



# Analysis of spatial (in)equality of urban facilities in Tehran: an integration of spatial accessibility

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Received: 26 March 2020 / Accepted: 6 July 2021 / Published online: 16 August 2021  
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## Abstract

The urban expansion and growth of Tehran have caused many challenges and issues for the city, which has been shown in the form of spatial–social balances with informal expressions, weakness of local governments, biological pollution, etc. The lack of balance in urban service facilities has led to a significant gap in different parts of the city. In this research, main providers of urban facilities concerning spatial inequality were used. The results of this study, using spatial statistics methods and fuzzy logic, showed that the pollutants of the city of Tehran are distributed in three ways: cluster, random, and disperse. Hospitals, police stations, subway lines, local governments, and gas stations are clustered. Fire stations, Red Crescent, food and wholesale centers, medical services, housing prices, bus terminals, and hotels are random. Ambulance services and sports clubs are dispersed. These ways of distribution have resulted in a significant difference in the use of services provided by residents of different regions and have contributed to unequal opportunities for citizens in the use of facilities. Deprived districts represent the fact that the urban population is growing faster than the necessary infrastructure which can be built by urban management. The least developed and underdeveloped areas are mostly in the south and south-east of Tehran city, the medium and relatively developed areas are located in the center and west of the city, and the developed areas are located in the north of the city. Findings in this paper are trying to provide main criteria and the results to have a rational assessment of the current situation in the city to solve problems to urban managers and planners, as well as policy and planning strategy for urban development programs to achieve urban sustainability.

**Keywords** Spatial inequality · Urban facilities · Urban welfare · Spatial analysis · Tehran

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## 1 Introduction

The spatial and social inequities have been of increasing concern to both academics and policymakers in urban services. Lack of access to any services will decrease their expected opportunities, and this will consequently lead to deprivation, social exclusion, and decreasing quality of life (Barbieri et al., 2019; Sun et al., 2018).

People usually work together in a wide array of social activities. They pursue their goals through social groups. In order to secure a society's various equal needs in urban space, the concept of social justice arises (Harvey, 1992). Neglecting it results in a series of unwanted consequences, such as poverty, marginalization and excessive density of the area, unilateral development of cities, unpopulated urban areas, bourse lands, and many other issues (Fraser, 2014; Young, 2011). Thus, identifying the effects of social justice is an essential component of urban studies and the city. In the 1960s, a practical tradition of advanced planning emerged in the field of urban planning, focusing on justice and equality in societies (Bingham & Mier, 1993; Davidoff, 1965; Krumholz, 2011; Krumholz & Clavel, 1994; Thomas, 2006). One of the crucial aspects of human societies reflecting social events and the manifestation of social communication is organizing space.

Space justice is the bridging point between social justice and space, which refers to the geographical or spatial aspect. Therefore, analyzing the interaction between space and society in the understanding of social injustice and the regulation of policies to reduce or solve them is necessary. So, it can be considered both an output and a process. It is a focal point where the concept of social justice is developed (Dufaux et al., 2009; Soja, 2009). The concept of spatial justice has created several approaches in the field of social sciences. Philosophers have polarized two mutual visions of justice discussions of this issue. One focuses on the issue of redistribution and the other ones on decision-making processes (Dufaux et al., 2009).

One of the most important goals of urban planners is the approach of justice and equity in the distribution of public utilities (Dadashpoor et al., 2016). Therefore, the general concept of justice for professionals and scholars during various periods has received great acceptance and popularity. The result is a large collection of different and diverse theories based on the concept of justice in the city (Harvey, 2010; Jost & Kay, 2010). Recent urban study debates have suggested that development and planning policy should consider normative social justice theory based on the shift in the understanding of morality and the perceived need for new normative frameworks to structure society (Visser, 2001).

The geographical approach of urban social justice is synonymous with the equitable spatial distribution of facilities and resources between different urban areas and their accessibility, because their unequal distribution will lead to social crises and complex spatial problems (Blacksell, 1990; Pacione, 2003; Soja, 2013). The economists emphasize multidimensional measures in the human development index (HDI), such as income, life expectancy, level of education, and the gender inequality index, while anthropologists and sociologists use dimensions including the neighborhood attachment, sense of place, abiding attachment to place, material resources, access to collective and public resources, the attendance to legal and social rights, and the discernment of quality and prosperity such as inhabitants (Barbieri et al., 2019; Méndez & Otero, 2018).

Providing equitable urban services and facilities in the city can be achieved by offering equal opportunities to city residents for self-improvement and good quality of life (Griffin, 2015). Public services, regardless of their spatial dimension, should be readily available in terms of funding constraints or people's physical ability (Kaphle, 2006). Public services

generally are defined as economic entities that have a general and generic interest and are the initiative of public institutions. Although the support and maintenance of public services for investment are vested in the private and public sector independent of public institutions, receiving public services on a large scale has a direct impact on people's daily lives. These services have spatial functions. Public services should be readily available, regardless of location, in terms of financial constraints or physical capabilities (Kaphle, 2006).

The rapid growth of urbanization, excessive building and population density, a loss of public facilities, and the unparalleled demand for infrastructure development have put pressure on the sustainability of cities (Ali et al., 2019a, 2019b). Urban management follows policies, plans, programs, and procedures that seek to ensure that population growth is coordinated with access to basic infrastructure, housing, and employment (Davey, 1993). Urban area development is about the art of managing, coordinating, guiding, and perhaps even guiding the decisions of many stakeholders involved in urban development toward a high-quality result, meaning everyone should enjoy urban places (van Bueren et al., 2016). Therefore, the conscious action of urban management in the spatial distribution of social benefits to reduce spatial inequality and enhance the quality of the physical environment and thereby enhance the quality of life and achieve urban sustainability requires an analytical understanding of the situation. Citizens' life-lasting with maturity, social welfare, economic and environmental welfare of human settlements would be also achieved in the shade of spatial equality (Hosseini et al., 2015). For many cities, sustainability actions not only improve environmental situations and quality of life but also play a fundamental role in attracting investment and highly skilled labor (Miller & Mossner, 2020). To eliminate inequalities, urban managers and planners seek to allocate resources with the most desirable combinations.

