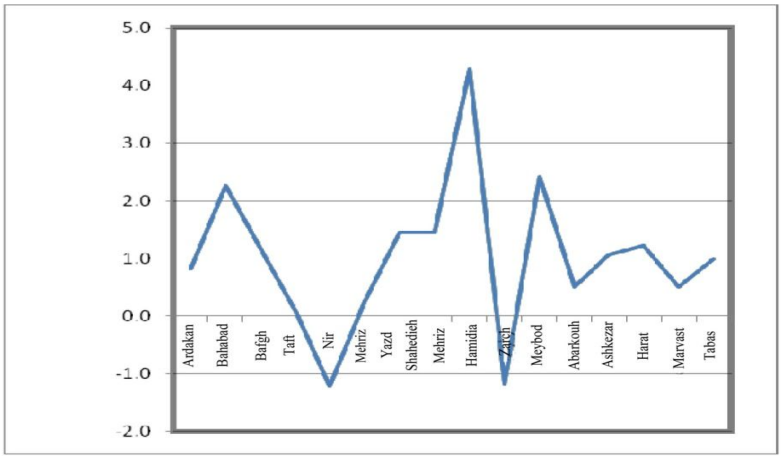


Diagram 1 : Tensile Rate of Cities in Yazd Province

Determining Entropy Degree of Cities in Yazd Province

This theory is based on prediction of probabilities appropriate to regularity or irregularity of studied phenomena behavior in the past can be effective in predicting directions of organizing them in future. The more regular formation and changes of a phenomenon in past, the more probable to predict acceptable form feasibility in future. As entropy is primarily depended on Stochastic rules of mathematical method which predicts system function and behavior based on previous function, therefore, it can be used in organizing and finding certain orders of various constructive systems for national, regional, and urban systems. The theory and its methods are also used for describing residencies, population distribution in geographical space, determining population density degree in an area. The related equation is: (Technical, 2003)

$$H = \sum_{i=1}^{n} P_i \log \frac{1}{P_i} = \sum \; - P_i \log P_i$$

$$^{2}R = 1 - \frac{H}{H_{\max}} = \frac{H}{\log K}$$

H= absolute entropy

P_i= class Population frequency

Log= natural logarithm

R= relative entropy

H_{max}= maximum absolute entropy equal to population complete steady distribution

To compute entropy, you should:

Compute population frequency in each sub-area (P_i)

Compute irregularity rate of phenomenon distribution in sub-area (H)

We can use irregularity (R) for comparing sub-areas in terms of desired spatial distribution phenomenon.

If R=0, it shows absolute concentration in an area and if R=1, it shows high distribution and the population is distributed relatively and steadily.

To understand the balance or imbalance of urban network, entropy index for all cities in the province was calculated based on censuses in years 1976, 1986, 1996, and 2006. Entropy of years 1976 and 1986 was about 1.6, year 1996 around 1.8, and year 2006 around 1.9. Indicated in table (6).

Table 6: Entropy coefficient in 4 censuses. Source: Iran Statistic Center and Author's calculation

Year	Number of Cities	Entropy Coefficient
1976	10	1.6
1986	14	1.6
1996	16	1.8
2006	23	1.9

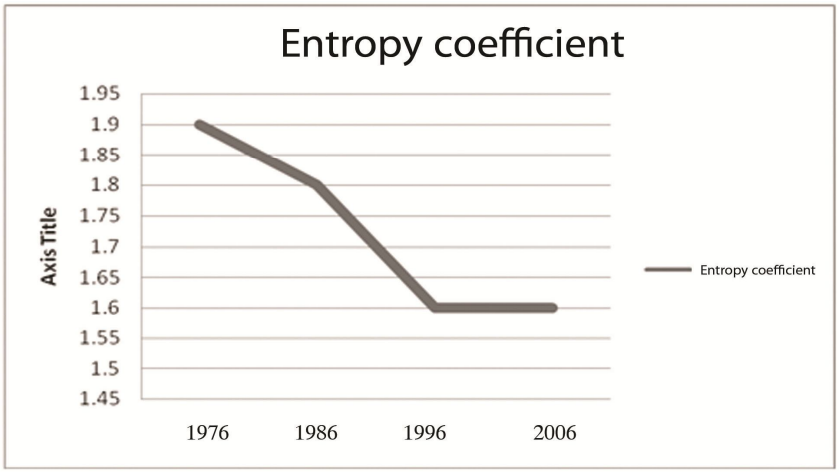


Diagram 2: Entropy coefficient of cities in Yazd province from 1976 to 2006

Above values shows that distribution of population in cities and urban network has moved toward imbalance during years 1976 to 2006.

