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Ranking healthy city condition applying numerical taxonomy (case study: main cities of Mazandaran)

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Abstract: Growth and increase of urbanization across the globe led to priority of attention given to the health and quality of life of citizens of the towns. Mazandaran province is more sensitive than other cities because of the potential of the residence, economic and tourism.The objective of this study is to analyze the spatial indicators of healthy urban areas index in various areas of the province. The method is based on an analysis of data from 2006 using techniques of numerical taxonomy.For this objective, we applied 40 different indicators selected based on the theoretical foundations of healthy city and analysis was performed using Excel software.The results indicated that city centers can be classified into 5 groups among which the healthiest group included Babel and the least healthy one was Galogah. 14 other cities were in the middle and the third group with ten cities had maximum number of cities.Also, it was observed that distance from city center has no influence on the health of the city.

Key words: Healthy city; Mazandaran; Numerical taxonomy; Classification; Ranking

1. Introduction

More than half the world's population are living in urban areas today. By 2050, this proportion is expected to reach 70 percent of the world population (Shen et al., 2013). In 2000 the urban areas composed less than 0.2% (300 000 km²) of droughts across the globe. It is estimated that by 2030it will increase to 2.6-fold and include nearly 770000 square kilometers of land (Angel et al., 2011). This means that 60% of the world's population lives in 6% of land. (Alvarez- Berrios et al., 2013). The blinding speed in the past 50 years, especially in developing nations, as high-speed physical phenomena has covered cities and villages (Ibrahim et al., 2002) has caused environmental changes and urban landscapes (Hedblom and Soderstrom, 2008; Catalan et al., 2008). There have been too much requests for basic infrastructure (Schouten and Mathenge, 2010).

Because of lack of infrastructure, this led to uncontrolled urban development,establishment of new settlements, loss of man welfare (Ortega et al., 2011), raising of environmental problems, threat to public health indicators, limited access to recreational facilities and at last lack of access to sustainable development.Meantime, given the worrying trendon the environmental factors threatening the health of citizens, health planners and urban areas offer a relatively new term used by health plans which tries to link the physical and mental health of the urban environment and strengthen their decisions regarding some significant issues of urban environment, like health, social welfare and improving quality of human life (Thompson, 2007).

These scholars believe that the city is living, dynamic and human-centered that needs a long-term plan in order to be healthy. The issue is currently the responsibility of managers and urban planners who can help citizens to achieve their demands to have a healthy city, and lifestyle and proper air condition.Healthy City is understood based on the situation and social, economic, cultural and climatically diverse regions.Because each of the cities have their own features, the city with its citizens as well as the combination of social, economic, social, cultural structure and activity levels, abilities and capacities are different from each other.Therefore, with lack of indicators and standards for understanding social development in our country(Armaki et al., 2012) it is important to recognize healthy city.

Because of its potential and actual aspects of residential, commercial and tourism Mazandaran Province becomes more important. In this respect, the cities situation in regional and national scale, the scale of cities in terms of healthy city can help planners and managers to take effective steps to establish a healthy and dynamic urban environment.On the other hand, by considering the fact that whether or not this movement has made no difference over the next few decades is a substantial issue is to find an appropriate approach to evaluate variables and a set of logical steps towards healthy city is open to discuss, yet (Oneill and Simard, 2006). The objective of this study was to rank the cities of

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the province in terms of the criteria for a healthy city.

2. Literature review

The study was conducted in various cities that have different parameters. The most important indicators of a healthy city in Taipei for the program were intended which are as follows**?**

- Security (road safety, occupational safety, reducing crime and violence, and accidents which are caused by fire)
- Life (and comfortable living environment, bike lanes, parks and green space, physical activity)
- Sustainability (piping, sewer, sidewalks, improvement, development of public transportation, recycling, waste, water and air pollution **(**preservation of cultural heritage)(Taipei Healthy City Project, 2005).

In another study in Korea in Jean-Jo which was done to evaluate the indicators**,** indices were classified into 4 groups of indicators physical, economic, social and physical health. Each contains following components**:**

- Physical Environment: parking space per capita per person, drinking water supply, bike lane, level of waste produced**.**
- Economic: gross domestic product (GDP), unemployment rate, export of agricultural products**.**
- Social: the number of students per teachers, rate of participation in social activities, the crime rate**.**
- Physical health, physical activity, number of physicians, birth rate, proportion of elderly population in the total population (healthy cities initiative of Jin-Ju city-Korea, 2005).