Previous studies have approached spatial statistics and fuzzy logic with spatial inequality. Using spatial statistics in spatial inequality research, Brooks (2019) states that these methods allow more accurate identification of spatial patterns and show outstanding outcomes. McLennan et al. (2016) suggest using socioeconomic inequality dimensions to explore whether there are any links between exposure to inequality and disturbances of social unrest and criminal activity or to explore relationships between exposure to inequality and people's opinions about poverty, inequality, and rehabilitation. The results express that exposure to inequality is markedly higher for members of the poor community subgroup in urban metropolitan areas and there are firm differences in exposure depending on where a person lives within an urban (or indeed a rural) area. Bulti et al. (2019) show how the nearest neighbor analysis can provide an accurate clustering pattern for spatial distributions. The Niranjani (2020) study using spatial autocorrelation as a branch of spatial statistics shows that increasing access and services at the spatial microlevel leads to reducing spatial inequality and reinforces human development. In the same way, Duncan et al. (2014) use it to accurately understand the effects of socio-demographic inequality on the spatial distribution of an ecological study. On the other hand, the scholars use fuzzy logic as a common tool for the interpretation of data for accurate outputs (Wu et al., 2018; Hosseini et al., 2021). Fuzzy logic allows flexibility and is conceptually easy to understand, which can model nonlinear functions of arbitrary complexity. Fuzzy logic can be built on the experience of experts and can be mixed with conventional control techniques (Piroozfar, 2012). Mullick et al. (2019) state that GIS can provide a more realistic representation of spatial diversity with fuzzy logic. That's why GIS-based studies have expanded more to solve previously difficult problems. Thériault et al. (2005) have used fuzzy logic to model urban centrality and spatial access to urban facilities. The purpose was to reveal significant

differences in access to municipal services between homes and types of activities. Bostanc and Erdem (2020) have used a fuzzy model to examine citizens' satisfaction with urban services, their aim developing a new approach in evaluating the quality of urban services. They presented a method with local references and illustrated the results by analyzing citizens' satisfaction from the municipality.

Tehran is in the context of the present study to evaluate the spatial justice of urban services. Due to its population growth, the city's attractiveness and its social and economic potentials have grown rapidly (Hosseini et al., 2015). Because of the rapid unplanned growth of and migration to Tehran and its surroundings, severe inequality grew within this city, especially in comparison with other Iranian cities. Between 2011 and 2016, a total of 404,496 immigrants have arrived in Tehran (Statistical Center of Iran, 2016). Subsequent abnormal urban development increased informal settlements, urban poverty, and the gap in the application of urban services; however, it decreased the quality of life within urban areas. Therefore, the lack of proper distribution of urban services can not only disrupt the balance of population but also forms urban spaces contradictory to justice in the social and economic dimensions. In this paper, authors pursued two purposes: First, we examined the distribution of facilities with spatial statistics using average nearest neighbor index (ANNI) and spatial autocorrelation; second, we used many criteria, mapping spatial inequality of different regions of Tehran. The integrated study of spatial access not only provides a resource for better identifying inequality at a mesolevel but is also essential as an important tool for planning and managing urban development policies or strategies.

## 2 Literature review

The concept and function of social justice first entered the geographical literature in the late 1960s onward (Harvey, 2010). The concept of social justice influenced radical and liberal geography more than any other school. Lefebvre and Nolla (1972) view space as a political and ideological concept, and because of social struggles, they see it as a framework for revolutionary action, which they consider a social act. Leading research in social justice is highlighted by Smith (1977). In 1991 the Committee on Social and Cultural Geography of the British Institute of Geographers published a report on social justice and geography, which included analysis of (community winners) and (community losers). Harvey (2010) argues the importance of contributing to public welfare, income distribution in places, equitable allocation of resources, and meeting the basic needs of the people. He also emphasizes the inherent tendency of the contemporary capitalist to geographically spread social inequality and the continuous competition for the growth of new spaces and territories (Harvey, 1987).

To date, the term spatial justice has not been widely used, and even recently, geographers and planners are reluctant to use the term "spatial" in describing research on justice and democracy in contemporary societies (Soja, 2013). Justice can be described as "Who, What, Where, When, and How" (Merrett, 2004; Smith, 1995). Philippopoulos-Mihalopoulos (2014a, b) defines spatial justice as the struggle between humans and other creatures for the occupation of certain materials and metaphorical spaces at a particular time. This can make a connection between settlement, time, space, and the relationship with other objects (Brown et al., 2019).

Belonging to a city means far more than individual freedom to access urban resources: and in fact, it is the right to change ourselves by changing the city (Harvey,

2003, 2008). Environmental justice theory predicts that traditionally marginalized groups (e.g., low-class, color-coded, low-educated) have less access to facilities and power to determine their distribution. Fainstein (2005) defined the just city in terms of democracy, equity, diversity, growth, and sustainability. Collaborative democracy shows that spatial inequalities cannot be changed unless people fight against inequality (Boone et al., 2009; Fainstein, 2014).

The sustainability of spatial justice is a long-term goal, and all stakeholders must be involved in different movements on different geographic scales (Meng, 2018). Merging concepts mentioned in the definition of Feinstein's just city is a complex task because they could contradict one another, cause a legitimization crisis through redistribution, spur a social breakdown in connection with diversity, and reduce growth, thereby producing unemployment for sustainability (Fainstein, 2009).

Justice should not be referred to in purely economic contexts (Martínez, 2009) because space is also a vital aspect in human society in which social justice should be spread (Soja, 2009). This is where justice and injustice should be differentiated (Ghaedrahmati et al., 2018). A more recent approach to spatial justice attempts to understand the relation between space and social justice in their dialectic nature (Cassiers & Kesteloot, 2012). The concept of social justice in social policy has a current meaning (Barry, 2005) used in the field of environmental management and indicators as well (Schwarz et al., 2018; Syme & Nancarrow, 2001). Justice remains an indispensable asset that allows for peaceful coordination and coexistence between different groups in any society (Helbling et al., 2015).

For some scholars, spatial justice is just equal access to basic public facilities, such as access to schools, health facilities, and so on. In some studies, spatial justice has a broader meaning. Some studies show evidence of a positive correlation between socio-spatial inequality and urbanization as well as urban expansion in concepts such as shrinking, sprawl, and inner-city decline. The migration of wealthy populations from the core city to the surrounding suburban areas connotes the deep social cleavage between the core and the fringes (Brinegar & Leonard, 2008; Galster & Cutsinger, 2007; Marsh et al., 2010; Ortiz-Moya, 2018; Sulemana et al., 2019; Xie et al., 2018). In terms of the planning of public facilities, spatial justice means separation or proximity of urban facilities and services to residents (Tsou et al., 2005). John Rawls's principal components of justice for urban service use state that: (a) Equal opportunities should be the starting point; (b) a minimum level for each service; (c) before the distribution results are known, an agreement must be reached on the allocation rule (James, 2017; Pogge & Pogge, 2007; Rawls, 2009).