Analysis of Urban Primacy Changes Rate in Urban System of Yazd Province Urban Primacy index:

Urban Primacy includes one city's dominance of population, economical, social and political over all other cities in an urban system (Smith, 1998:13). Mark Jefferson, an American geographer, using population data of cities in 44 developed countries to determine Urban Primacy degree observed that in 44 countries first city is twice larger than the second ones and in 10 other, first city is 3 times larger than the second ones. However, measurement and Urban Primacy index determining method is not mentioned, it is known that he has used "relative method" based on which first city proportion over second city was calculated.

Urban Primacy index is calculated by largest city population (P_1) over total urban population (P) of national or regional urban system.

$$UPI = \frac{P_1}{p}$$

The more numerical value of the index, the more dominant the first city is (Krugman, 1996).Although calculating the index is so simple, the index has a basic problem: first, it does not regard city rank; second, it does not end to a unifying base enabling the researcher to know what value is balance or first city dominance (Taghvaii and Mousavi, 2009). Some researchers have interpreted Urban Primacy to Macro Clay in which urban city possesses a very huge head and a slim body (Tofighi,1997).

Two-city index: Jefferson called Two-city index a relative method based on which first city population proportion is calculated over second city. The bigger the index, the more Urban Primacy ratio the city has:

$$TCI = \frac{P_1}{P_2}$$

Four-city or Ginsberg index: Clark suggests that choosing four first cities rather than two cities is a better choice for calculation. Therefore, he suggested four-city term in which first city proportion is calculated over next three cities (four cities in total) as follows: (Azimi, 2002)

$$Ginsbergshdex: \frac{P_1}{P_2 + P_3 + P_4}$$

Mehta index: Mehta (1964) suggested the best method for calculating Urban Primacy ratio correcting Clark's equation using first city proportion over four first cities:

$$Mehta\ index = \frac{P_1}{P_1 + P_2 + P_3 + P_4}$$

Moumav and Alvesabi index: This index is provided by dividing sum of first and second city population over sum of third and fourth city population. The bigger the index, the more Urban Primacy ratio urban system has (Zebardast, 2007).

$$\frac{P_1 + P_2}{P_3 + P_4}$$

Table7: four first cities population in Yazd province in various periods.

Year / City	1976	1986	1996	City / Year	2006
Yazd	135925	230483	326776	Yazd	432194
Ardakan	20914	34838	44398	Meybod	58872
Meybod	17848	27143	38061	Ardakan	52881
Mehriz	12308	20830	25239	Tabas	31948

Source: Author

You can see results of calculation in table 9 and figure 3.

Table8: Urban Primacy indexes in Yazd province from 1976 to 2006.

Year / Index	1976	1986	1996	2006
First City Index	0/623	0/603	0/580	0/547
Two-city Index	6/499	6/616	7/360	7/341
Ginsberg Index	2/661	2/783	3/034	3/008
Mehta Index	0/727	0/736	0/752	0/750
Mumav& Alvesabi Index	5/201	5/531	5/864	5/789

Source: Author

Table9: Urban Primacy indexes in Yazd province from 1976 to 1986.