Several studies have also been performed the most important of which is as follows**;**Rahnama et al. analyzed the indicators of the health of Baharestan Neighborhoods in Mashhad City in terms of social, economic, environmental, health, and cultural indices and compared them with normal standards. The results demonstrated that based on five Health Foundation indices the neighborhood is far from the ideal situation (Rahnama and others, 2011). Ghadami et al. in a comparative study of indicators of a healthy national and international scale evaluated social, demographic and urban areas of Iran compared to average level of developed countries in the context of a healthy city**.**The results showed that although the country's urban areas are in good condition in some indicators of population health and individual and social, they still need to be improved in many indicators of a healthy city (Ghadami and others, 2010).

In evaluation of the Healthy City Project of Sizdah-Aban Dorms, Parhizgar et al. examined views of the people and authorities of the Healthy City project plans. The results show that the in relation to the level of satisfaction with the project, although there was no important difference between the views of the public and authorities**;** there is a significant difference between their views on the level of social participation, (Parhizgar and others, 2007).

2.1. Theoretical study

The idea of a healthy city was raised for the first time by Professor Leonard Drum, 1984 in Toronto, Canada. In his article titled "Healthy City", effects of urban models on mental health of citizens was reviewed and addressed by urban health experts**.**

In this paper, healthy city was defined as follows: the city which is continuously developing or improving social and physical development of its activities**,** thereby allows full function properly to achieve the maximum utilization of human capabilities (Bahreyni, 2005). Two years later, in collaboration with Professor Duhl and Hancock definition of Healthy City was defined which is as follows**:**

Healthy city is a city which is constantly and continuously being established, improves its social and physical environments, and expands its social resources**;** therefore the environments enable people to perform all the functions of social life and they mutually support each other in expanding their maximum potential (Hancock and Duhl, 1986).

With a small modification World Health Organization defines healthy city as the city whose physical and social environments continuously improve and its resources develops. So that all individuals can understand their ability to mutually support each other (the board of management of urban and rural, 2008). The organization provided a model for introducing healthy cities in this form (Leeuw, 2009):

- Clean and safe and high quality physical environment, including adequate housing**.**
- Healthy neighborhoods and supporting each other**.**
- Appropriate use of public participation and guidance of people in areas that influence on lives and well-being**.**
- Provision of basic needs (food, water, housing and employment opportunities for all citizens)
- There is a high level of health (low disease prevalence)

Thus it can be observed that in a society it is not enough to not have a disease to define it as a healthy city but residents of a healthy city should have the potential of a high quality life (Department of Health and Human Services, 2001, 1; Pauliet and Duhme, 2000, 1). Naturally, the criterion was used to assess the health of the city which is a challenging issue**.**Indicators of a healthy city include a set of criteria which are associated with health**,**health care, and environment, social and economic condition which should in fact be done as the first step in providing a comprehensive picture of the health condition of a city**.**Results that have been obtained from the study and analysis of the indicators demonstrated that indicators should be available and applicable in different countries and information

obtained not only should have validity and reliability, but also they should have the comparative advantages at international level (Webster et al., 1996,1).

3. Research method

The current study is practical in terms of purpose and it is analytical in terms of methodology. The sample included16 cities of Mazandaran province.In order to achieve this goal, after reviewing the literature, the criteria for urban settlements of city of the province were set with healthy city approach.In this study, the results of the General Census of Population and Housing in 2006 and indicators of a program of economic, social, cultural, 2006 of Deputy Planning Mazandaran and finally, numerical taxonomy analytical model was all applied.

NTA affinity was applied for evaluating similarity between taxonomic units, grading and ranking them.The approach is based on the analysis of a series of determined indices which are applied to prioritize options and a full scale for the assessment of alternatives is provided.

Taxonomy analysis stages in 8 steps are as follows (Rajab Zadeh, 2002):

Step 1: Identifying the different options and indices:

At this stage, the number m of options (1 A and Am) by analysts and experts with respect to the index n (1 C to Cn) are evaluated.