The goal of spatial justice is equitable distribution of necessary facilities and services among different neighborhoods and districts of the city so that no quarter or district has a spatial advantage over another (Harvey et al., 1996). Spatial injustice, on the other hand, can be considered as a result as well as a process, such as the scattering patterns that in turn unfair (Iveson, 2011). Rawls (2009) argues that principles of justice to determine fundamental rights and freedoms to regulate social and economic inequality in life prospects included each person has the same infeasible claim to a fully adequate scheme of equal basic liberties, which scheme is compatible with the same scheme of liberties for all. Socioeconomic inequalities are to satisfy two conditions: First, they are to be attached to offices and positions open to all under conditions of fair equality of opportunity. Second, they are to be to the greatest benefit of the least-advantaged members of society (the difference principle).

## 2.1 Distribution of urban services based on social justice

Recently, social justice is one of the largest achievements of culture and civilization and one of the most pervasive social phenomena of this era. Sustainable urban growth is putting more pressure on urban infrastructure; therefore, spatial justice is merely a framework that highlights the socio-spatial distribution of benefits and barriers among human societies (Nygren, 2018; United-Nations, 2014).

Looking at Tehran from the perspective of social justice may be one of the rarest yet most fundamental attitudes. A sense of place is a concern and an important topic of social justice that has not received much attention (Barton, 2002; Long, 2013). Urban planners must seek to determine the level of inequality in the position found, how the inequalities are distributed, and what groups in society are most deprived (Hewko et al., 2002). Harvey (2010) applies the concept of social justice in the support of public good and public interest, the distribution of income, equitable allocation of resources, and meeting basic needs of the people, and stresses the ethical aspects of geography regarding the provision of social justice and the mission of geographers in the provision of spatial justice.

Research on the distribution as an element of justice has spread to examine issues related to social welfare. Achieving spatial justice in the distribution of urban services is one of the more important goals of urban planners to equitably distribute social costs and usage of local capacities. Justice theories, based on all perspectives of traditional justice theories, show that the issue of justice is broader than the problem of distribution of goods (Mattila, 2002). Social justice is a multidimensional concept, but the two axes of the study of quality of life and how to distribute opportunities, access to social, physical, and virtual infrastructures, are always the focus of studies in this field (Martínez, 2009). However, the basic function of urban public services and the citizens' equal access to these services is also one of the most important issues in urban management and social justice area. As Miller (1999) notes, distribution in the traditional theories of justice distribution refers to the way goods are distributed among individuals. Service and urban facilities refer to all elements of a city. It facilitates citizens' lives. This definition of urban facilities and services is very extensive and includes urban amenities and facilities. The urban services in the general sense can include many service activities required to manage urban affairs. However, it should be noted that the recognition and classification of activities on urban services has a strong dependency on urban management, since determining the practical scope of activities in urban services needs to determine the level of urban management and establish district relations.

Cities can only exist where residents have the right to live together with rights to participation in city plans. The centralization of service centers in a particular location, while creating bipolar areas in the cities, leads to the influx of consumers into these areas. On the one hand, this increases environmental pressure, nuisances, traffic, pollution including noise and air, and odors (Méndez & Otero, 2018). On the other hand, it results in the attraction of complementary, parallel, polarization of space in the cities. Hence, it becomes impossible to achieve sustainable urban development.

Spatial inequality is measured based on a particular measure while the status of spatial inequality is based on each indicator (Stillwell et al., 2010). Another factor influencing the increase in socio-spatial inequalities is a kind of "emphatic turn towards neoliberalism in political-economic practices." It is presented in the form of a policy of post-industrialization to services that moves toward more deregulation in markets

rapidly. Neoliberal practices also force the unemployed or those who have dropped out of school to accept low-paying, less-skilled jobs. Finally, the erosion of social housing and the privatization of the housing market provides an opportunity for the rich to move to more locations, leading to segregation (Shi & Dorling, 2020).

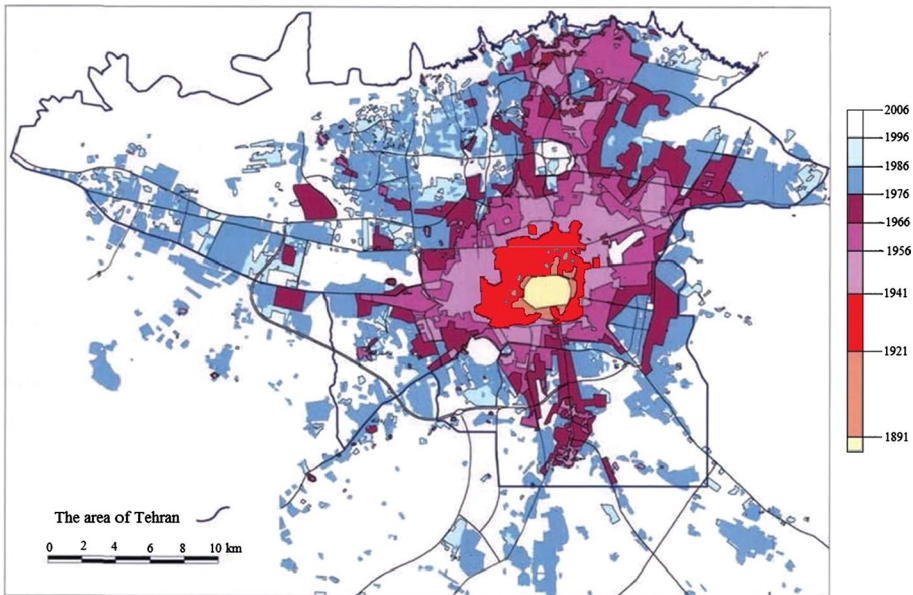
In many cases, urban justice is presented as a moral approach, although it aims to encourage fundamental efforts to improve the inequality between the populations through a set of reformist principles created to improve the daily management of cities (González, 2019). Therefore, the discussion of spatial inequality in cities and the necessity of social justice in the enjoyment of public services have become one of the most important issues facing planners and urban managers, and one of the most important factors that must be observed to implement social-spatial justice in planning for cities is proper distribution of urban services and economic resources as well as proper utilization of spaces. In other words, in the optimal distribution of services and facilities, the benefit of all strata and social strata of the society should be considered to achieve social and spatial justice. However, we must have a deep sensibility toward spatial justice to help understand justice as a geographical combination in multiple scales, rather than only as an absolute or total scale (Dikeç, 2001; Harvey et al., 1996; Massey & Massey, 2005; Philippopoulos-Mihalopoulos, 2014a, b; Soja, 2013).

Ensuring equality of opportunities and spatial distribution of functions is important. In analyzing equality of opportunities and spatial distribution issues in a place, it is regarded to pay enough attention to the population of study areas, the proper access to service centers, the activity that the objective, and physical aspects. In this regard, some have defined spatial justice as equal access to public facilities and have measured it based on the civilians' distances from the services. Also, Talen and Anselin (1998) argue that to analyze spatial justice emphasis should be placed on comparing the spatial distribution of public services and facilities with the spatial distribution of different socioeconomic groups.

