RESEARCH PAPER

INTRODUCING THE MOUSAVI PRIMATE CITY INDEX FOR IRAN'S URBAN SYSTEM ASSESSMENT

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ABSTRACT. The main goal of this research study is to analyze the urban system of Iran during the years 1956 to 2021 to propose a new model. This is done by examining the primate city index of the urban settlement system based on previous models. The study employs a descriptive-analytical approach. Initially, it investigates the population trends and the number of cities in Iran over the specified period, comparing the growth rates of the total population and the urban population to assess changes in population distribution across the country. Additionally, spatial analysis of population distribution is conducted using Hot Spot Analysis and Directional Distribution methods. This article evaluates the advantages and disadvantages of various primate city indices, ultimately leading to the formulation of a new index for measuring the degree of urban primacy. The findings reveal that the percentage of the urban population in Iran surged from 31.41% in 1956 to 75.99% in 2021. According to the Mousavi primate city index, urban primacy in Iran exhibited an upward trend from 1956 to 1986, followed by a decline from 1986 to 1996. However, this trend reversed upwards in 2016, attributed to the rising number of cities and migration to newly established urban areas due to drought and relative stagnation in agriculture. The rank-size pattern further validates the outcomes of the new index.

INTRODUCTION

The rapid urbanization process around the world has brought renewed interest to the question of the size distribution of cities (Düben and Krause 2020). Studies show that all over the world, a growing proportion of the population lives in cities. Ten years ago, 51.1 percent lived in urban areas. By 2019, the share of the urban population increased to 55.7 percent. It is generally higher in the developed world (80.5 percent in 2019) in comparison to the developing world (51.1 percent), with transition economies in between the two (65.4 percent) (UNCTAD 2020). This trend shows that urbanization is occurring so rapidly in many areas that it has become difficult to distinguish between cities, suburbs, and towns (Decker et al. 2007). In general, the rate of growth in large cities is much faster than the total population growth (Ding et al. 2022). Metropolitan areas with over one million inhabitants grew half a percentage point faster per year than smaller ones (OECD 2020). Although cities tend to grow over time, they do not grow uniformly at the same rate (Duranton and Puga 2013). Much of the existing research on city size distributions has primarily focused on the largest urban centers, overlooking smaller cities, towns, and settlements (Decker et al. 2007). In essence, attention has mainly been given to large cities and metropolitan areas, while small and medium-sized cities (SMSC) have received little consideration (Wagner and Growe 2021).

The expansion of the largest cities appears to happen at an accelerated pace, leading to a trend of "region-based urbanization" rather than "city-based." Consequently, addressing regional developmental imbalances should be a key focus in future planning efforts (Wilonoyudho et al. 2017). As a result, a greater focus should be on the development of small towns. Small towns are essential, as they play a key role as regional service centres in rural hinterland development through direct production linkages, as well as "spread" and "trickling down" effects. Reinforcement of small-town production and institutional structures not only contributes directly to rural and regional development but can also be considered a necessary condition (Abou-Korin 2014). An undeniable feature of contemporary urban population growth is how the largest cities appear to grow at increasingly rapid rates. This phenomenon has given rise to the concept of urban primacy which is the demographic, economic, social and political dominance of one city over all others within an urban system (Smith 2000). Present-day usage of the term "primacy" and "primate city" stems directly from the 1939 article, "The Law of the Primate City," by Mark Jefferson (1863-1949), a professor of geography at the U.S. Michigan Normal School (Meyer, 2019). In concept, primacy is a ratio of the characteristics of a country's dominant city (e.g. population, economic activity, and political influence), relative to smaller cities (Hartley 2015).

The irregularity begins to surface when metropolitan populations are examined, rather than those within city limits. Studies further demonstrate geographers have backed away from the use of the rank-size rule in favour of the primate city law. For instance, London and Paris are not twice the size of their second-ranked cities (Birmingham and Marseilles) but seven times larger. Bangkok, meanwhile, has twenty-two times the population of Nonthaburi (Campanella 2015). This means that urban primacy (i.e., the concentration of the urban population in only one or two centres), is a characteristic of many developing countries, and is viewed by many social scientists as detrimental to the balanced development of the country as a whole (Sokona, 1985). Over the past several decades, many studies about city size distribution have been launched, with most of them concentrating on only the largest cities while ignoring smaller cities, towns, and settlements. This is mainly due to the lack of accurate data for small cities. However, despite this, as much as 70% of the population may reside in these smaller areas, and omitting such a large majority of the population may lead to biased characterizations of city size distributions (Decker et al. 2007; Bhalli and Ghaffar 2015; Li et al. 2016; Nasar-u-Minallah et al. 2017; Riaz et al. 2017; Nasar-u-Minallah et al., 2021), Furthermore, political power is often concentrated in these large urban agglomerations (Sokona, 1985). Large differences across countries in the size and structure of local administrative units seriously affect cross-country comparisons and represent an obstacle to compiling robust worldwide evidence on the features of urbanization and its consequences (Nasar-u-Minallah et al. 2016; Parveen et al. 2019; Naeem et al. 2021; Moreno-Monroy et al. 2021; Zia et al. 2022).

