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An analysis of the urban system of Chaharmahal and Bakhtiari province (1956-2016)

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Abstract

In country of Iran also like developing countries, Excessive concentration of national capital and job opportunities has been Cause of increase urban attractions and the emergence of great migrations from villages, small and medium-sized cities to political and regional centers that have created urban primacy phenomenon and an increase in the number of cities. Regarding the importance of the subject, this study was conducted with the aim of evaluating and analyzing the urban system of Chaharmahal and Bakhtiari province during the period 1956 to 2016. The research method is based on the applied purpose with descriptive-analytic nature. The statistical population of the research is all 40 urban settlements of Chaharmahal and Bakhtiari province during the period 1956 to 2016. Indicators used in research include urban primacy, urban concentration and balanced distribution and dispersion patterns of urban settlements. In sum, the results of urban primacy evaluation indexes shown that the urban system of Chaharmahal and Bakhtiari province during the period of 1956-2016 is moving towards the imbalance and urban primacy dominance. The results of the Herfindahl Concentration Index show that concentration in the urban system of the province has been decreasing from 1956 to 2016 and is moving toward balance. The results of the class difference method indicate the difference in the population classes of cities over time and increase the distance of the first city of the province from the second city and other cities. The results of the entropy coefficient show the balancing of spatial distribution of population in the urban system of Chaharmahal and Bakhtiari province. The result of the analysis of the nearest neighbor also indicates a roughly uniform distribution of the settlements in the province.

Key Words: *Urban system, urban primate, urban concentration, balanced distribution*

Introduction

Urbanization occurs as countries shift from rural-agricultural activity into urban-industrial activity (Davis & Henderson, 2003: 2). Urbanization has been a universal and important social and economic phenomenon taking place all around the world. This process, with no sign of slowing down, may be the most powerful and visible anthropogenic force that has brought about fundamental changes in land use and landscape pattern around the globe (Deng et al, 2009: 1). Globally, more people live in urban areas than in rural areas, with 54 percent of the world's population residing in urban areas in 2014. In 1950, 30 percent of the world's population was urban, and by 2050, 66 percent of the world's population is projected to be urban (United Nations, 2014: 1). Rapid urbanization, especially in the developing world, will continue to be one of the crucial issues of global change in the 21st century affecting the human dimensions (Deng et al, 2009: 1). By 2030, according to the projections of the United Nations (UN) Population Division, each of the major regions of the developing world will hold more urban than rural dwellers; by 2050 fully two-thirds of their inhabitants are likely to live in urban areas (Montgomery, 2008: 1). It focuses excessively on the operation of the international capitalist system and pays insufficient attention to internal cultural and political forces operating in 'dependent' countries (Pacione, 2005: 621).

Up to the beginning of this century, Iran had a relatively balanced urban network but with the rule of political economy of oil and land reforms (1962 to 1972), huge rural -urban migration was instigated, leading to instability and heterogeneity of Iran's urban network (Shamaei & Hajinejad, 2014: 1). Since 1950s, extraordinary growth of cities, and increase in urban population have led to change the model and system of human settlements (Ghanbari et al, 2016: 2). Population growth and increase in migration over the past decades have raised population density in some Iranian cities and provinces (Khalili Araghi et al, 2017: 1). So that, the development of large cities and population density in them is the main characteristic of the urban system of the country (Ghaibi & Jajarmi, 2011: 3). In fact, urbanization in Iran, during the recent decades, similar to other developing countries has been increasing and the population has concentrated in urban areas. Despite high urbanization level and increase in the number of cities during the past 55 years, urban growth rate has not been consistent and different urban growth rates have changed the urban system substantially. Some cities have improved their status because of economic, political and environmental factors, while other cities have lost their status in urban hierarchy (Seifolddini, 2014: 2).