### 3 The study area

The purpose of this study is to analyze and detect interurban spatial inequality in the welfare facilities of the city of Tehran, since the city of Tehran suffers from various injustices such as political capital, large population centers, and industrial centers.

The current metropolis of Tehran, when selected as the capital in 1785, had only 15,000 inhabitants. The transformation of Tehran from an ordinary city into a modern capital began in the early Pahlavi era (1925–1941). During the Pahlavi era, state affairs were concentrated in the capital, and the number of government employees in the city increased rapidly. The city of Tehran, in addition to both political and commercial duties, accepted administrative duties. The population growth of the city has been increasing steadily since 1923, reaching 1626 thousand people in 1959. Its area was 606 hectares in 1951, which reached 100 hectares in 1956. However, from 1956 onward, the rapid growth of population and area began to increase. The city had an annual growth rate of 5.2% between 1966 and 1976. The city's territory also had been increased from 190 to 260 hectares during this decade. This indiscriminate expansion, like the rest of Iran's cities, was carried out without a preconceived urban plan and proper monitoring and control. In general, the space size of Tehran over the past two hundred and twenty-five years (1785–2010) has increased from about 440 hectares to 75,000 hectares, which is 150 times larger. Figure 1 shows the urban growth process of Tehran during a period



**Fig. 1** The process of physical development of Tehran (reprinted from Ministry of Housing & Urban Development & Tehran Municipality, 2006)

of 115 years. From the 1780s to the 2010s, its population had grown 400 times larger—from 15,000 to 8,693,706—which is physically effective in sustainable urban development. The process of physical development of Tehran can be divided into three periods based on the evolution of its urban structure: (a) the period of emergence and development (1889–1931), (b) renovation and modernization period (1931–1953), and (c) metropolitan period (1953 to present). In the first period of urbanization, the pace of development of Tehran was very gradual and slow. With the demolition of old fences and towers and the construction of new fences and gates, the area of the city increased from three to nineteen kilometers. The popularity of the means of transportation has led to the expansion and widening of the streets. These factors in the second period led to the establishment of urban institutions such as *Baladiéh* and *Shahrbaní* and the modification of the urban transit network, the complete demolition of towers and fences, and the conversion of urban space from closed form to open.

The pace of urbanization was increasing. A new source of revenue (oil) and a different source of government revenue during the Qajar era (agriculture) empowered the first Pahlavi government. In the third period, as in the previous period, the growth and development of Tehran continued to be unplanned and chaotic, in the second and third periods, due to the prevailing conditions, the effects of Tehran's development became more intense. However, what followed years of disruption was the expansion of land and housing speculation in Tehran due to increased migration (Hosseini et al., 2015).

Tehran is currently the largest city in the Middle East and ranks 16th among the world's most populous cities. It has a population of 8,693,706 people according to the latest Iranian population and housing census (Statistical Center of Iran, 2016). Currently, Tehran consists of 22 districts (Fig. 2).



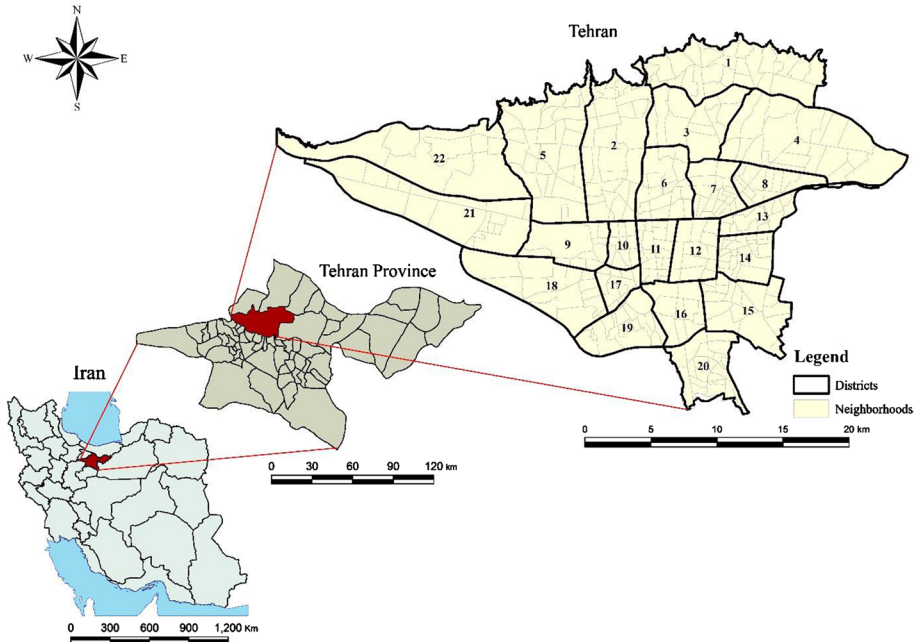


Fig. 2 Tehran position in province level and Iran

## 4 Methodology

### 4.1 Method

#### 4.1.1 Fuzzy logic

Fuzzy logic first appeared in the new arena of computation following Zadeh (1988) adjustment of fuzzy set theory. The word fuzzy means inaccurate, imprecise, and vague. The term fuzzy logic did not leave the university context until more than twenty years after 1965 because only a few people understood it. In the mid-1980s, Japanese artisans understood the industrial value of this science and applied fuzzy logic. Europeans began to use this science quite late, in the mid-1990s, after a wave of scientific debate over fuzzy logic. The application of this topic to software science can be simply defined in the following way; fuzzy logic goes beyond the logic of the values of classical software "zero and one" and opens a new door to the world of software science and computing because the space is infinite between zero and one (Van Pelt, 2008).

Crisp sets are ordinary sets introduced at the beginning of the classical set theory. Adding a definite adjective really makes a distinction, which helps to make it one of the most innovative and crucial concepts in fuzzy logic. This concept is called the "membership function" easy to bear in mind. In crisp sets, the membership function has only two values in its range (in mathematics, a function is Eq. 1 to the set of all outputs of the function), which are the same two possible values in classical logic, so

$$\mu A(x) \{ 1 \text{ if } X \in A, 0 \text{ if } X \notin A, \quad (1)$$

Here  $\mu A(x)$  is the membership function of the element  $x$  in the crisp set  $A$ .

The membership function range of  $\{0, 1\}$  for crisp sets is converted to closed intervals  $[0, 1]$  for fuzzy sets.