Step 2: Decision matrix, and then calculating the mean and standard deviation:

According to the index, the numbers of options and parameters to evaluate all options of decision matrix were established in Table 1. This table rij describes the utility of alternative i by considering the index j qualitatively or quantitatively.

Once the data matrix is composed, the mean and standard deviation of each index is calculated.

Table 1: Decision Matrix (Azar and Rajabzadeh, 2002)

Option \ Indices	C_1	C_2	C_3	.	.	.	C_n
A_1	r_{11}	r_{12}	r_{13}	.	.	.	r_{1n}
A_2	r_{21}	r_{22}	r_{23}	.	.	.	r_{2n}
.	.	.	.	.	.	.	.
A_m	r_{m1}	r_{m2}	r_{m3}	.	.	.	r_{mm}
Mean	$\bar{x}_1$	$\bar{x}_2$	.	.	.	.	$\bar{x}_n$
SD	σ_1	σ_2	.	.	.	.	σ_n

Step 3: Standard matrix (normalized) Z: At this point they are seeking to destroy different units that work in relation to the standards prescribed Z:

$$Z_{ij} = \frac{x_{ij} - \bar{x}_j}{\sigma_j} \quad (1)$$

$\bar{x}_j$ is the mean of each index (each of the columns of the matrix) and σ_j standard deviation of any indicator. At the end of the standard matrix for each of the positive indicators, the number of visible positive (positive ideal) and for negative indices, the largest negative number (negative ideal) are determined to be displayed as DO_j.

Step 4: Determining the distance between the compound options: In this section with a standard matrix Z, the distance between any options from other options to any of the parameters is determined by following equation:

$$D_{ab} = \sqrt{\sum_{j=1}^{m} \left(Z_{aj} - Z_{bj}\right)^2} \quad (2)$$

Here we have a and b which are two evaluated alternatives. This function calculates a pair of both options together, so that the distance between any two of its options becomes zero and distance from a choice of a and b is equal to the distance b option.Due to the above mentioned cases, matrix of interval between options is formed and its diameter shows the distance of each option to itself which is equal to zero.

Step 5: Determining the shortest distance: In this step, lowest distance between each row of the matrix is determined.The mean and standard deviation of each interval is achieved and the same work is performed for the shortest distance.

Step 6: Navigation of options (homogenization options): Units may exist that has far much more or less distance than other alternatives. This option must be removed from the set of heterogeneous; to do this, upper limit and lower limit are obtained using the following equations:

$$O_r = \bar{d}_r \pm 2\sigma_{dr} \quad (4)$$

$$O_r(+) = \bar{d}_r + 2\sigma_{dr} \quad (5) \text{ upper limit}$$

$$O_r(-) = \bar{d}_r - 2\sigma_{dr} \quad (6) \text{ lower limit}$$

The decision matrix is repeated without removed options again.

Step 7: Identifying the model or paradigm options: In this step, the distance between each of the options is obtained from the ideal value (specified in Step 4), low distance shows the ideal situation and long distance expresses condition whose option is inappropriate. Model or paradigm of options is obtained from the following equation:

$$Cio = \sqrt{\sum_{j=1}^{m} (Z_{ij} - Z_{bj})^2} \quad (7)$$

Step 8: Grading or ranking the ration of option development (F_i): At this point, the scale of development and the options condition

arediscussed. If the development of an option is the right condition of an option, then:

$$F_i = \frac{Cio}{Co} \qquad (8)$$

In this regard, is the example of each option and is level of development**.**

To calculate C_o, the mean and standard deviation of C_o s are to be determined which is done at the end of the step seven and is calculated as follows:

$$Co = \overline{Cio} + 2\sigma_{Cio} \qquad (9)$$

As F_i is smaller; it represents a further development of option (located in the higher rank) and as it is further; it is an indication of non-development.

Considering the evaluation indices of healthy city approach, there are a number of indicators that are applied result of the broad definition of health in the communities. This leads to a large number list that includes a large number of legitimate parameters (Oneill and Simard, 2006).