Accordingly, many believe that the study of the urban system illuminates a lot of issues, including the causes of the displacement of labor and capital among cities, and intense concentration in a region, and the recession and depletion of population in another region of the country (Babaie et al, 2016: 2). At the level of the regions and the provinces, this urban system also represents the national space on a smaller scale. A superior city on the upper level of the city's pyramid, a few heterogeneous cities at a great distance from it, and the crowds of small village -towns with poor performance that can't compete with the city of superiority (Hajipur & Zabardast, 2005: 2). The case study (Chaharmahal and Bakhtiari province) is no exception. The city of Shahr-e-Kord, as the capital of Chaharmahal and Bakhtiari province, Due to its proper political, administrative and geographic location, it is considered the main pole of the province. This has caused the population of surrounding cities and villages to be absorbed into this city and kept small cities from development; so that the city has a high population and urbanization than other cities of the province; therefore, it should be carefully and thoroughly studying the urban system of the

province Chaharmahal and Bakhtiari discovered the strengths and weaknesses of this organization and made the necessary arrangements to organize it. Therefore, considering the importance of studying the urban system and its changes over time, the main objective of this research is to evaluate and analyze the urban system of Chaharmahal and Bakhtiari province during the period 1956-2016.

Methodology

The present research is an applied research with descriptive-analytic nature. To collect data, the results of general population and housing censuses of Chaharmahal and Bakhtiari province during the period of 1956-2016 were used. The statistical population of the study consisted of all urban settlements of Chaharmahal and Bakhtiari province during the period of 1956-2016. In this research, the applied models of urban system assessment include urban primacy assessment index's (Urban primacy index, two city index, Mehta four city index, Moomaw and Alwosabi), Urban concentration Assessment Index (Herfindahl Index), balanced distribution assessment index's (class difference method and Entropy Coefficient) and The nearest neighbor method have been Used.

Study Area

Chaharmahal and Bakhtiari Province is one of the 31 provinces of [Iran](#). It lies in the southwestern part of the country. Chaharmahal and Bakhtiari Province is surrounded by Isfahan province from north and east, Khuzestan province from west, Kohgiluyeh and Boyerahmad province from south and Lorestan province from northwest. Its capital is [Shahr-e Kord](#). It has an area of 16,421 square kilometers, and had a population of 947,763 in the last population census (2016).

During the years 1956-2016 the number of Chaharmahal and Bakhtaran's cities has constantly increased from 6 cities in 1956 to 40 in 2016. Table 1 shows the increase of population and number of cities in the province during the period 1956-2016.

Table 1: Number and Population of cities in period of 1956-2016

year	Number of cities	Population of cities
1956	6	53376
1966	9	85660
1976	12	140269
1986	13	237758
1996	18	337973
2006	26	431782
2016	40	607444

(Reference: Researchers finding, 2018)

Analysis of urban primacy of chaharmahal and bakhtiari province

The concept of primate city was initiated by Mark Jefferson, he studied over fifty one countries and found primacy in 46 countries of major city, on the premise of empirical observations he initiated the concept of Primate City in 1939 in his paper entitled “Law of the primate city” his speculation was “A country's leading city is always disproportionately large and exceptionally expressive of national capacity and feeling. The primate city is commonly at least twice as large as the next largest city and more than twice as significant” (Dolui, 2017: 1).

Urban primacy index (UPI)

This index is measured with the population ratio of the largest city to total urban population of the country or region (Maqsoodpoor, 2016: 6). This may be expressed as a ratio:

$$(1) UPI = \frac{P1}{P}$$

Table 2: Urban primacy index of Chaharmahal and Bakhtiari province

Year	1956	1966	1976	1986	1996	2006	2016
Urban primacy index	0.289	0.277	0.287	0.315	0.290	293	0.313

(Reference: Researchers finding, 2018)

The results of Table 2 show that the Urban primacy Index has risen from 0.29 in 1956 to 0.31 in 2016, indicating the movement of the urban system to imbalance.