Linguistic variables are known as variables that are accepted values rather than numbers, words, and sentences of human or machine languages. As in mathematical calculations of numerical variables, linguistic variables (speech or non-numeric) are used in fuzzy logic. Linguistic variables are expressed based on linguistic values, which are in the expression set (words/expressions). Linguistic terms are features for linguistic variables.

The degree of membership of  $\mu A(x)$  represents the degree of membership of the element  $x$  into the fuzzy set. If the degree of membership of an element is equal to zero, the member is entirely out of the set and if the membership degree is equal to one, the member is fully in the set. If the degree of membership is between zero and one, the number represents the degree of membership as increasing intervals. The attribute of uncertainty arises in different forms, in all fields and phenomena regardless of the methodology used for study, design, and control. Fuzzy logic is a new technology that replaces techniques that require sophisticated and advanced mathematics to design and model a system, using linguistic values and expert knowledge.

#### 4.1.2 Average nearest neighbor index

The average nearest neighbor index is based on measuring the distance of each use or service to their nearest neighbor in a geographical area. The index is used to determine the point convergence and divergence between different types of uses. Through this analysis, it is possible to understand the distribution pattern.

This index first measures the distance between the center point of each object and the center point of its nearest neighbor, then calculates the average of the nearest neighbors. If the calculated average distance is less than the average hypothetical random distribution, it can be concluded that the distribution of the studied phenomenon is clustered. If the calculated mean distance is greater than the mean of the hypothetical random distribution, it can be concluded that the effects are distributed uniformly.

Z-score test statistics can be used to ensure the accuracy of the nearest neighbor index test. This test determines, in a statistical concept, how the average distance from the nearest real neighbor changes. The general rule is that the larger the negative Z-score, the more accurate of the nearest neighbor index test result.

The average nearest neighbor in terms of the neighborhood is statistically calculated as Eq. 2:

$$\text{ANN} = \frac{D_o}{E_o} \quad (2)$$

where  $D_o$  is the average distance observed between the phenomenon and its nearest neighbors, which is Eq. 3 will be evaluated:

$$\bar{D}_o = \frac{\sum_{i=1}^n d_i}{n} \quad (3)$$

$E_O$  in this formula is the average distance between the phenomenon and its nearest neighbors assuming the distribution of phenomena is random, and it is expressed in the form of Eq. 4:

$$E_O = \frac{0.5}{\sqrt{\frac{n}{A}}} \tag{4}$$

In the above equation,  $d_i$  is the distance between the studied phenomenon, and its nearest neighbor,  $n$  is the total number of features, and  $A$  is the total area of the studied area.  $Z_{ANN}$  score can be also calculated as Eq. 5:

$$Z_{ANN} = \frac{D_o - E_O}{SE} \tag{5}$$

And SE is equal to Eq. 6:

$$SE = \frac{0.26136}{\sqrt{\frac{n^2}{A}}} \tag{6}$$

The  $p$  value for a given distribution will be the approximate area under the curve, which is limited by a statistical test.

### 4.1.3 Spatial autocorrelation

To describe the spatial properties of a variable, we employed spatial autocorrelation analysis of Global Moran  $I$  statistics for an entire region. It can be used to identify the average spatial difference between all spatial features (pixels) and adjacent features (pixels). Global Moran  $I$  statistics can be derived from Eq. 7.

$$I = \frac{n \sum_{i=1}^n \sum_{j=1}^n w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{S^2 \left( \sum \sum_{i \neq j} w_{ij} \right)} \tag{7}$$

where  $n$  refers to the number of regions,  $x_i$  refers to the coefficient of variable distance or relative in the units of regions  $i$ , and  $\bar{x}$  is the average, and  $w_{ij}$  is the weight between regions  $i$  and  $j$ . Showing that  $S^2 = \frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})^2$  is the variance of the distributions. In calculating the weight value, the weight coefficient is placed between two areas that are directly related or have a common border. In areas that do not have a common border with each other, the weight coefficient is zero. The interpretation of the Moran coefficient is such that it lies between the values of  $-1$  and  $+1$ .

With a null hypothesis of no spatial autocorrelation, the expected value of  $I$  is given by Eq. 8

$$E_I = -\frac{1}{(n - 1)} \tag{8}$$

In this formula,  $n$  is the number of regional units and  $E_I$  is the expected coefficient. When the calculated Moran  $I$  statistic is greater than the expected coefficient value, the positive spatial cluster pattern is confirmed and vice versa. A value close to zero indicates a random and insignificant pattern at the desired confidence level.

**Table 1** Indicators used to analyze spatial inequality

Indicators	Examples in use
Fire stations	Adewoyin (2017), Chang et al. (2019), Enright (2019), Greer (2002) and
Red Crescent	Hewko (2001), Iveson (2011), Morais and Camanho (2011), Pacione
Ambulance service	(2003), Perucca et al. (2019), Philippopoulos-Mihalopoulos (2014a, b),
Hospital	So (2016), Soja (2009), Tsou et al. (2005), Wang and Lan (2019), Yin
Police stations	et al. (2018), Yin et al. (2019), Zhao et al. (2020)
Gas station	
Food and wholesale centers	
Medical services	
Sport clubs	
Housing price	
Subway lines	
Local governments	
Bus terminal	
Hotel	

## 4.2 Research design and data

Based on effective factors of spatial inequality when accessing urban facilities in Tehran, also found through studying literature and theoretical frameworks of research, the layers of GIS have been identified (Table 1). To carry out this research, the GIS layers of the Tehran facility were taken from the Statistical Center of Iran based on the latest statistics census, coming from 2016.

*Step 1* In the ArcMap environment, Euclidean distance operations were performed for each utility shapefile. This function of GIS expresses the relationship of each cell with a feature (consisting of one or more cells) in terms of distance, direction, and position, defining the distances around the objects as equal intervals. This means that the actual distance of each cell to the desired condition can be calculated.

*Step 2* At the second stage of this study, the reclassification operation in ArcMap environment was calculated and executed on all shapefile of the urban facilities. Running the reclassification tool in ArcGIS on a raster map causes the values and amounts of the pixels to change according to the target.

*Step 3* Implement fuzzy logic operations on each of the facilities shapefile in Arc Map environment; in the fuzzy logic method, all the effective criteria contributing to the inequality of access to the urban facilities are converted to a raster map and are now able to have different units as well as be scaled by the fuzzy membership method. As a result, all values between 0 and 1 fluctuate. Fuzzy logic goes beyond the classical logic of "zero and one" values, opening a new door to the world of software and computers, now able to address the infinite floating space between zero and one. In this step, along with fuzzy logic operations, we used ANNI and spatial autocorrelation such as Global Moran  $I$  for each indicator to determine their spatial distribution between random, clustered and dispersed.