Given these considerations, examining the urban system to achieve the distribution and arrangement of the population and cities in the territorial structure is necessary and inevitable. This is largely because the optimal distribution of population and cities in the spatial organization of the land will lead to a balanced distribution of facilities and services. In this regard, the investigation of the structure of the urban system of Iran using the rank-size model shows the unbalanced distribution of the population in the urban hierarchy (Feizpour & Asayesh 2022). In general, the city size distribution can be categorized into rank-size and primate distributions, which include lognormal, primate, and intermediate types. Zipf's law, particularly its exponent of one, has been a focal point for understanding optimal city size distribution and is supported by empirical studies that also examine the implications of Gibrat's law. These studies explore how various factors, including geographical scale and developmental levels, influence Zipf's exponent (Li et al. 2016; Moreno-Monroy et al. 2021).

Rank size and primate distributions are two primary models of city size distribution, which can be categorized into three types: lognormal, primate, and intermediate. Zipf's law has long attracted significant attention for its compelling explanation of optimal city size distribution, grounded in the criterion of Pareto optimality (Li et al. 2016). In this paper, we question whether there is an optimal method to fully identify the "primate city" phenomenon. Many methods have already been proposed since Jefferson's initial idea. These proposals include six indicators which are suggested to determine the prime city. However, they fail to discuss two critical points. One is the lack of attention of this index to all cities of the urban system, considering their rank. Second, most of these indexes do not lead to a single basis. This has caused these indicators to not correspond to the results of the rank-size of cities in some cases. This shows that the phenomenon of "primate city" cannot be accurately expressed only by examining the first few cities. Rather, it must consider the ratio of the first city to all cities in the urban system. This problem occurs when the researcher encounters many cities. Therefore, the negative effects of the growth of the first urban phenomenon are obvious in the urban system of any country. Identifying this phenomenon can help development planners to select policies and measures to solve this problem.

By accepting Jefferson's definition of a "primate city", the primacy of Tehran during the 2020s becomes readily apparent. In 2020, Tehran had 2.8 times more people than the next largest city, Mashhad (Iranian Statistics Center 2021). Important reasons accounting for such a high growth rate are the natural increase in the population, urban and rural immigration, as well as an expansion of the city limits (Feizpour & Asayesh 2022). This issue has led to doubts about the concept and theoretical basis of the prime city. The main goal of this research is to analyze Iran's urban system from 1956 to 2021, to develop a new model by evaluating the primate city index of various cities based on prior frameworks. It highlights the strengths and weaknesses of existing primate city methodologies and suggests a more effective approach to address their limitations. However, while the study presents data and trends, a more concise explanation of the findings from 1956 to 2021 would enhance the analysis, particularly in terms of how these results relate to the gaps identified in earlier research.

Material and Methods

Study area

In terms of geographical location, Iran is in the southwest of Asia and the Middle East region and is the eighteenth in the world in terms of size (Fig. 1). Iran is divided into thirty-one provinces. According to the statistical yearbook of the country 2021 (Iranian Statistics Center 2021), it has an area of 1.6 million square kilometres and a population of 84 million people, it is situated in the geographical coordinates of 25 to 40 degrees North latitude and 44 to 63 degrees East longitude, which has 8640 kilometres of border lines with neighbouring countries. The number of cities in Iran has increased to 1428 cities in 2021. Tehran, Mashhad, Isfahan, Tabriz, Shiraz, Ahvaz and Qom are among the biggest cities in Iran (Iranian Statistics Center 2021).

Data Sources

The main data used in this study are aggregate population data in the cities of Iran from 1956 to 2022 (www.amar.org.ir/english). Additionally, the point data of Iranian cities during the years 1956 to 2021, based on the latest census in Iran, has been entered into the GIS software.

Data Analysis Methods

The study method is descriptive-analytical. First, the situation of the population and the number of cities in Iran in the years 1956 to 2021 has been investigated, and in this regard, the data of the Iranian Statistics Center has been used. Eq. No. 1 was used to check the population growth rate and Eq. No. 2 was used to check the urban growth rate.

