Evolution of urban system in Mazandaran province during 1956-2011

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ABSTRACT: studying urban system in Iran is known as urban network. Urban planning should be done with corporation of geographers, urban sociologists, economists, planners and architects to be in the best manner. Obviously, entering different specializations in studying of urban system provides looking at its concepts from various aspects. Therefore identifying this field and finding out its general rules has become more available. However, due to its multi-dimensional nature, the only successful ones were familiar with social and economic sciences as well as spatial and positional perception of the issue. In this study, using common models and techniques in analysis of urban system such as the Zipf's rank-size pattern, primate city indicators and concentration in 7 censuses at 1956-2011, the population distribution of Mazandaran province has been investigated. The results show that the rank-size pattern of Mazandaran's cities in 1956-1971 tended to change from binary pattern to Theorical (lognormal) pattern in the next years. The findings also indicate that Mazandaran province has not been suffered by primate city phenomenon, which are suffered most of Iran's provinces.

Keywords: urban system, primate city, rank-size pattern, Mazandaran Province

INTRODUCTION

In the real world there is no city which is needless of communication and interaction with other cities. This reciprocal link seems more necessary when the society evolves and numerous and complex Division of labor occurred. This communication is independent of citizens' request and desire and happens in the context of survival and reproduction of social expansion.

Besides this reciprocal relationship between Cities getaway, a system is shaped called urban system. For the first time, Brian Berry (1964) suggested this term in his study, titled "cities as systems fitted within the system of cities" (Johnson et al., 1996, p. 664) and then different theoretical ideas were provided by other researchers.

All efforts of these scholars aimed to find general rule to show that how the construction and operation of urban system are constructed? Why are the sizes of urban residences organized hierarchically? Are the urban sizes in an urban system determined by reciprocal communications between cities? What are the effects of geographic context on shape and function of urban system? These questions were answered from different aspects (Azimi (a), 2002: 11-12) and in the present study: we are going to investigate the urban system of Mazandaran province.

Theoretical Framework

Urban system consists of a set of dependent cities which construct the structure of urban residences in an area, region, country and world. Urban system is not only limited to build the physical structure of urban residences but also covers their flows and communications.

These flows include flows of population, capital, factors of production, Ideas, information and innovations. Hence, the urban systems are open systems that studying them requires investigating their extensive relations with their environment. These systems constantly adapt themselves to cities' structural changes and their external communications (Azimi (b), 2002: 22).

Urban system is such studies which identify different levels of population and functional city centers as well as determine the scope of functional areas. According to the nature of urban systems, there is a hierarchy of different cities in each region which has one or two regional center at the head to play both local and regional roles.
This regional center supports other internal regional cities regarding to superior urban services and communicates with other regional centers at national level.

Therefore, on the one hand it causes functional integration within the region, and on the other hand it cooperates in creation of unity and integrity. Thus, it can be expected that with the analysis of the urban system in each of country's regions, these can be find out: communication process, the regional center service providing ability, and the existence, unity and integrity of an area.

Iran's urban system in its developments passed different periods. Since the initiate of modernization and various encroachments to physical, social, economic structure of urban communities, urban system has faced with a lot of changes and developments.

Entering capital flows into Iran's major cities and being deprived of small cities caused unbridled and pathological growth of provinces' capitals and deprivation of others.

Thus in most provinces, this phenomenon has been occurred as prime city and has made a huge gap between prime city and others.

Among other provinces, Mazandaran province for different reasons has excluded from this phenomenon and with starting a process of modernization and capitalism in many cities, its urban system has not faced with deep fissures as other country's urban system.

Mazandaran province with its special climate and physiographic conditions from west to East has significant geographical differences. The pattern of urban development complying with the geographic space of the province generally has evolved along the rivers' Collision and on the alluvial coastal plains. Constant shaping and physical development of urban texture are not the same in all parts of the province.

Reviewing demographic changes and rate of urbanization in Mazandaran province indicates the increasing number of urban areas and the urban population during the past decades. Demographic studies of cities represent immense demographic, economic, and social changes and also competition among four major cities of Sarrey, Ghaemshahr, Babol, and Amol.

The present research is tried to investigate the hierarchical process of Mazandaran and effective mechanisms on its urban system to offer suggestions for improving the situation of Mazandaran urban system.