Two city index (TCI)

One of the most commonly methods of determination urban primacy is the two-city index, which, due to its simplicity in wider level has used by urban and regional planners. This index is related to the Zapf's law (rank-size) and has a specific basis that is obtained by calculating the prime urban population ratio to the second urban. In this index, numerical value obtained if was 2, is balanced but if it is above 2, then the urban primacy is dominant (Amanpur et al, 2013: 6). This may be expressed as a ratio:

$$(2) TCI = \frac{P1}{P2}$$

Table 3: Two city index of Chaharmahal and Bakhtiari province

Year	1956	1966	1976	1986	1996	2006	2016
Two city index	1.32	1.54	1.93	2.19	2.32	2.58	3.34

(Reference: Researchers finding, 2018)

The results of Table 3 show the upward trend of the two cities index over the period of 1956 to 2016. Until 1976, there was no urban primacy in the province of Chaharmahal and Bakhtiari, but since 1986, urban primacy is dominant and has been added in subsequent periods.

Mehta Four city index (MFCI)

In 1964, as suggested by Mehta, the best method for determining the urban primacy index is the ratio of the first city to the first four-cities of the urban system (Nazmfar, 2012: 2). This may be expressed as a ratio:

$$(3) (MFCI) = \frac{P_1}{P_1+P_2+P_3+P_4}$$

Then Richardson adjusted four city indexes with rank-size rule's criteria. In this case, if on the basis of rank-size rule the optimum size of cities in urban system are such that the primate city equals to double of second city, triple of third city and quadruple of fourth city, then the proportion of primate city to total four cities equals to 0.48{0.48 = (0.33+ 0.25+0.5+1) ÷ 1}. This distribution is the best and the most common form of urban Excellence. Based on such criteria, the degree of proficiency and Excellence of primate city on the urban system is proposed in table 4 (Dadfar & Azimi, 2013: 8).

Table 4: Degree of primate city in urban system, based on four-city index

Four City Index	Kind of superiority
1-0.65	Ultra superiority
0.65-0.54	Superiority
0.54-0.41	Desired superiority
Less than 0.41	Minimum superiority

(Reference: Dadfar and Azimi, 2013: 8).

For assessment of urban system of Chaharmahal and Bakhtiari province based on fitting urban system pattern based on four city index table 5 is provided. As observed, the primate city change pattern of Iran urban system is different from Chaharmahal and Bakhtiari.

Table 5: Four city index in national and Chaharmahal and Bakhtiari province urban system

Index/Year	1956	1966	1976	1986	1996	2006	2016
MFCI of national urban system	0.657	0.687	0.701	0.638	0.608	0.589	0.570
Superiority	US	US	US	S	S	S	S
MFCI of chaharmahal and bakhtiari's urban system	0.363	0.417	0.474	0.511	0.527	0.549	0.596
Superiority	MS	DS	DS	DS	DS	S	S

(Reference: Taghvaie and Mousavi, 2009: 7 and Researchers finding, 2018)

Based on the results of the Mehta's Four City Index, the urban system of Chaharmahal and Bakhtiari province in 1956 was in a state of minimum superiority, during the period from 1966 to 1996, it was in a superiority favorable situation and in the years 2006 and 2016 it was in the superiority status. The results of this indicator indicate the movement of the province urban system to imbalance.

Moomaw and Alwosabi index

This index is obtained by dividing the total population of the first and second cities into the total population of the third and fourth cities (Zabardast, 2007: 7).

$$(4) \text{ Moomaw and Alwosabi index} = \frac{P_1 + P_2}{P_3 + P_4}$$

Table 6: Moomaw and Alwosabi index of Chaharmahal and Bakhtiari province urban system

Year	1956	1966	1976	1986	1996	2006	2016
Moomaw and Alwosabi	1.767	2.212	2.563	2.913	3.072	3.189	3.425

(Reference: Researchers finding, 2018)

According to the Moomaw and Alwosabi index, urban primacy in Chaharmahal and Bakhtiari province has been intensifying from 1956 to 2016.

Herfindahl Index

This index indicates that during the statistical periods, the whole urban system has been movement toward equilibrium or not. The Herfindahl index is calculated by the following formula (Taghvaie & Saberi, 2010: 6): (P_i); the population of the city i and p ; the total urban population of the region (Karimi et al, 2016: 6).

$$(5) H_i = \sum_{i=1}^n \left[\frac{P_i}{P} \right]^2$$

Table 7: Herfindahl Index of Chaharmahal and Bakhtiari province

Year	1956	1966	1976	1986	1996	2006	2016
Herfindahl Index	0.195	0.154	0.139	0.151	0.126	0.121	0.124

(Reference: Researchers finding, 2018)

The Herfindahl concentration Index has been used to assess urban concentration in Chaharmahal and Bakhtiari province. The results of this index indicate that concentration in the urban system of the province during the period of 1956 to 2016 has been decreasing and moving toward balance.