Index \ Year	1976	1986	1996	2006
First City Index	0/623	0/603	0/580	0/547
Two-city Index	6/499	6/616	7/360	7/341
Ginsberg Index	2/661	2/783	3/034	3/008
Mehta Index	0/727	0/736	0/752	0/750
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Source: Author

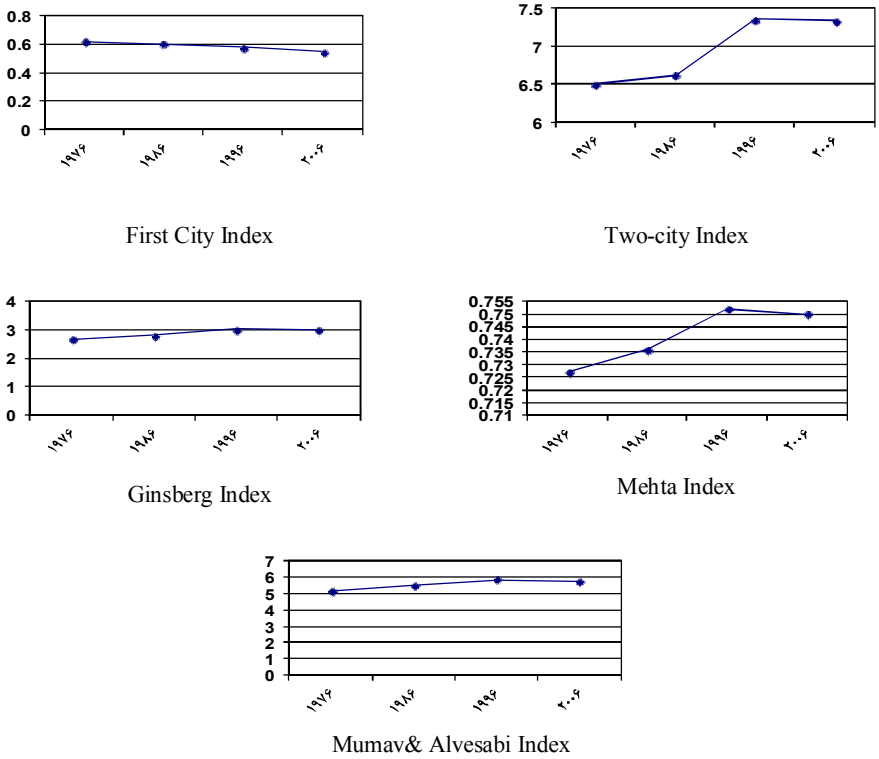

Figure3: increase and decrease process of Urban Primacy ratio in urban system of Yazd province from 1976 to 1986.
Source: Author

Analyzing Urban System Concentration Changes in Yazd Province

Hirschman- Herfindahl Index (HHI):

Hirschman- Herfindahl index is the best one to evaluate urban concentration degree. This index is used to determine Urban Primacy – the largest city share of national population- degree. It can be measured grossly. Urban Primacy measurement has a close relation with HHI (Henderson, 1999). Herfindahl (1950) represented this index in his Ph.D thesis in Colombia University. Then Hirschman (1964) explained this index (Tabner,2003).The index is an absolute criterion in evaluating inequality.

$$HHI = \sum_{i=1}^{i=n} \left(\frac{Xi}{\sum_{i=1}^{n} Xi} .100 \right)^2$$

X_i is the population of city I and $\sum X_i$ is total urban population. (Urquiola and other, 1999:12).

$$H = \sum (P_i / P)^2$$

Henderson Decentralization Index: Similar to Herfindahl index shows decrease in urban system concentration.

$$UD = \left[\sum_{i=1}^{n} \left(\frac{P_i}{P} \right)^2 \right]^{-1}$$

According to equation, P_i is population of city I, P is total urban population, and n is the number of cities in urban system (Zebardast,2007:37).

Table10: Concentration indexes in Yazd province in 1976-2006.

Index / Year	1976	1986	2006	2006
Herfindahl Index	0.413	0.386	0.354	0.318
Henderson Index	2.424	2.590	2.822	3.148

Source: Author

Herfindahl Index Henderson Index

Figure4: increase and decrease concentration ratio process in urban system of Yazd province. ***Source: Author***

Spatial Development Analysis of Cities in Yazd Province

Numerical Taxonomy method was used to study development of cities in the province. Regarding limitations in accessing to data and non-cooperation of related organization, calculations were done based on available indexes and data(Table11).