$$r = \left(\sqrt[n]{\frac{P_n}{p_0}} - 1 \right) \times 100 \tag{1}$$

$$r = \frac{b - a}{a} \times 100 \tag{2}$$
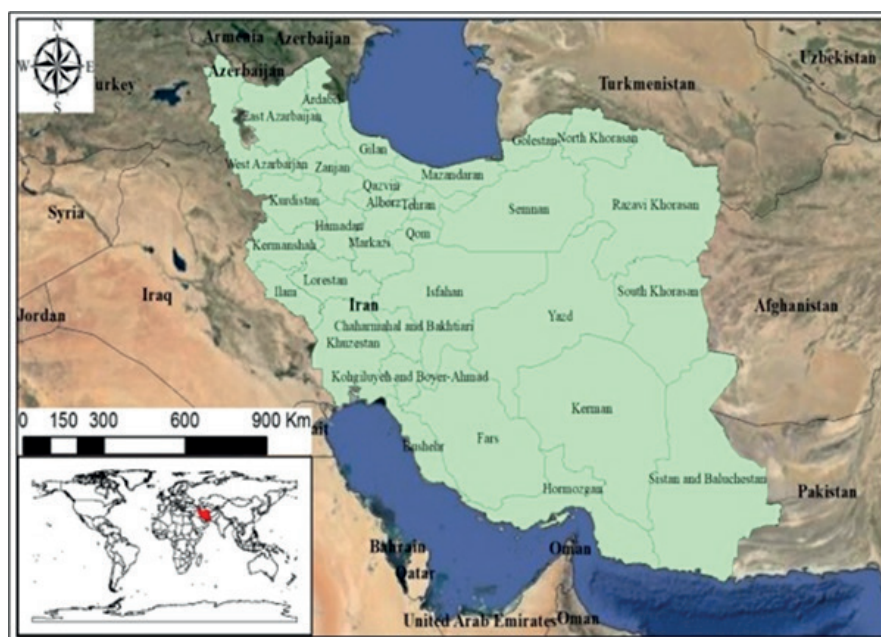
Fig. 1. Geographical location of the study area (Iran)

In the following analysis, the growth rate of the total population and the growth rate of the urban population have been compared to determine the changes in population distribution in the country. Furthermore, in this research study, the methods of Hot Spot Analysis and Directional Distribution were used for the spatial analysis of the population distribution. The Directional Distribution, represented by the Standard Deviational Ellipse, was used for the spatial analysis of population distribution, as it delineates the geographical distribution trend by summarizing both the dispersion and orientation of the observed samples (Wang et al. 2015). Hot Spot Analysis (Getis–Ord (Gi*)) spatial statistics were used for the spatial analysis of the population distribution, as they jointly evaluate the spatial dependency effect of both frequency and attribute values within the framework of the conceptualized spatial relationship (Songchitruksa & Zeng 2010).

Moreover, the first urban indicators, two cities, four cities, Mahta's four cities, Herfindal concentration, and Momoa Al-Wasabi have been studied. This article examines the strengths and weaknesses of prime urban indicators. The results of these studies have led to the presentation of a new index to determine the degree of primacy.

Primate City Index

The degree of the primacy of the largest can be measured by the ratio of its population to that of the second larger city or those of some other ranks of cities combined. Primacy is the superlative lead of the largest or primate city over the smaller cities and towns. This could be expressed as a ratio:

Index of primacy = p1/p2

Where P1 and P2 are the populations of the first and second largest settlements respectively, or Primary Index (2) = P1/P3, where P1 and P3 are the populations of the first and third settlements respectively. It is necessary under the rank-size rule that the primacy index for P1 and P2 settlements be 2; for P1 and P3 it must be 3 and so on. When the second largest city has less than half the population of the largest city, then the degree or level of primacy is said to be high and vice versa (Dolui 2017).

Two City Index: One of the most common methods of determining the "primate city" is the index of two cities, which has been used by urban and regional planners due to its simplicity on a larger scale. This index is related to the Zipf law (rank size) and has a definite basis that is obtained by calculating the population ratio of the first city to the second city.

$$TCI = \frac{P1}{p2}$$

If the numerical yield concluded is 2, it is determined to have balance, and urban primacy is not dominant. However, if it is greater than 2, the urban primacy index is dominant (Henderson, 2003). The primary issue with this method is that the rest of the cities of the urban system are not considered. This is due to the consideration that it is possible the prime city would not be dominant over the second city in an urban system but has urban primacy toward other cities. In other words, this index does not calculate urban primacy toward the total cities of the urban system. Hence, it may raise criticism or questions regarding the urban system and urban primacy concept theoretically.

Four City Index: This index like the city index is based on urban Rank-Size distribution and includes the ratio of the prime city toward the total population of second, third and fourth cities obtained by this formula (Henderson, 2003):

$$FCI = \frac{P1}{P2 + P3 + P4}$$

This index numerical base is 0/923 which mostly shows urban primacy domination. The primary issue with this method is there is a lack of focus on the other cities' urban systems as a city index. It can lead to misunderstanding about existing urban systems, and their abundance of cities.

Mahta's Four City Index: Mahta (1964) proposed the best method to study urban primacy according to primate city size toward the first 4 cities by revising the four cities formula:

$$\frac{p1}{p1 + p2 + p3 + p4}$$

Richardson then adapted the four-city index to the criteria of the rank-size rule. If the desirable sizes of cities in an urban system according to the urban rank-size rule are apparent, then the prime city size will be twofold the second city, threefold the third city, and fourfold the fourth city. As a result, the ratio of the prime city toward the total urban system of prime four cities can be determined to be 0/48. A major caveat and consideration for this method, like other methods, is the need to focus on other cities' urban systems.