Entropy Coefficient

Entropy is one of the theories, derived from probability laws and based on probability models. This model initially is applied by the physicians to recognize the regularity and anarchy in nature and it determines the instability and the lack of uniformity in a system. If the entropy tends to zero, it shows more centralization or less balance in population distribution of cities, while the value near 1 indicates more balanced distribution in the region (Hekmatnia & Moosavi, 2013). Among the many available indexes, research shows that relative entropy is better than others because it is not affected by the number of sub-areas (Tsai, 2005: 6). Total form of this model is as the following equation:

$$(6) H = -\sum_{i=1}^n P_i \times \ln(P_i)$$

$$(7) G = \frac{H}{\ln k}$$

Which H is total frequency in neperian logarithm, P_i is the ratio of i -th city population to the total cities population, G is entropy amount and K is number of categories (Sangi, 2011: 5). H and G was calculated in the years 1956, 1966, 1976, 1986, 1996, 2006 and 2016 respectively as:

Table 8: Entropy coefficient in 7 statistic periods

Year	Number of cities	H	Entropy coefficient
1956	6	0.693	0.387
1966	9	0.854	0.477
1976	12	1.090	0.608
1986	13	1.325	0.740
1996	18	1.267	0.707
2006	26	1.426	0.796
2016	40	1.669	0.931

(Reference: Researchers finding, 2018)

According to the model, whatever entropy index approaches to zero, indicating more centralization and lack of balance in population distribution and if approaches to one, indicating balanced regional distribution. Entropy index for the years 1956, 1966, 1976, 1986, 1996, 2006 and 2016 was calculated 0.387, 0.477, 0.608, 0.740, 0.707, 0.796 and 0.931, respectively. These values show that chaharmahal and bakhtiari hierarchy is going to a balance situation.

Urban hierarchy determination using class difference method

This scientific method can be performed using statistical formulae especially with highest and lowest population data. The general structure of the model is as follows:

First stage: Determination of frequency amplitude of the population in cities

$$(8) R = \text{Max}(P) - \text{Min}(P)$$

Second stage: Determination of class count using "Sturges" rule

$$(9) K = 1 + 3.3 \log N$$

K : class count N =city number

Third stage: Determination of class difference

$$(10) H = R/K$$

Fourth stage: Forming a matrix and dividing the cities (Khazae et al, 2015: 3).

Hierarchy in Chaharmahal and bakhtiari province was evaluated based on 7 statistical periods (1956, 1966, 1976, 1986, 1996, 2006 and 2016), using population factor.

Table 9: Determination of cities hierarchy in 1956 using class difference method

Raw	Percent	Number of cities	Population group	City
1	16.66	1	12871-15476	Shahr e kord
2	16.66	1	10265-12871	Borujen
3	16.66	1	7660-10265	Farrokh Shahr
4	50	3	5054-7660	Other cities
Sum	100	6	-	-

(Reference: Researchers finding, 2018)

Table 10: Determination of cities hierarchy in 1966 using class difference method

Raw	Percent	Number of cities	Population group	City
1	11.11	1	19842-23757	Shahr e kord
2	-	-	15928-19842	-
3	11.11	1	12014-15928	Borujen
4	11.11	1	8100-12014	Farrokh Shahr
5	66.66	6	4186-8100	Other cities
Sum	100	9	-	-

(Reference: Researchers finding, 2018)

Table 11: Determination of cities hierarchy in 1976 using class difference method

Raw	Percent	Number of cities	Population group	City
1	8.33	1	33347-40359	Shahr e kord
2	-	-	26334-33347	-
3	8.33	1	19322-26334	Borujen
4	8.33	1	12309-19322	Farrokh Shahr
5	75	9	5297-12309	Other cities
Sum	100	12	-	-