Table 1: The criteria for evaluation of the Healthy City (authors, based on WHO, 2000)

index	criterion	index	criterion
Number of emergency centers	Health services	Family	Social andeconomic
Number of active ambulances		Population density	
Number of radiography		Growth rate of population	
Number of health and medical centers		Urbanization rate	
Number of health school		Literacy rate	
Number of welfare complex		School shares	
Number of specialized doctors		Active population rate	
Number of general practitioner		Unemployment rate	
Number of psychologist		Employment rate	
Number of drug maker		Sports spaces per capital	
Number of employed staff in health organization		Water produced per capita	environmental
Death rate of infants less than one month	health	Consumed water per capita	
Death rate of infants less than one year		Population using drinking water	
Death rate of infants less than five years		Ratio of waste under waste management	
Level of those bornweighing less than 2500 grams		Green space per capita	
Birth rare		Public green space area	
Life expectancy inbirth		Ratio of drained land area	
Mental retardation		Number of split wastewater	
Severe mental illness		Number of hospital	

4. Research Area

With an area of about 238 thousand kms, Mazandaran Province is located between 35 degrees and 36 degrees 47 minutes and 35 minutes north latitude and 50 degrees 34 minutes and 54 degrees 10 minutes east from Greenwich and it has borders with the provinces of Golestan**,** Semnan, Tehran, Qazvin and Gilan**.**The estimation of 2010 showed that it has a population of about 3, 13,123 people (1,655,719people in the city and 1, 347,404 people in rural areas) and includes 52 cities, 46 districts, 117 villages and 3665 hamlets**.**Fig. 1 shows the research area.

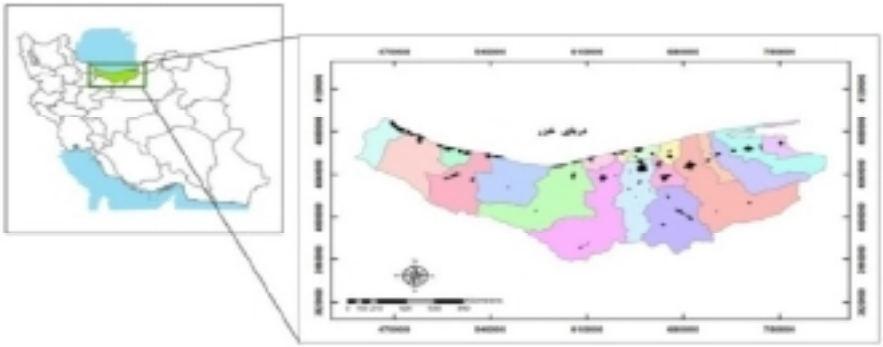

Fig. 1: Location of mazandaran province in the country and divisions

5. Discussion and analysis

Once values of all the parameters for the cities studied were collected, they were analyzed using Excel software in action. In Table 2 indices for individual cities are presented.

Table 2: The decision matrix (data were extracted by the authors)