Herfindal Concentration Index: This index studies the degree of concentration in the urban system which is obtained by the below equation (Zebardast 2007):

$$Hi = \sum_{i=1}^{n} \left(\frac{p_i}{p} \right) 2$$

Where (pi) is the population of the studying city (i), and P is the total urban population. The issues with other methods do not particularly apply to this method. It studies the ratio of every city to the total urban population. However, it does not conclude. Moreover, the ratio of cities to total urban population cause cities' rank and rank-size rule to lack a role or necessity.

Moomav & Alwosabi Index: This index obtains from the fraction of the sum of the first and second population toward the sum of the 3rd & 4th cities:

$$Moomay \ \& Alwosasavi = \frac{p1 + p2}{p3 + p4}$$

The greater this numerical index is, the more urban primacy can be characterized as part of the urban system. This index, such as theHerfindal Concentration & Urban Primacy indexes, does not conclude with a unique base. On the other hand, it ignores the other cities' urban systems and does not conform to the Rank-Size Rule.

Providing a new primate city index

Providing a New Index for Assigning Primate City: The type of index that is to be provided will not have the existing problems of the other indexes from the author's point of view. The four-city index is provided as (1) Eq. containing the total urban system cities:

$$\frac{P1}{P1 + P2 + P3 + \ldots + Pn} = \frac{P1}{P} \tag{1}$$

Although the (1) equation contains all the cities, the rank-size rule does not have any role. In other words, the city rank is not considered. In these circumstances, it has been decided to combine the Rank-Size Rule with the (1) Eq. in this study, to design a new urban primacy index in which the cities' rank will be considered. The general structure for the Rank-Size Model is as follows (Guerin 1995):

$$Pr = \frac{P1}{rq} \tag{2}$$

where, "Pr" is the population of the city that is ranked "r", "P1" is the prime city population and "q" is the line slope. The desired size of cities in equation (2) is obtained when "q" is equal to 1 or -1. In that case, the second city can be determined to be 1/2 of the prime city, the third city is 1/3 of the prime city and the n city is $\frac{1}{n}$ of the prime city. If "q"

is greater than 1, the prime city is dominant. If it is smaller than 1, the domination of cities is meant little (Hekmatnia & Moosavi, 2006). Therefore, providing the index will conclude to 1 according to the Rank-Size Rule. The number is considered when it is dominant to Rank-Size. It means that the indexes will be concluded to a unique base to compare different urban systems together. So, we will have:

$$P1 = \frac{p1}{R1} \gg P1 = P1R1 \tag{3}$$

For a city that is nth rank:

$$Pn = \frac{P1}{Rn} \gg P1 = PnRn \tag{4}$$

(4) Eq. is equal to the below equation:

$$\frac{Pn}{P1} = \frac{1}{Rn} \tag{5}$$

On the other words, it is equal to equation (6):

$$\frac{P1}{Pn} = Rn \tag{6}$$

To bring the base to number one, we combine the first and second parts of Equations 5 and 6. In this case, we will have:

$$\frac{Pn}{P1} \times Rn = \frac{P1}{Pn} \times \frac{1}{Rn} = 1 \tag{7}$$

If we consider the above relation, for each of the cities, the obtained number will be equal to one. However, if we consider the above relation for all cities (i.e. if the city system according to the rule of Rank-Size slope of the line is equal to 1), the number obtained will be equal to the number of cities.

$$\left(\frac{P1}{P1} \times \frac{1}{R1} \right) + \left(\frac{P1}{P2} \times \frac{1}{R2} \right) + \ldots + \left(\frac{P1}{Pn} \times \frac{1}{Rn} \right) \tag{8}$$

In Eq. (8), the number of cities is equal to:

$$1 + 1 + 1 + \ldots + 1 = N \tag{9}$$

Therefore, to conclude the designed indexes to 1, according to the Rank-Size Rule, we should necessarily divide Eq. (8) by Eq. (9) means the number of cities, to conclude to 1. If it is greater than 1, it shows urban primacy domination and less than 1 shows the middle & small cities domination. Therefore, the urban primacy index is as below (10):

$$P.C = \frac{\left(\frac{P1}{P1} \times \frac{1}{R1} \right) + \left(\frac{P1}{P2} \times \frac{1}{R1} \right) + \ldots + \left(\frac{P1}{Pn} \times \frac{1}{Rn} \right)}{N} \tag{10}$$

As a result, According to Eq. (10) Mousavi primate city index is presented as follows (Mousavi and Taghvaei, 2009) (11):

$$P.C = \frac{\sum_{i=1}^{n} \left(\frac{P1}{Pi} \times \frac{1}{Ri} \right)}{N} \tag{11}$$

The basic capability of this index is that it can show the prime city domination over the total urban system cities on their rank base. This differs from the previous indexes which only show the prime city domination over some cities. It is possible that the prime city does not have as much domination over some cities in an urban system. However, it is also possible to have high domination over the next-rank cities, and this index can assist in calculating and assigning that domination.

RESULTS

Urbanizing Trends and Dynamics in Iran

Urbanization, as driven by higher population growth in urban than in rural areas, constitutes one of the most important transformations in contemporary population geography (Lerch 2017). In this regard, migration can play an important role in determining population growth in an area (Liu and Yamauchi 2014). Migration to cities in recent decades has led to an increase in population density as well as the level of large cities in Iran. Often after each general population and housing census, the data obtained can show the status of changes in population distribution. In this regard, the situation of urbanization trend in Iran during the years 1956 to 2021 has been investigated in Table 1.