(Reference: Researchers finding, 2018)

Table 12: Determination of cities hierarchy in 1986 using class difference method

Raw	Percent	Number of cities	Population group	City
1	7.69	1	60930-75080	Shahr e kord
2	-	-	46780-60930	-

3	7.69	1	32631-46780	Borujen
4	7.69	1	18481-32631	Farrokh Shahr
5	76.92	10	4331-18481	Other cities
Sum	100	13	-	-

(Reference: Researchers finding, 2018)

Table 13: Determination of cities hierarchy in 1996 using class difference method

Raw	Percent	Number of cities	Population group	City
1	5.55	1	82630-98174	Shahr e kord
2	-	-	67085-82630	-
3	-	-	51541-67085	-
4	5.55	1	35996-51541	Borujen
5	5.55	1	20452-35996	Farrokh Shahr
6	83.33	15	4907-20452	Other cities
Sum	100	18	-	-

(Reference: Researchers finding, 2018)

Table 14: Determination of cities hierarchy in 2006 using class difference method

Raw	Percent	Number of cities	Population group	City
1	3.84	1	106005-126746	Shahr e kord
2	-	-	85263-106005	-
3	-	-	64522-85263	-
4	3.84	1	43780-64522	Borujen
5	7.69	2	23039-43780	Farrokh Shahr, Farsan
6	84.61	22	2297-23039	Other cities
Sum	100	26	-	-

(Reference: Researchers finding, 2018)

Table 15: Determination of cities hierarchy in 2016 using class difference method

Raw	Percent	Number of cities	Population group	City
1	2.5	1	163407-190441	Shahr e kord

2	-	-	136373-163407	-
3	-	-	109339-136373	-
4	-	-	82305-109339	-
5	2.5	1	55271-82305	Borujen
6	7.5	3	28237-55271	Lordegan, Farrokh Shahr, Farsan
7	87.5	35	1203-28237	Other cities
Sum	100	40	-	-

(Reference: Researchers finding, 2018)

Results show that there are serious difference in the urban classes of the Chaharmahal and bakhtiari Province, in all studied periods. These differences increased over time. In 1956, there were no differences between classes of urban levels, and in 1966 – 1986 differences of classes of urban levels were 1 and they were 2 from 1996-2006. In 2016, these differences reached its maximum 3 classes.

The nearest neighbor

To determine the type of dispersion of settlements, the nearest neighboring method is used. Using this method, an index called "Rate Neighborhood" is obtained, which its variation ranges is from 0 to 2.15. This index expressed dispersion at the surface of the region apart from the factors affecting its formation. As a result, the index closer to zero represents a dense and cluster distribution pattern, and closer to the 2.5, represents a regular distribution pattern, and the number 1 also represents a random distribution pattern of the settlements (Mohammadi & Rostami, 2016: 9). The steps of the nearest neighbor model are as follows:

Step 1: Calculate the distance of each urban settlement from its nearest neighbor

Table 16: Calculating the distance of each urban settlement from its nearest neighbor (km)

Row	Settlement	Nearest neighbor	distance	Row	Settlement	Nearest neighbor	distance
1	Shahr-e Kord	Kian	9	21	Gujan	Farsan	3
2	Borujen	Naqneh	5.5	22	Taqanak	Hafshejan	5.5
3	Lordegan	Sardasht	21	23	Naghan	Ardal	14
4	Farrokh Shahr	Kian	12	24	Sardasht	Lordegan	21
5	Farsan	Gujan	3	25	Sudjan	Haruni	27
6	Hafshejan	Taqanak	5.5	26	Sefid dasht	Faradonbeh	15
7	Junqan	Cholicheh	11	27	Aluni	Lordegan	27