Table11: used indexes in writing urban system in Yazd province

	Literate percent	Literate women percent	Reversed family over population	City population over total province population	Hospital beds per person	Specialist per person	Pharmacy per person	Post office per person	Communication agencies per person	Technical and vocational training centers per person
Yazd	91.6	89.12	3.76	0.5472	4.31	1.0	0.16	0.01	0.09	0.01
Meybod	88.29	84.82	3.75	0.0745	1.63	0.54	0.14	0.02	0.07	0.03
Ardakan	88.29	84.12	42.99	0.067	2.8	0.3	0.13	0.2	0.06	0.04
Tabas	92.29	90.4	4.0	0.0405	2.35	1.06	0.13	0.03	0.03	0.03
Bafq	90.42	87.05	3.91	0.0393	3.09	0.87	0.1	0.03	0.1	0.03
Hamidia	93.52	91.93	3.81	0.035	0.0	0.0	0.07	0.0	0.07	0.0
Mehriz	86.49	83.1	3.89	0.0343	3.54	1.07	0.15	0.04	0.07	0.07
Abarkouh	87.8	84.08	3.7	0.0276	1.47	1.01	0.14	0.05	0.09	0.05
Taft	91.51	89.03	3.84	0.0208	13.37	1.7	0.18	0.06	0.12	0.06
Shahedie	86.01	82.34	3.81	0.0182	0.0	0.0	0.07	0.0	0.14	0.0
Ashkezar	87.48	84.46	3.75	0.0177	0.0	0.0	0.21	0.07	0.07	0.07
Harat	87.89	85.08	3.96	0.0138	2.29	0.37	0.18	0.09	0.18	0.09
Zarch	86.53	82.27	4.08	0.0126	0.0	0.0	0.2	0.1	0.1	0.1
Marvast	80.75	79.21	3.87	0.0096	0.0	0.0	0.13	0.0	0.13	0.0
Bahabad	90.23	87.59	4.57	0.0094	0.0	0.0	0.14	0.14	0.14	0.0
Mehrdasht	85.46	82.2	4.1	0.0091	0.0	0.0	0.14	0.0	0.14	0.0
Ahmadabad	85.74	82.76	3.87	0.0060	0.0	0.0	0.0	0.0	0.21	0.0
Eshghabad	90.06	87.72	3.83	0.0060	0.0	0.0	0.21	0.21	0.21	0.21
Diehouk	82.66	77.09	3.89	0.0038	0.0	0.0	0.0	0.33	0.33	0.0
Nodoshan	76.38	72.21	3.65	0.0030	0.0	0.0	0.0	0.0	0.42	0.0
Nir	73.87	70.39	3.27	0.0021	0.0	0.0	0.0	0.0	0.6	0.6
Aqda	82.82	76.71	3.72	0.0020	0.0	0.0	0.0	0.0	0.62	0.0
Khezrabad	76.58	63.16	4.49	0.0004	0.0	0.0	0.0	0.0	3.53	0.0

Source: Author

Following equation is used to calculate development degree:

$$DL = \frac{C_{io}}{C_o}$$

In this equation:
DL= Level of development of the city/town
Cio= city compound distance from ideal city
Co= is derived from following equation:

$$C_o = \overline{C_{io}} + 2S_{io}$$

DL is continuously variable between 1 and 0. As it gets close to 0, it shows more development and closing to 1 shows non-development (Table12).

Table 12: final ranking of Cities.

Rank	City	DL
1	Yazd	0.75
2	Taft	0.76
3	Ardakan	0.77
4	Eshghabad	0.81
5	Mehriz	0.82
6	Harat	0.82
7	Tabas	0.83
8	Bafq	0.83
9	Abarkouh	0.84
10	Meybod	0.85
11	Zarch	0.87
12	Bahabad	0.87
13	Ashkezar	0.88
14	Deihouk	0.9
15	Hamidia	0.91
16	Mehrdasht	0.92
17	Nir	0.92
18	Shahedie	0.93
19	Marvast	0.94
20	Ahmadabad	0.94
21	Aqda	094
22	Khezrabad	0.95
23	Nodoshan	0.98