According to Table 1, During the years 1956 to 2016, the urban population as well as the number of cities has increased in Iran. In this regard, the number of cities in Iran has increased from 199 cities in 1956, to 1428 cities in 2021. This has in turn led to an increase in the percentage of urbanization in the urban system from 31.41 to 75.99. Additionally, the geographical location of Iranian cities using GIS during the years 1956 and 2021 is shown in Fig. 2.

The trend of urban development and urbanization in Iran's urban system, according to Table 1 and Fig. 2, is that the number of cities in Iran has increased from 199 cities in 1956 to 1428 cities in 2021. One of the main reasons for the increase in the number of cities in Iran has been the conversion of large villages into cities to prevent the migration of villagers to cities. Furthermore, the percentage of the urban population in Iran has reached 75.99% from 31.41% in these years; over 65 years, the percentage of the urban population has increased by 44.58% (i.e. by 57,922,437 people). While from 1956 to 2021, the total number of people added to the population of Iran was 65,100,296 people.

Moreover, according to Table 1, the growth rate of the total population and the urban population of Iran shows that the urban population has faced greater growth than the total population. As such, the main cause of this issue is the centralized policies of the government in big cities and the concentration of industries mines and major economic activities in cities. Finally, the phenomenon of industrialization of cities in Iran simultaneously with lifestyle changes and the transition from tradition to modernity, is another factor that has increased the trend of urbanization in Iran.

Spatial Analysis of the Urbanization Process

In this section, the spatial analysis of the distribution of Iranian cities in the years 1956 and 2021 has been investigated, so that the hot spots (densely populated

Table 1. Urbanizing Trend and dynamics in Iran

Year	number of cities	total population	Urban population	Urban population (%)	The growth rate of the number of cities	Population growth rate	Urban population growth rate
1956	199	18954704	5953563	31.41	-	-	-
1966	272	25788722	9794246	37.98	36.68	3.13	5.1
1976	373	33708744	15854680	47.03	37.13	2.71	4.93
1986	487	49445010	26844561	54.29	30.56	3.91	5.41
1996	612	60055488	36817789	61.31	25.67	1.96	3.21
2006	1015	70495782	48259964	68.46	65.85	1.62	2.74
2016	1242	79926270	59146847	74.00	22.36	1.26	2.06
2021	1428	84055000	63876000	75.99	14.98	1.01	0.77

Source: Statistics Center of Iran, 1956-2022
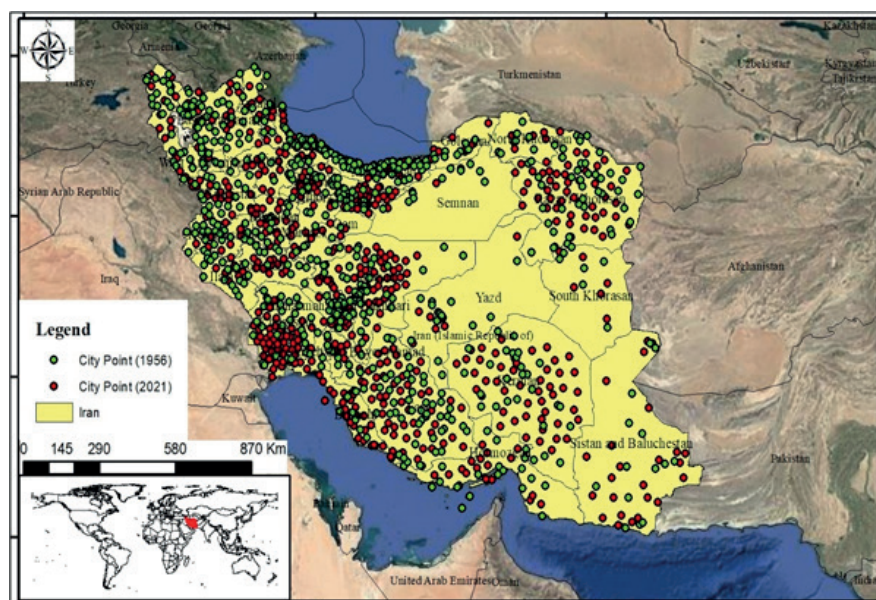
Fig. 2. Distribution of Iranian cities in 1956 and 2021

cities) in Fig. 3 have been examined first, and the changes in the concentration of cities have been investigated in Fig. 4.

The results of Fig. 3 show that in 1956, the population was more concentrated in the north of the country, while in 2021, the population of the country was more concentrated in Tehran and Khorasan-e-Razavi. Investigating the urbanization development process in Iran between 1956 and 2021 using hot spots in the ARC GIS environment shows a variety of considerations, for instance, the increasing number of cities and shift of the population to the central and southeastern regions of Iran was aimed at balancing the distribution and dispersion of the population, according to the purpose of the territorial land use planning. Most of the cities in the north and west of Iran have been able to have a better population due to their location on the slopes of the Alborz and Zagros mountains, and having favourable water, soil, and better climatic conditions. This issue was further corroborated by the study conducted by Seifoldini et al. (2014) and

Zebardast (2007), which revealed a concentration of densely populated cities in the central region of the country and close to Tehran.