*Step 4* Fuzzy overlap: After we have scaled all the criteria and converted the values to numbers between 0 and 1, we can begin to use the fuzzy membership method with integration and overlap of all indicators used in the Arc Map environment was done through fuzzy

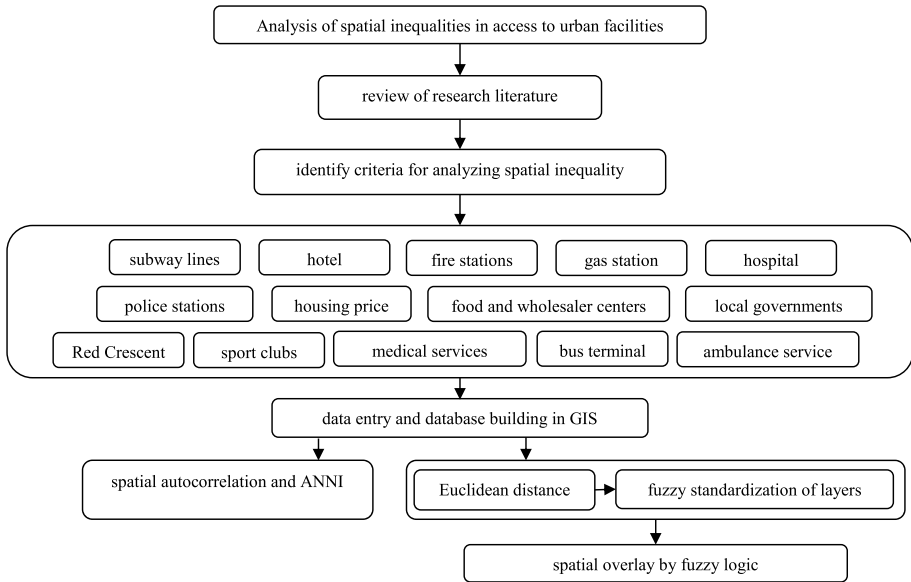


Fig. 3 Flow diagram of the stages of spatial analysis

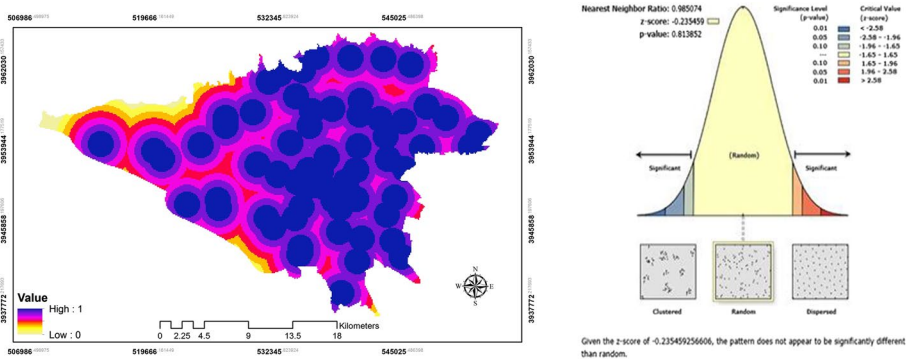
overlay operation to determine spatial inequality in Tehran. In this paper, the AND method is used for fuzzy overlap. The research process is shown in Fig. 3.

## 5 Results

### 5.1 Distribution and accessibility of the urban facility

The existence of cities is generally coupled with service and service delivery to residents, within the jurisdiction and privacy of cities and fire stations as locations for the establishment and expectation of fire and rescue vehicles, which are among the vital and critical centers of service in cities that increase the efficiency of investments. The distribution of fire stations is usually based on the requirement to provide such facilities by various organizations, including the municipalities and in terms of demand for the site inhabitants as well as the projected provision for the utility of installations and urban facilities within the approved urban development schemes and an appropriate situation, relevant facilities are deployed.

The distribution pattern of the location of fire stations in cities is one of the major issues related to urban facilities that are strongly influenced by population density and land use, the average rate of fire, dimensions and severity of fires, and average damage incurred in different locations. Therefore, urban planners try to provide a proper distribution pattern to distribute fire stations, by applying complete idea containment specifications. Studies show that seven factors are involved in the classification of factors affecting the location of fire stations including geotechnical considerations, accessibility, useful performance radius, population, development of the city, adjacency and land use, and parcel size.



**Fig. 4** Fuzzy mapping and spatial statistics of ANNI for the fire stations

In the spatial distribution map of firefighters, more equity is visible in terms of spatial distribution across Tehran, and except the northwest and southwest, the rest of the districts occupy the highest levels of occupied blue clusters, which has a high value of access to the fire service. Central, west, and north and southwest districts have a higher population density than east Tehran. In the central districts of Tehran, the density of administrative and governmental land use is more than other districts and is very high due to the sensitivity of administrative districts. These districts have nonstandardized passing through their old texture. All these factors are required for the multiplicity of fire stations. It also has more green space and parks in district 22 per capita than other districts, limited to commercial, industrial, and residential use, so the number of fire stations is less. District 21 also has the most industrial and warehousing uses, and population density in these districts is lower than in other districts. In the northern part of zones 3 and 4, population density, housing density, and other uses are low due to the high per capita green space—parks and recreation—sports. In the north of these two districts we see fewer fire stations than in other parts of Tehran. Also, the results of the ANNI model show that the distribution pattern of the fire index in Tehran is random. According to the numerical output, the ANNI is 0.98, since its value is positive, the  $z$ -score is  $-0.23$ , and the  $p$  value of 0.81 is not significant (Fig. 4).

The Red Crescent Society of Iran is a nongovernmental organization (NGO) and a member of the International Red Cross and Red Crescent Movement. In this regard, 4, 6, 7, 11, 12, 21, and 22 have the most points for Holly Red in Tehran. The results of the ANNI model also show that the distribution pattern of the Red Crescent index in Tehran is random. According to the numerical output, the nearest neighbor index is 0.97 and since its value is positive, the  $z$ -score is  $-0.18$ , and the  $p$  value is 0.84 (Fig. 5).

The spatial clusters of urban ambulance services reflect the unfairness of the spatial distribution of this criterion of urban facilities, given the criterion that this criterion is unacceptable for most of Tehran's cities to have low access to this criterion of urban services. Also, the results of the ANNI model show that the distribution pattern of the ambulance service index in Tehran city is dispersed and scattered. The ANNI is 1.13, and since its value is positive, its  $z$ -score is 1.70, its number is above 1.65 and the  $p$  value is 0.08 (Fig. 6).