**Literature Framework**

Totally, a lot of studies in the field urban system (urban network and hierarchy) within and outside the country, whether in the form of a book and either theses or articles have been done. Each one investigated urban system from their especial viewpoints and perspectives and provided certain patterns and models, however none of them have not been carried out in Mazandaran province. The present study by using the results of previous researches tries to analyze of effective factors on the urban system in the province of Mazandaran.

Jamile Tavakoli Nia and Mohammad Shali published an article titled "urban system of Eastern Azerbaijan province" on 2012 in Journal of geography which has reviewed and analyzed of urban system of Eastern Azerbaijan province, using common techniques such as numerical taxonomy, rank-size law, difference limitation classification model, coefficient of Entropy and prime city indicators. The results show that the spatial distribution of cities and urban population in Eastern Azerbaijan is unbalanced.

Isfandiar Zebardast's article titled "prime city developments in Iran" in 2007 has been published in the magazine of fine arts. The results show that prime city do exist in the country. Despite this, the distribution of urban system in the country from 1956 to 1976 revealed extremely concentration on prime city. From 1976 to 1996 gradually the concentration was decreased and it moved to the proper distribution. Applying the policy of de-concentration from mid-1961, decreased Tehran prime city and influenced on structuring urban system of the country.

The article titled "the spatial distribution of population in Iran urban system during 1976 to 2006" was done by Rahmat-Allah Farhoodi, Saeid Zangeneh shahraki and Ramin Mochshi in 2009 and published in the journal of human geography. They used different methods and models due to evaluate the process of urban system changes in 1956-2006 and the impact of applied policy for balance, such as prime city indexes, concentration indexes and balance indexes. The results indicate the lack of balance in urban system from 1956 to 1976 and moving toward balance in spatial distribution of population and urban activities in the country since 1976.

Moreover, numerous books, in the field of Urban system have been published, including "economic and social developments of Gilan-a new look" written by Naser Azimi. He reviewed social, economic and urban system changes of Gilan province in his book regarding to three periods of classic stage, transition stage and economy development stage. His other book, "the scan urbanization and basics of urban system" reviewed and criticized valid and important theories and theoretical patterns of urban systems.
Hossein Rajabi Sanajerdi and Mohammad Hossein Papoli Yazdi also published a book titled "theories of the city and environment", to introduce theories of thinkers and intellectuals in the field of city, urbanization and urban systems included:"growth, build and design of the city", "theories of metropolis ", "theories of new cities", "theories of spatial system", "theories of urbanism and immigration", "theories of city and the countryside communications" and "spatial social, economic and political theories ".

Research Methodology
In this research, in order to explain the pattern of size changes of cities in urban system during 1956-2011 Zipf's rank-size pattern was used. To detect and determine the primate city in the province, primate city indexes were used including: "primate city, two city, four city, four city of Mehta and Moomaw and Alvasabi, and Herfindahl concentration indexes". Then the results achieved from these indicators were compared with each other, and finally the important results of four city index were compared to the results of this index at national system.

In order to specify the balance or lack of spatial de-concentration in urban system, coefficients of Entropy and Henderson were used.

Rank-Size Pattern
The oldest pattern to analyze the urban sizes in urban system is rank-size urban pattern. For the first time this pattern was proposed by Felix Auerbach - a German geographer-after an experimental research in 1913 (Lee, 1986, P.79; H. Carter, 1990, P.70).

During sorting urban residences at west of Germany, Auerbach found that there is a converse relationship between the size of cities and their ranks. Therefore he stated: "If we sort residence regarding to their population size, population of the nth city is equal to the largest city of that region".

In fact, this pattern reveals a converse relationship between the population of any city and its rank of urban system which is called rank-size rule (P. Haggett, 1972. P. 282).

Primate City Index and de-concentration
The index of primate city and concentration used in this article are as follows: primate city index, two city index, four city index, four city index of Mehta, Herfindahl de-concentration index, Moomaw and Alvasabi index, Entropy index, and Henderson de-concentration index. In table 1 the formulas of indexes are provided.