Fig. 4 also shows that the concentration of Iranian cities has been from the northwestern side of the country to the centre of the country, and the main reason for this is the better living conditions, security and proximity to the country's capital. Additionally, Bayramzadeh & Mousavi (2024) highlight that the development and emergence of new cities have occurred primarily in the more developed regions of the country, further reinforcing the findings of this analysis. According to the Spatial analysis of the urbanization process in Iran, the results show that in 1956, the population was more concentrated in the north of the country, while in 2021, the population of the country was more concentrated in Tehran and Khorasan-e-Razavi. Additionally, the concentration of Iranian cities has been from the northwestern side of the country to the centre of the country. The main reason for this is the better living conditions, security, and proximity to the country's capital.
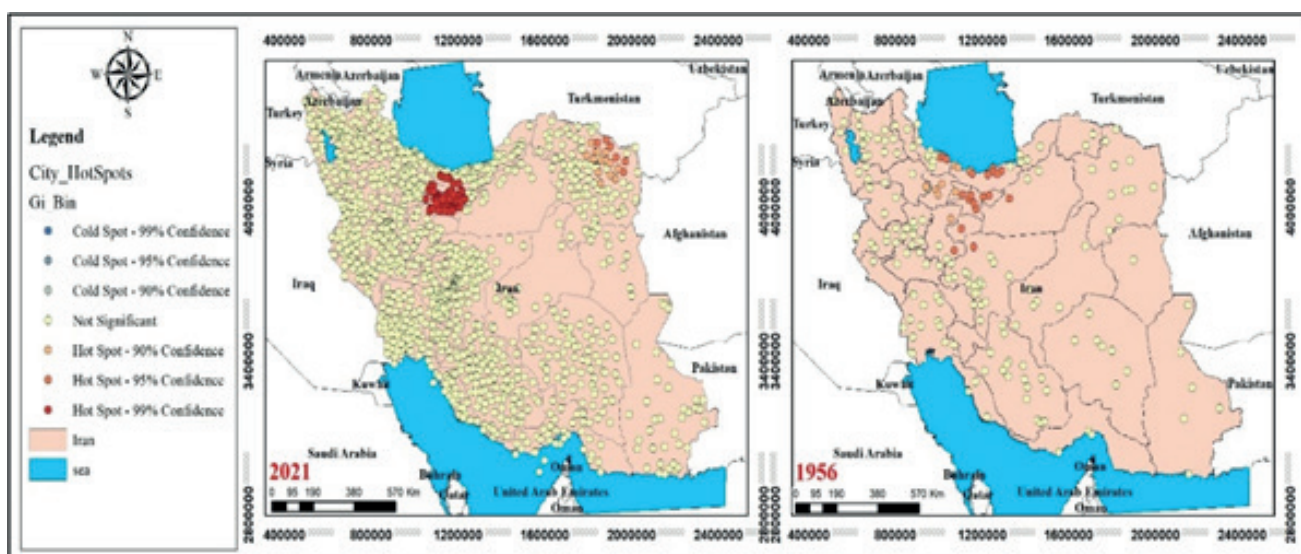

Fig. 3. Hot Spot Analysis in 1956 and 2021

Fig. 4. The trend of concentration of Iranian cities in 1956 and 2021

Analysis of Rank-Size Rule in Iran

In the following, the status of the rank-size rule in the years 1956 to 2021 has been investigated, and the results of this investigation are shown in Fig. 5 and Tab. 2.

The results of the analysis of Fig. 5 and Table 2 indicate the urban primacy in Iran in all the years investigated. The main reason for this is the accumulation of capital and activities in Tehran, the country's capital. These results indicate the increase of the urban primacy from 1956 to 2016. This amount has decreased slightly in 2021, which

is the main reason for this issue was the government's attention to the border areas and deprivation.