Source: Author

Considering above table, Yazd and Nodoshan are the most fruitful and the most deprived cities of respectively. Dividing province areas to fruition, semi-fruition, and deprived in terms of our studied features, we can say that Yazd, Taft, and Ardakan are fruition; Eshghabad, Mehriz, Harat, Tabas, Bafgh, Abarkouh, Meybod, Zarch, Bahabad, and Ashkezar are semi-fruition; and Deihouk, Hamidia, Mehrdasht, Nir, Shahedieh, Marvast, Ahmadabad, Aghda, Khezrabad, and Nodoshan are deprived cities of the province. Figure 5 shows cities distribution based on fruition rate:

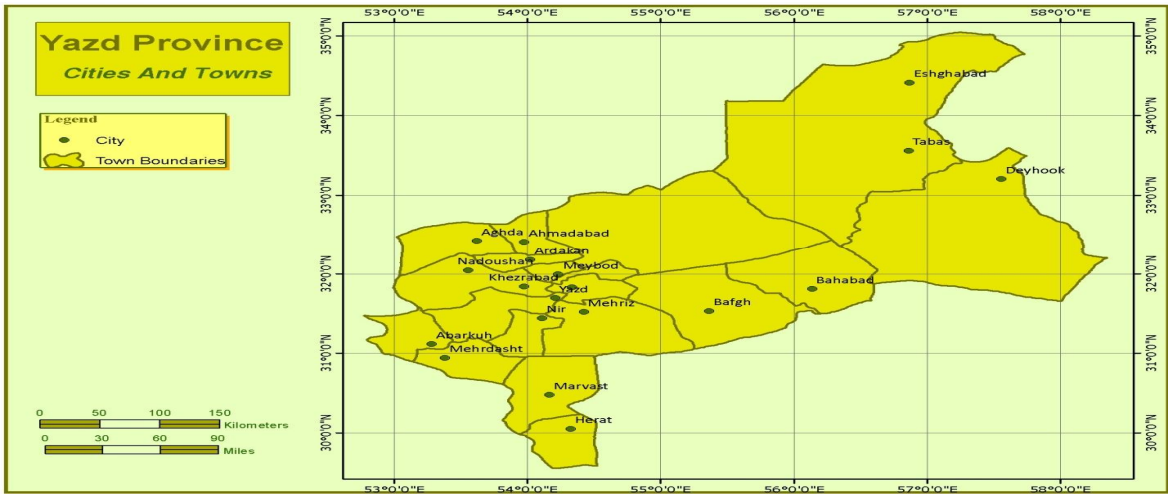

Figure 5: city distribution based on fruition rate map.
Source: Author

Conclusion

Now-a-days significant concentration of population, facilities,comprehensive sources in capital of Iran and some other metropolises such as Mashhad, Isfahan, Tabriz, Shiraz, and some other large cities has made the country facing with huge problems like many third world countries. For this reason, urban system concept can be studied in several directions. One of them is how distribution of population in many cities of the country and the quality of communications and interactions of these points in urban network and organizing and balancing of space. Since urban network is not only a collection of physical elements and communication directions and rates; but also, determines the role and importance of each residence in a system; large cities with attracting and concentration of more surpluses inflict the dominancy of their own on smaller cities.Such process leads to reproduction of dominant residencies and weakening smaller places functionally. Continuity of this condition results in forming imbalance in city spatial distribution and outbreak of problems caused by congestion and density in cities and discharge of other places. It also shows that instead of Urban Primacy domination in Yazd province, and the tendency to concentrating and priority in region via urban network polarization, the whole system is moving toward imbalance and as time passes concentration rate increases in the province. Regarding several models used in the study, we can conclude that province residence order and urban hierarchy has been changed in line with social, economical, and political changes in last four decades, so that determining urban hierarchy using Class Discrepancy Resolution Model represents that a severe gap can be seen in urban classes and the gap grows as time passes. In year 1976 class discrepancy was 2 classes, in years 1986 and 1996 grew to 3, and in 2006 reached 4, its maximum rate. The results achieved using entropy index shows that population distribution in Yazd province urban network and cities between 1976 to 2006 has moved towards imbalance making the process unequal. Moreover, spatial distribution of fruition levels is unequal in the province, so that Yazd as a center of province is the most fruitful and Nodoshan is the deprived one in terms of studied indice.

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