Noushahr	Nour	Neka	Mahmood Abad	Galougah	Ghaemshar	Savadkouh	Sari	Ramsar	chalous	Jouybar	Tonekabon	Behshahr	Babolsar	Babol	Amol	
3.71	3.82	3.95	3.75	3.81	3.7	3.79	3.72	3.46	3.7	3.85	3.52	3.86	3.76	3.75	3.72	Family
69.99	39.59	77.75	344.38	87.45	643.7	32.69	134.4	93.4	76.92	246.7	95.3	110.3	507.1	297.6	112.8	Population density
1.22	1.11	0.95	1.38	0.12	1.21	-0.19	1.52	0.56	1.11	0.59	1.12	19.1	1.21	1.09	1.37	Annual growth
36.8	45.4	44.7	37.7	47.5	62.8	52.9	56.3	73.6	52.7	41.31	45	68.2	54.7	53	59.9	Urbanization ratio
91.88	88.8	88.35	88.33	85.6	91.98	87.07	92	88.36	89.87	85.3	91.3	88.72	88.34	90.17	89.4	Literate percent
72.39	35.86	36.36	28.44	42.45	80.28	75.23	66.6	96.8	54.23	68.29	62.77	93.04	67.58	79.24	89.18	School percent
38.42	32.82	33.92	32.69	33.89	30.91	26.22	33.98	34.13	35.37	38.9	36.19	30.73	34.81	34.27	34.24	Active population ratio
93.72	94.94	83.8	81.75	80.74	94.65	81.71	98.19	51.85	91.99	15.64	94.68	91.98	81.65	91.1	93.14	Employment rate
56.68	1.18	1.46	54.11	13.53	0.58	6.64	3.24	33.41	2.27	2.51	11.13	1.67	4.15	0.76	2.39	Sports space per capita
1.48	2.03	1.57	1.63	1.56	1.71	1.61	1.65	2.25	2.15	0.00	2.11	1.41	0.42	2.62	1.65	Population consuming water
7.81	9.44	5.11	3.34	1.6	24.82	4.53	28.37	5.36	7.44	3.87	12.46	11.14	14.9	28.21	20.51	Population under drinking water
2.83	4.24	10.71	1.92	4	3.22	8.18	9.48	6.59	1.43	7.56	2.21	5.44	2.97	17.93	20.77	Waste ratio under management
1	4	1	2	1	1	3	4	1	3	0	6	4	2	3	2	Waste system
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	Greenspace per capital
0.06	0.1	0.01	0.01	0.01	0.02	0.01	0.1	0.01	0.07	0.03	0.04	0.01	0.14	1.1	1.4	Public greenspace area
0	0	7.67	1.85	0	62.96	18.25	16.96	43.48	0.8	66.67	295.7	32.29	145.7	49.63	16.22	Sanitized land area
0.24	0.21	0.22	0	0	0.11	0.27	0.33	0. 4	0.31	0.34	0.12	0.28	0.32	0.25	0.15	Hospital
0.24	0.21	0.22	0.29	0.53	0.05	1.09	0.11	0. 4	0.31	0.34	0.23	0.19	0.21	0.21	0.25	Emergency center
0.24	0.43	0.65	0	0.53	0.38	0.27	0.47	0.8	0.31	0.34	0	0.19	0.53	0.58	0.2	Ambulance
1.9	2.58	1.3	2.04	0	1.1	2.45	1.39	1.2	1.7	1.71	1.28	1.61	1.69	1.67	1.33	Medical lab
0.71	0.86	0.86	0.58	0	0.38	1.09	0.84	0.6	0.93	0.34	0.58	0.76	0.42	0.79	0.4	Radiography centers
0.71	1.29	0.65	0.87	0.53	0.44	1.09	0.51	0.8	0.77	1.03	0.93	0.47	0.53	0.71	0.49	Medical centers
16.6	19.46	14.26	12.51	7.48	4.23	14.17	6.61	5.4	7.77	10.29	10.56	4.54	5.79	7.29	6.47	Health school
0.24	0.21	0	0	0	0.11	0	0	0.2	0.15	0	0.12	0.19	0.11	0.08	0.05	Welfare complex ratio
9.25	5.8	3.24	0.87	0	5.54	4.09	14.78	8.39	10.81	1.37	6.5	4.54	3.37	9.21	5.73	Specialized ones n thousand
19.17	11.6	14.47	11.64	1.6	11.52	11.45	20.62	9.99	16.22	9.6	10.56	10.03	8.32	12.45	8.85	GP in thousand
3.79	2.68	2.81	0.87	0	3.4	2.45	7.96	2	6.49	2.06	4.29	1.8	0.95	6.54	3.95	Dentist
3.56	2.79	2.16	2.62	0	2.25	2.73	2.63	2.2	2.78	3.43	3.13	2.46	2.63	2.96	2.42	Drugmaker
150	120	52.28	54.99	0	39.62	105.5	68.44	83.53	69.83	88.47	79.51	69.28	50.67	129	61.92	Employed ones in medical sector

12.6	11.25	7.7	5.1	8.53	2.8	10.48	8.65	18.06	6.25	10.58	8.17	11.9	5.65	8	4.63	Infant death ratio under 1 month
12.6	15.22	0	0	10.66	0	16.47	12.11	20.83	8.6	12.93	10.09	17.6	7.94	12.5	6.17	Infant death ratio under 1 year
13.56	15.22	19.4	17.2	10.66	7.5	12.45	13.84	22.22	10.16	14.1	13.93	20.19	11.41	13	7.72	Infant death ratio under 5 years
3.71	4.36	5.9	5.5	4.26	3.4	6.59	5.85	4.9	7.04	5.52	3.33	5.33	3.03	5	2.17	Ratio of those born under 2.5ks
5	13.76	0	0	0	0	12.21	12.65	9.98	8.24	14.84	0	12.54	10.87	13	18.87	Birth ratio
74	76	77	73	76	74	75	74	74	71	75	75	75	76	74	77	Life expectancy
0	15.46	7.99	5.53	0	0	0	5.07	0	2.63	39.09	3.48	0	3.58	1.62	11.76	Mental illness
0	3.44	2.81	1.16	0	0	0	1.75	0	0.31	1.71	0.35	0	0.53	0.46	9.19	Psychological disease
359	0	0	0	0	1314	0	1851	0	452	1329	0	0	609	916	0	Sanitation

After the analysis we realized that all surveyed cities are in the range of taxonomic analysis

(See step 6 of the study).