Viewing Urban Primacy Changes in Iran

To view urban primacy changes in Iran, six previous indexes have been used, in addition to a proposed index. Undoubtedly, the purpose of this study is more to acquire the accuracy and falseness of the proposed index results and its superiority over the previous indexes. The results of this study are shown in Table 3.
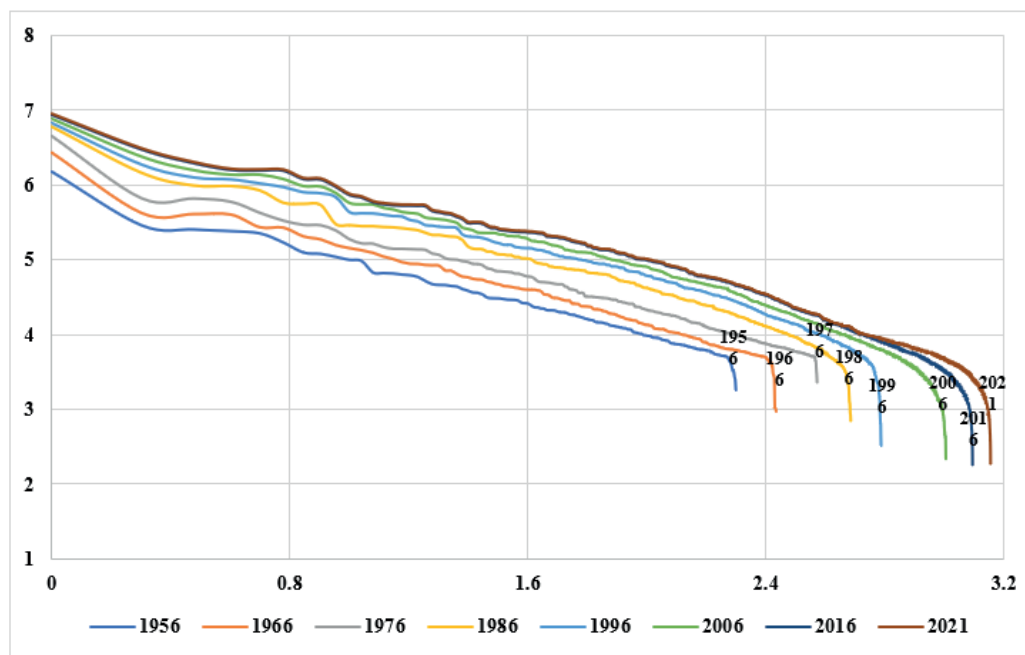

Fig. 5. Rank-Size rule trend in Iran

Table 2. Rank-size rule trend in Iran

Year	y	R^2
1956	y = -1.0294x + 6.0319	0.9837
1966	y = -1.1107x + 6.3305	0.9653
1976	y = -1.0694x + 6.4521	0.9928
1986	y = -1.2359x + 7.0064	0.9398
1996	y = -1.2786x + 7.2538	0.9265
2006	y = -1.4125x + 7.6566	0.9209
2016	y = -1.4145x + 7.7765	0.9342
2021	y = -1.3555x + 7.6797	0.9441

Table 3. Iran Urban Primacy indexes during 1956-2021

Index / year	1956	1966	1976	1986	1996	2006	2011	2016	2021
Urban primacy index	0.252	0.278	0.289	0.225	0.184	0.162	0.151	0.146	0.131
Two city indexes	5.21	6.41	6.78	4.13	3.58	3.2	2.947	2.89	2.54
Four city indexes	1.922	2.198	2.351	1.766	1.556	1.44	1.222	1.32	1.28
Mahta's index	0.657	0.687	0.701	0.638	0.608	0.589	0.550	0.570	0.567
Herfindal Concentration index	0.057	0.087	0.092	0.061	0.043	0.355	0.033	0.030	0.032
Moomav & Alvosabi index	3.37	3.78	4.31	2.38	3.25	3.42	2.797	3.29	2.08
Mousavi Primate City Index	1.161	2.2	2.27	2.35	2	2.85	2.327	2.24	2.26

According to Table 3, The study of Urban Primacy in the spatial structure of Iran shows that during the years 1956 to 2006in all the studied periods and based on all the indicators, the urban primacy phenomenon has been dominant. The results of the six indexes in Table 3 show that the urban primacy scale has been increased from 1956 to 1976 and it has the highest degree in 1976. The first six indexes had a descent trend from 1986 to 2021, but the proposed index had an ascent trend in 1986, and it had a descent trend from 1986 to 1996. However, this index had an ascent trend in 2006.

An analytical observation of the developments and the formation of the urban order shows that Iran's industrialization, following land reforms and government investment in large urban centres, has led to the emigration of the villagers to the city and the rapid growth of urbanization. This resulted in an increase in the number of cities from 199 cities in 1956, to 373 cities in 1976. After the Islamic Revolution, the government pursued spatial organization and population adjustment policy by investing heavily in deprived and rural areas of the country. However, factors such as the migration of population from the border areas to central Iran the increase in the natural rate of population growth and the intense migration of villagers to the city led to increased inequality and imbalance in the urban system of Iran. This inequality and imbalance in the urban system of Iran reached its peak in 1986. Accordingly, among the Urban Primacy indexes, only the Mousavi primate city index shows the reality of the current situation of Iran's spatial structure, while previous indexes do not have this capability.

Based on the results of the proposed index, the phenomenon of "Urban Primacy" in Iran increased in 2016, while other indexes do not show this phenomenon. The study of the model of the urban system based on rank size also clearly shows the inequality in the urban system in Iran in 2016. It can be said that since the rankings of other cities in the urban system are ignored in the previous indicators, as a result, they are not able to express reality, and their weakness is obvious, while the proposed index is fully compatible with the rank-size model. Accordingly, if we draw the draw $\left(\frac{1}{Ri}\right)$ logarithm & $\left(\frac{P1}{Pi}\right)$ logarithm on the diagram, we will get the same result as in the Zipf pattern.