<table>
<thead>
<tr>
<th>Index</th>
<th>Henderson de-concentration index</th>
<th>Entropy index</th>
<th>Moomaw and Alvasabi index</th>
<th>Herfindahl de-concentration index</th>
<th>Four city index of Mehta</th>
<th>Four city index</th>
<th>Two city index</th>
<th>Primate city index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formula</td>
<td>$\left(\sum_{i=1}^{n} p_i^2 \right)^{1/2}$</td>
<td>$\frac{1}{n} \sum_{i=1}^{n} \ln p_i$</td>
<td>$\frac{p_1 + p_2}{p_1 + p_2}$</td>
<td>$\frac{p_1}{p_1 + p_2 + p_3 + p_4}$</td>
<td>$\frac{p_1}{p_1 + p_2 + p_3 + p_4}$</td>
<td>$\frac{p_1}{p_1 + p_2}$</td>
<td>$\frac{p_1}{p_1 + p_2}$</td>
<td>$\frac{p_1}{p_1}$</td>
</tr>
</tbody>
</table>

Region Recognition
Mazandaran province is at the north of Iran and covers an area of more than 23756 Km which is about 1.4 percent of Iran. Mazandaran province is surrounded by Caspian Sea from north, Golestan province from east, Semnan, Alborz, Tehran, Qazvin provinces from south and Gilan province from West. Map 1 presents the location of Mazandaran province in Iran.

Findings
Investigation of urbanization changes of Mazandaran in Census of 1956-2011 and its comparison with the country
During the years 1956-2011 the number of Mazandaran's cities as well as the entire country has constantly increased from 20 cities in 1956 to 53 in 2011. The share of Mazandaran from the country urban population has declined from 5/15 percent to 3/14 percent in 2011 which shows almost 40 percent decline. The results indicate that the country's urban population growth is much higher than the Mazandaran's (Tables 2 and 3 and chart 1 and 2). As it is obvious, the large decline of 30 percent has happened in 1966 and after that we saw a relatively lesser decline.
In the last population census (2011), Mazandaran province has 53 cities and 1,682,152 population. Map 2 shows distribution of cities in Mazandaran province.
Table 2. Urban population of Iran and Mazandaran province

<table>
<thead>
<tr>
<th>Year</th>
<th>Iran</th>
<th>Mazandaran province</th>
<th>Urban Population share of Mazandaran</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>53,646,661</td>
<td>1,682,152</td>
<td>3.14%</td>
</tr>
<tr>
<td>2006</td>
<td>48,259,964</td>
<td>1,554,143</td>
<td>3.22%</td>
</tr>
<tr>
<td>1996</td>
<td>36,817,789</td>
<td>1,194,233</td>
<td>3.24%</td>
</tr>
<tr>
<td>1986</td>
<td>26,844,561</td>
<td>893,023</td>
<td>3.33%</td>
</tr>
<tr>
<td>1976</td>
<td>15,854,680</td>
<td>537,110</td>
<td>3.39%</td>
</tr>
<tr>
<td>1966</td>
<td>9,794,246</td>
<td>343,479</td>
<td>3.51%</td>
</tr>
<tr>
<td>1956</td>
<td>5,953,563</td>
<td>309,421</td>
<td>5.15%</td>
</tr>
</tbody>
</table>

Source: author’s calculations based on Censuses during 1956-2011

Figure 1. Share of urban population of Mazandaran province in the country during 1956-2011

Table 3. Proportion of urban population of Iran and Mazandaran province (%)

<table>
<thead>
<tr>
<th>Year</th>
<th>Iran</th>
<th>Mazandaran province</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>71.39</td>
<td>54.72</td>
</tr>
<tr>
<td>2006</td>
<td>68.48</td>
<td>53.18</td>
</tr>
<tr>
<td>1996</td>
<td>61.31</td>
<td>45.90</td>
</tr>
<tr>
<td>1986</td>
<td>54.39</td>
<td>39.27</td>
</tr>
<tr>
<td>1976</td>
<td>47.03</td>
<td>33.64</td>
</tr>
<tr>
<td>1966</td>
<td>37.98</td>
<td>27.48</td>
</tr>
<tr>
<td>1956</td>
<td>31.67</td>
<td>24.75</td>
</tr>
</tbody>
</table>

Source: author’s calculations based on Censuses during 1956-2011

Figure 2. Comparison of urban population changes of Iran and Mazandaran during years 1956-2011

As observed, the process of urban population changes in Mazandaran has been in conformity with Iran's urban population changes and both have incremental trends.
**Mazandaran province rank-size urban pattern in 1956-2011 Censuses**

To evaluate theory of rank-size mentioned in theoretical framework, rank-size of Mazandaran's cities based on 1956-2011 Censuses was expressed in Excel software. To outline these charts, both logarithmic axes were calculated based on 2 done only for parts with more than five thousand population (see charts 3-9).