The results in Table 3 are based on the sorting from low to high rating and also show the health ratio of the cities**.**

Table 3: Results of the healthy development centers in Mazandaran province (writer)

downtown	development Rate
Babol	0/6785
Sari	0/7410
Nour	0/7486
Behshahr	0/7870
Savadkouh	0/7950
Noshahr	0/8000
Amol	0/8006
Ramsar	0/8049
Chalous	0/8190
Tonkabon	0/8300
Joybar	0/8457
Babolsar	0/8480
Neka	0/8491
GhaemShahr	0/9183
Mahmoud Abad	0/9254
Galougah	1/0543

As it is seen, the highest and lowest points are in Babol and Galogah, respectively.

It is seen in Fig. 2 that based on 4 identified points of fail, one can recognize 5 different groups

The first group can be assigned to Babol and cities of Nour and Sari are in the second group. Behshahr, Savadkoh, NowshahrAmol, Ramsar, Chalous, Tonekabon, Joybar, and Nekaand Babolsar are in the third group**,** Mahmudabad and Ghaemshahr are in the fourth and the last group only includes Galougah.

6. Conclusion

The study sought to evaluate health indicators in urban areas of the province and studies the way of using indicator based on the spatial patterns of urban areas. As it can be observed the concepts of distance, near the center of the spatial distribution don't have any effect on health city. This cause is quite seen especially in the third group. Presence of Nour and Sari Cities in the second group which are far from each other indicates that there is no clear relationship between distance and urban health in developed cities. In this regard, Babol with the highest relative proximity to ideal is in the first place among indicators of a healthy city in the province**.**The chief reason for this could be having management of waste**,** per capita green space, public green space area and the number of employees working in Medical University**.**At last, it should be noted that to remedy the situation one can start at the bottom of Table 3 and funds can be allocated due to the lack of development.

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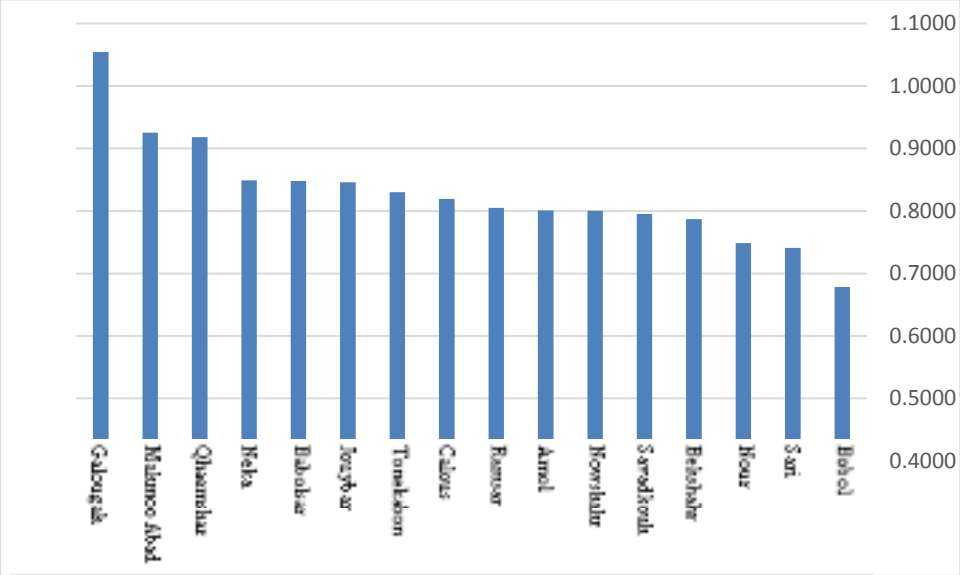
Fig. 2: Diagram of normal points of Mazandaran Province (writer)



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