However, in the case of the Urban Primacy phenomenon in Iran, it can be inferred that the transformation of large and small villages into cities, great distance from the first city based on the rank of any city is the main cause of disorder and imbalance in the spatial structure of the country. These issues have led to the formation of the Urban Primacy phenomenon in the urban system of Iran. Given that this research has resulted in the development of a practical model that has yielded positive outcomes in the context of Iran, which is more reflective of real-world conditions, it is recommended to apply this model (Mousavi primate city index) in various geographical settings. Additionally, comparing its results with those of this study would facilitate a more thorough investigation.

DISCUSSION

The law of the primate city is one of the most basic generalizations regarding the size distribution of cities introduced by M. Jefferson. The law is established on the agglomeration effect by which a city repeatedly the capital city grows inexplicably to outshine the rest (Bajpai Tewari, 2024). The provided indexes' weaknesses are revealed when the various methods are exposed to case studies.

The objective is to compare the results of the obtained indexes to gain a more informed understanding of each of their strengths and weaknesses. Of course, however, it is important to consider that critics often focus on the weaknesses, while investigators insist more on the strengths. From Jefferson's era until now, many methods have been provided to assign urban primacy according to his idea. The two main points were not referred to in those indexes, however. It can be concluded that the provided indexes cannot state the urban primacy main concept based on the urban system (Moshfegh 2023- Lotfi et al. 2013- Mousavi & Tagvaei 2009).

• This is due to the lack of focus on the total urban system cities. If their ranks have a role in the calculation, the Rank-Size Rule principles will not be observed in urban primacy calculations.

• According to Table 3, some of the provided indexes have not been concluded to a unique base, this problem mainly manifests when we are deciding to compare different cities together.

Finally, as it is obvious from urban definition and concept, its assigning means the superiority of primate cities toward the total urban system cities. Hence, the theoretical basement of the provided methods is doubtful. This is due to the provided indexes only highlighting the prime city and or the total urban population as being of importance. In comparison, Rank-Size order may have been considered in the first cities, but urban primacy would be dominant over the down-ranked cities, or some down-ranked cities would be dominant over the prime city.

In this case, the provided methods are not able to acquire urban primacy superiority on the space structure related to an urban system. Therefore, the authors are trying to give a better index toward the provided ones to solve this problem. In this regard, researchers and planners can use Formula No. 11 (provided in the material and methods section) to evaluate the Urban Primacy Index. This index fundamentally enhances our understanding of urban dominance by allowing us to assess how the leading city compares, not only to a select few cities but to all cities within the urban system, while taking their ranks into account. While the top city might not exert significant influence over certain districts, it often wields considerable dominance over cities in the subsequent ranks. This index effectively captures and quantifies that relationship.

RESEARCH LIMITATION

One of the possible limitations of this research could be the lack of access to new data so the latest data published about the population by the Iranian Statistics Center is for 2021, which may change the results of the research with the presentation of new population statistics. Additionally, the lack of the existence of a government institution to provide population statistics is another factor. As a result of this, the validity of population data cannot be controlled and presents limitations.

CONCLUSION

This article has reviewed the strengths and weaknesses of the index's prime city, two-city index, four city indexes, Hrefindal Concentration index and Moomav & alosabi index. To solve the problems and inadequacies caused by these indicators, it has presented a new index called the Mousavi primate city index. The authors reviewed and analyzed Iran's urban primacy status according to the previous and new indexes from 1956 to 2021, to examine

the new index. However, according to the new index, urban primacy status in Iran had an upward trend from 1956 to 1986 and a downward trend from 1986 to 1996. This trend has taken an upward trend in 2016 due to the increase in the number of cities and migration to new cities due to drought and relative agricultural stagnation. The status of the rank-size pattern confirms the results of the new index. The results show that since Mark Jefferson's initial idea, six indicators have been proposed to determine the prime city, in which, two main points are not discussed. One is the lack of attention of this index to all cities of the urban system, considering their rank. Second, is that most of these indexes do not lead to a single basis. This has caused these indicators to not correspond in some cases to the results of the rank-size of cities. This issue has led to doubts about the concept and theoretical basis of the prime city. Therefore, this demonstrates that the introduction of mathematical models and formulas into geography is a critical turning point and is referred to as a quantitative revolution.

However, it is important to note that the weakness of this index points out to researchers and geographers that most models and methods are inconsistent with the theoretical and philosophical basis of geographical phenomena. Moreover, relying solely on these methods will deter geographers from the facts and realities of geographical and spatial phenomena. Of course, it is also noteworthy that these methods and models, as lawful tools, have a great impact on the understanding of geographical phenomena. Due to the inclusion of the rank-size rule and the potential to compare several cities, the presented model can help researchers in future research to evaluate urban primacy and this issue can provide better results than other models. This can be useful for planners to create a vision for the development path and plans. Finally, to thoroughly assess the model's efficiency, it is recommended that this model be utilized in various geographical locations and compared with the findings of this research. ■

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