8	Saman	Nafech	19	28	Dastana	Shalamzar	5
9	Faradonbeh	Borujen	8	29	Cholicheh	Pardanzan	8.5
10	Ben	Vardanzan	9	30	Vardanzan	Nafech	6
11	Kian	Shahr-e Kord	9	31	Kaj	Ardal	14
12	Sureshjan	Pardanzan	14	32	Nafech	Vardanzan	6
13	Boldaji	Gandoman	15	33	Male Khalifeh	Aluni	49
14	Babaheydar	Farsan	15	34	Dashtak	Kaj	22
15	Ardal	Naghan	13	35	Haruni	Sureshjan	16
16	Naqneh	Borujen	5.5	36	Chelgard	Sudjan	33
17	Pardanzan	Farsan	3.5	37	Sar Khun	Manj	58
18	Shalamzar	Dastana	5	38	Bazoft	Samsami	46
19	Gandoman	Boldaji	15	39	Manj	Lordegan	24
20	Gahru	Shalamzar	11	40	Samsami	Kaj	43

(Reference: Researchers finding, 2018)

Step 2; Calculate the mean distances using the formula:

$$(11) Dobs = \frac{\sum D}{N} = \frac{652}{40} = 16.3$$

D: distance between settlements and N: number of measurements

Step 3; earn an average amount of random distribution using the formula:

$$(12) Dran = 0/5 \sqrt{\frac{A}{N}} = 0/5 \sqrt{\frac{16421}{40}} = 10.13$$

A: Area (area of the province in square kilometers) and N: number of settlements

Step 4; Calculate the Nearest Neighborhood Index (Rn) using the formula:

$$(13) Rn = \frac{Dobs}{Dran} = \frac{16.3}{10.13} = 1.609$$

As it is seen, the Rn index in this province is 1.609 and, given that the index value is closer to 2.15, the distribution of settlements in Chaharmahal and Bakhtiari province has a nearly uniform pattern which resulting from the compact form of the province as well as a more compact spatial distribution Urban settlements are in all regions of the province except in the northwest and western parts; therefore, according to the results of this model, there is almost an equilibrium in Chaharmahal and Bakhtiari province.

Conclusion

The results of the urban primacy index for the province of Chaharmahal and Bakhtiari indicate that the urban system of the province has been moving towards the imbalance and dominance of

urban primacy over the period from 1956 to 2016, and during this time the amount of urban primacy dominance has been added. The results of two-city index show that, until 1976, the urban primacy phenomenon in the province was not dominant and the urban system had a balance, but since 1986, urban primacy in province emerge, and it has intensified in subsequent periods. According to the Mehta's Four City Index, the urban system of the province in 1956 have been in the urban primacy condition (Minimum superiority), from 1966 to 1996 in the urban primacy condition (Desired superiority) and in the years 2006 and 2016 is in the urban primacy condition (superiority). According to the results of this index, the urban system of province during the period of 1956-2016 is moving towards imbalance. The results of the Moomaw and Alwosabi Index indicate the domination of the urban primacy phenomenon in the province during the period 1956-2016, which is being added at an increasing pace. In sum, the results of urban primacy index indicate that the urban system of Chaharmahal and Bakhtiari province during the period of 2016-1956 is moving towards the imbalance.

The result of the Herfindahl Concentration Index used to evaluate urban concentration in the province indicates that concentration in the urban system of the province during the period of 1956-2016 has been decreasing and moving to decentralization. Also, for evaluation the balanced distribution of cities in the province, the class difference method and entropy coefficient have been used. The results of the class difference method show that there is no disparity in the population classes in 1956, but the increase in the population of the first city compared to the second city and other cities in subsequent periods, leads to a disparity in the population classes, so that the class differences in 1966, 1976 and 1986 was 1 in the period 1996 and 2006 to 2, and in the 2016 period, this difference be increased to 3 classes. Also, the percentage of cities in the first class of the population has increased from 50% in 1956 to 87.5 in 2016. The aforesaid results indicate the emergence of disparity in the population classes of cities, which has been leads to unbalanced distribution of cities in the provincial urban system. According to the results, the entropy coefficient was arrived from 0.376 in 1956 to 0.931 in 2016, indicating the balanced spatial distribution of population in the urban system of Chaharmahal and Bakhtiari province. Based on the analysis model of the nearest Neighbor, the distribution pattern of settlements in Chaharmahal and Bakhtiari province is almost uniform and indicates a fairly regular distribution pattern.

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