As observed, the rank-size distribution pattern followed multiple patterns (Binary Pattern) during 1956 to 1976. Peter Hogget an English geographer identified multiple distribution patterns (Binary Pattern) which generally appear in regions or countries with a federal system in which the states or provinces have numerous administrative, political, social and economical centers which makes it possible for capital city of each state to compete equally with others.

Regarding to this, the process of capital, activity and population absorption will have a relatively equal spatial distribution. Hence in countries such as Australia, Germany and to some extent the United States, urban size distribution is equal to rank distribution or the multiple patterns have been emerged (physical plan north coastal area, 2006: 87)

In Mazandaran province regarding to close competition between cities, this chart has followed multiple patterns. Rank-size Chart of the province during 1986-2011 by maintaining multiple patterns has moved towards Theorical/Lognormal Pattern.
Investigation of primate city index and de-concentration in Mazandaran in 1956-2011 Censuses

The results of primate city indexes are presented in Table 4. Applied indexes are going to be explained in the next part.

Table 4. Primate city indicators in the province of Mazandaran, 1956-2011

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Primate City Index</td>
<td>0.176</td>
<td>0.168</td>
<td>0.164</td>
<td>0.158</td>
<td>0.132</td>
<td>0.145</td>
<td>0.162</td>
</tr>
<tr>
<td>Two City Index</td>
<td>1.348</td>
<td>1.298</td>
<td>1.231</td>
<td>1.193</td>
<td>1.026</td>
<td>1.122</td>
<td>1.122</td>
</tr>
<tr>
<td>Four City Index</td>
<td>0.466</td>
<td>0.454</td>
<td>0.425</td>
<td>0.411</td>
<td>0.353</td>
<td>0.405</td>
<td>0.405</td>
</tr>
<tr>
<td>Four City Index Of Mehta</td>
<td>0.318</td>
<td>0.312</td>
<td>0.298</td>
<td>0.291</td>
<td>0.261</td>
<td>0.288</td>
<td>0.288</td>
</tr>
<tr>
<td>Herfindahl De-concentration Index</td>
<td>0.088</td>
<td>0.084</td>
<td>0.088</td>
<td>0.086</td>
<td>0.079</td>
<td>0.081</td>
<td>0.097</td>
</tr>
<tr>
<td>Moumaw and Alvasabi Index</td>
<td>1.243</td>
<td>1.235</td>
<td>1.177</td>
<td>1.154</td>
<td>1.063</td>
<td>1.197</td>
<td>1.197</td>
</tr>
</tbody>
</table>

Source: Author's calculations based on Censuses during 1956-2011

Four-City Index

After adding population of primate city (P1) by "Mehta" in the Clark formula he could modify four city indexes as (Omuts, 1986, PP112-115):

\[
\frac{P_1}{P_1 + P_2 + P_3 + P_4}
\]
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 systems are such that the primate city equals the 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 5 (Gilbert et al, 1898, p. 198).

<table>
<thead>
<tr>
<th>Four-City Index</th>
<th>Excellence of primate city in urban system</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-0.65</td>
<td>High Excellence</td>
</tr>
<tr>
<td>0.65-0.54</td>
<td>Excellence</td>
</tr>
<tr>
<td>0.54-0.41</td>
<td>Optimum Excellence</td>
</tr>
<tr>
<td>Less than 0.41</td>
<td>Minimum Excellence</td>
</tr>
</tbody>
</table>

For assessment of urban system of Mazandaran province based on primate city of region and fitting urban system pattern based on four city index, Table 6 is provided. As observed, the primate city change pattern of Iran urban system is different from Mazandaran's.