The reason for the lack of access to ambulances in western parts of Tehran is due to the use of these districts, which are mostly green and military and industrial, and population density in these districts is less than in other parts of Tehran. The city of Tehran has a

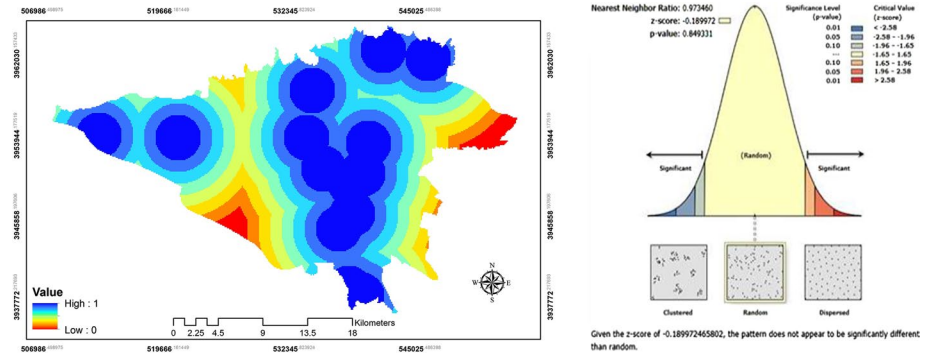


Fig. 5 Fuzzy mapping and spatial statistics of ANNI for Red Crescent

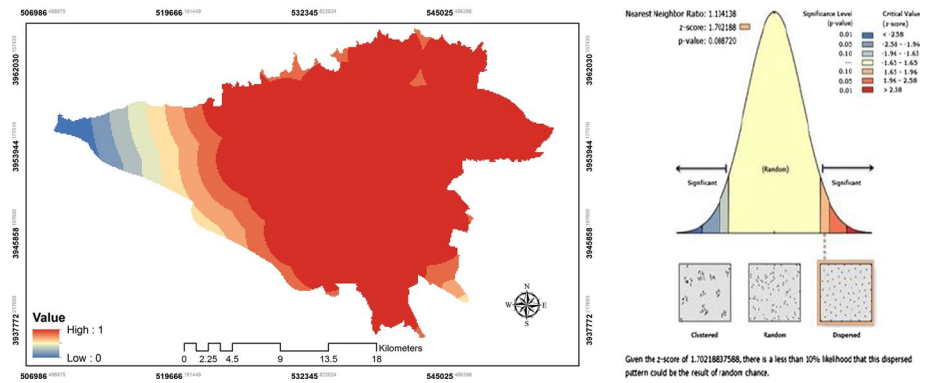
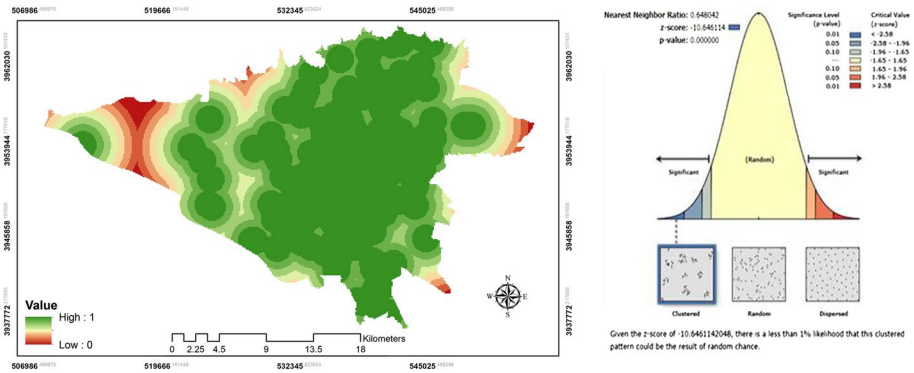


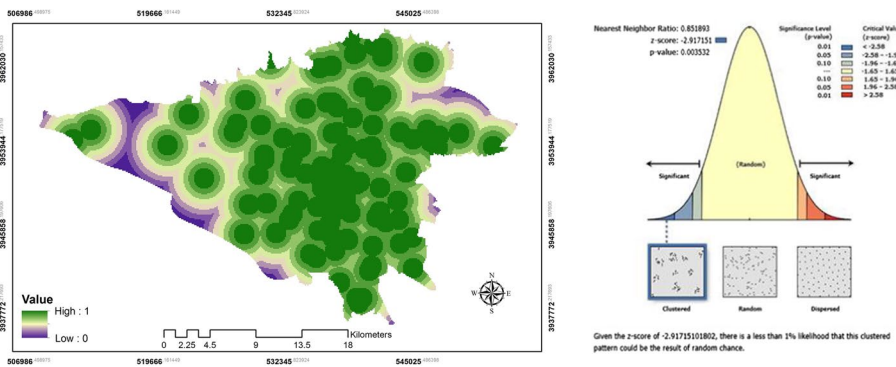
Fig. 6 Fuzzy mapping and spatial statistics of ANNI for ambulance services

population of around 14 million people, and based on international standards, it requires an ambulance system per 20,000 populations. So Tehran must have around 500 ambulances, while the number of ambulances in Tehran is only 230. A number of available ambulances are worn out and need replacement or reparation.

The accessibility to hospitals, which is highlighted in purple, indicates that access to these services is in a good position in Tehran so that in the index of hospital access except districts 21 and 22, the rest of the districts are in better condition of access. The distribution of hospitals has been good, but the number of public hospitals is not enough and we are facing a shortage of hospital beds. In Tehran, the hospital bed occupancy rate is one bed per thousand people, and at least it must be above one and a half percent. The Ministry of Health should receive government funding and the capacity of the private sector to address hospital problems in Tehran. Municipalities can also enter the health sector and provide the land needed to build a clinic and hospital to the Social Security Organization (SSO). Also, the results of the ANNI model show that the distribution pattern of the hospital access index in Tehran is clustered. According to the numerical output, the ANNI is 0.64, and since its value is positive and the  $z$ -score is  $-10/64$ , we can conclude that the index has spatial statistics, and its distribution throughout Tehran is clustered (Fig. 7).



**Fig. 7** Fuzzy mapping and spatial statistics of ANNI for accessibility to hospital



**Fig. 8** Fuzzy mapping and spatial statistics of ANNI for accessibility to police services

Access to police services is indicated by the green cluster. Except for parts of districts 21, 22, 18, and 19, other districts are well distributed in the index of access to police services. The number of police stations in Tehran has not grown in proportion to the dramatic increase in population in the metropolis, and this deficiency is most evident in the marginal districts that have experienced high crime rates due to poverty, migration, and cultural differences. Certainly, the current police stations should be upgraded and there need to be more police stations throughout Tehran as the city expands and the population increases. Also, the results of the ANNI model show that the distribution pattern of the police base index in Tehran is clustered. According to the numerical output, the ANNI is 0.85 and its value is positive, while the  $z$ -score is  $-2.91$ . The index has a spatial statistic and it is clustered in Tehran can be concluded (Fig. 8).