Table 6. Four city index in national and Mazandaran province urban system based on Censuses during 1956-2011

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Four city index of national urban system</td>
<td>0.492</td>
<td>0.574</td>
<td>0.608</td>
<td>0.638</td>
<td>0.701</td>
<td>0.687</td>
<td>0.657</td>
</tr>
<tr>
<td>Excellence</td>
<td>Optimum Excellence</td>
<td>Excellency</td>
<td>Excellency</td>
<td>Excellency</td>
<td>High Excellency</td>
<td>High Excellency</td>
<td>High Excellency</td>
</tr>
<tr>
<td>Four city index of Mazandaran's urban system</td>
<td>0.288</td>
<td>0.288</td>
<td>0.261</td>
<td>0.291</td>
<td>0.298</td>
<td>0.312</td>
<td>0.318</td>
</tr>
</tbody>
</table>

Source: Farhoudi et al., 2006 and author’s calculations

![Figure 10. Change trend of four city index in national and Mazandaran province urban system based on Censuses during 1956-2011](image)

As indicated, during this 60-year period, four city index of Mazandaran has been dramatically less than national index. This difference means that in Mazandaran province there is no city which can be dominated others. The shape of the region as well as the size of primate city hinders the dominance of one city in the region.

Second, the national four city index has decreased regularly since 1976 from 0.7 to 0.49 but in Mazandaran province since 1956 to 1996 it has decreased and then increased in 2006. In the next period it has been unchanging.
Third, as it observed four city index in Mazandaran’s urban system for all periods is between 0.26 and 0.31 and has minimum Excellency. Comparison with national urban system index, it is found that size distribution of the city in this province than the entire country is more appropriate.

**Primacity index, Two city index, and Moumaw and Alvasabi index**

The results of applied models based on census taken on 1956 until 2011 in Mazadaranshow that primacity phenomenon has not existed in any of these courses (table 7).

The primacity index decreased to 0.162 in 1956 and then to 0.132 in 1976, however it has increased since 1986 finally reached 0.176 in 2011. In a similar process, two city index, as well as primacity index, decreased from 1956 to 1976, and increased from 1986 to its maximum value of 1.348 in 2011.

So, as it considers these two indicators by the same trend confirm each other. Similar changes also were found for Moumaw index so it can be concluded that all indicators confirm each other: all of the indexes have dropped from 1956 to 1976 and moved increasingly since 1986.

However, Herfindahl index behaved differently as it decreased until 1976 and showed not certain trend in 1986-2011 (table 11 and 12).

**Entropy and Henderson de-concentration indexes**

As the results show in table 7, Entropy index has not had a specified trend in six censuses: enhancement in 1956-1976, reduction 1976-1996, and again enhancement in 1996-2006 and partial increase again in 2011 (chart 13).

The amount of Henderson de-concentration index has almost the same trend as Entropy index which show periodic increase and decrease.

But the important point is that these two indicators confirm each other in all censuses.

Table 7. de-concentration indicators in the province of Mazandaran in 1956-2011


<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Entropy index</td>
<td>2.94</td>
<td>2.96</td>
<td>2.83</td>
<td>2.84</td>
<td>2.89</td>
<td>2.85</td>
<td>2.58</td>
</tr>
</tbody>
</table>

Source: author's calculations based on Censuses during 1956-2011

CONCLUSION

Zipf used rank-size law for providing hierarchy of urban system. The pattern is also a model to analyze the city size of the urban system. In order to that, distribution model rank-size is presented to analyze the location of cities and determine optimal size and position. It assumes that set of cities in national or regional space are ranked based on their population rather than primacity. The researcher used this method for recognition of the existing structure of urban system in Mazandaran.

Investigating of urban system in Mazandaran province based on 1956-2011 censuses reveals following results:

1. Overall review of urban hierarchy and its evolution process indicate that the province of Mazandaran, in contrast to the urban system of the country, does not encounter with imbalance population distribution.

2. As stated previously, rank-size pattern of Mazandaran province moves from Binary Pattern to rank-size pattern (Theoretical/Lognormal Pattern). This distribution pattern is caused by development shape of the province extend along the Caspian Sea coast as a wide transverse bar. Plain part of this bar allocates to activity and Residence. This means that in such form of expansion, control of a city on city network is impossible. Indeed this bar area grows with closed cities which can play role in top levels of hierarchy with certain intervals from each other.

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