As can be seen in the maps of gas station access, this indicator shows the distribution of this criterion of utilities. As the blue clusters of the map also show, except for parts of districts 21, 22, 5, 18, 19, and 4, the other districts have almost the same access to the gas station due to their low use and low population density. Generally, Tehran is facing a severe shortage of gas stations. According to international standards, the average level of access to a gas station should be one kilometer, but statistics show that it takes 6–7 km to reach a gas station in Tehran. The lack of petrol stations exacerbates the major problem of heavy traffic



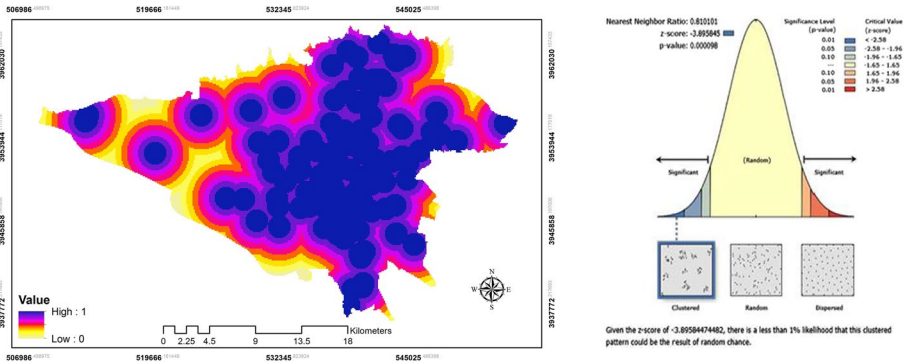


Fig. 9 Fuzzy mapping and spatial statistics of ANNI for accessibility to gas stations

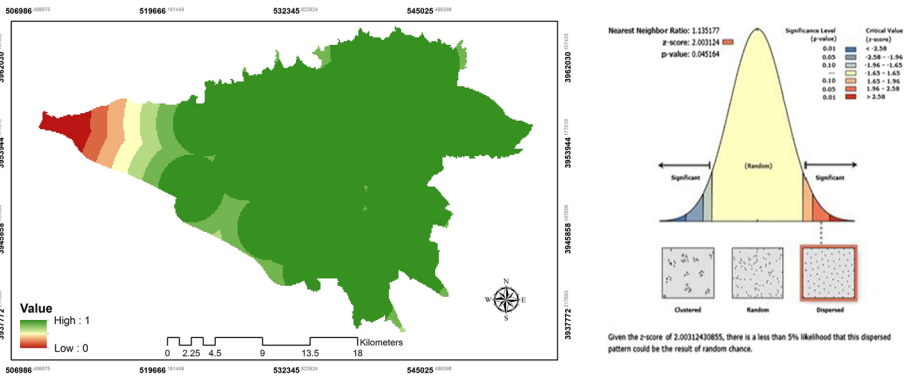


Fig. 10 Fuzzy mapping and spatial statistics of ANNI for accessibility to food and wholesale centers

in Tehran. The results of the ANNI model show that the distribution pattern of the petrol station index in Tehran is clustered. According to the numerical output, the ANNI is 0.81, and since its value is positive and the  $z$ -score is  $-3.89$ , we can conclude that the index has spatial statistics (Fig. 9).

The distribution of food and wholesale centers in Tehran is in good condition, and as the green clusters show, all districts have a high value of good access to this criterion. Except for districts 21 and 22, other districts are in very good condition of access to food and wholesale. Food and wholesale centers are often created by private investors because they are mostly privately owned and profitable for their owners. Thus, anywhere in the city that feels lack of access to food and wholesale centers. There are a favorable availability and dispersion in the criteria for access to food and wholesale centers in Tehran. The results of the ANNI model show that the distribution pattern of food and wholesalers in Tehran is dispersed and dispersed. According to the numerical output, the ANNI is 1.13, and since its value is positive, the  $z$ -score is 2.03, which the numerical value is higher than 1.65.  $p$  value with 0.04 is significant (Fig. 10).

Access to the medical services criterion in the districts was another criterion of spatial inequality that we examined in this study, as the blue clusters show. Except for districts 21, 22, 5, 9, and 18 due to lower population density, the rest of the districts have good access

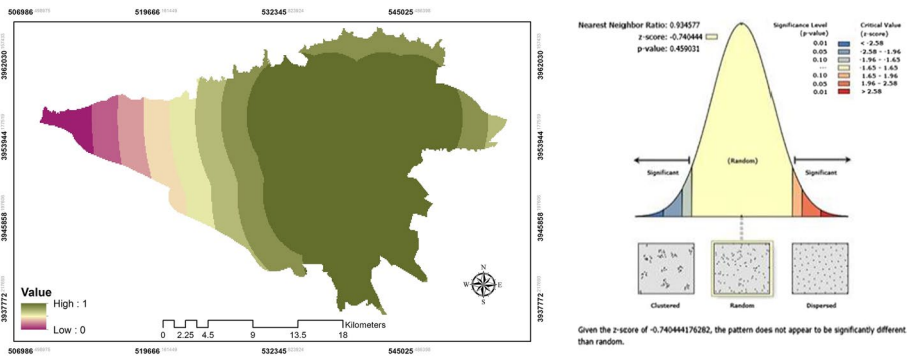


Fig. 11 Fuzzy mapping and spatial statistics of ANNI for accessibility to medical services

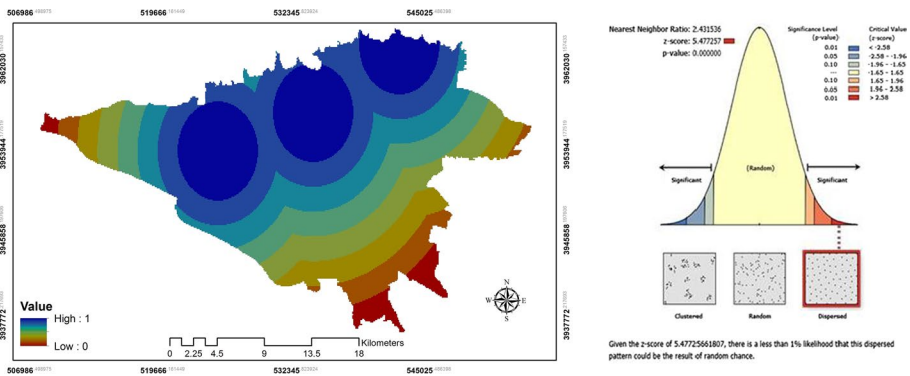
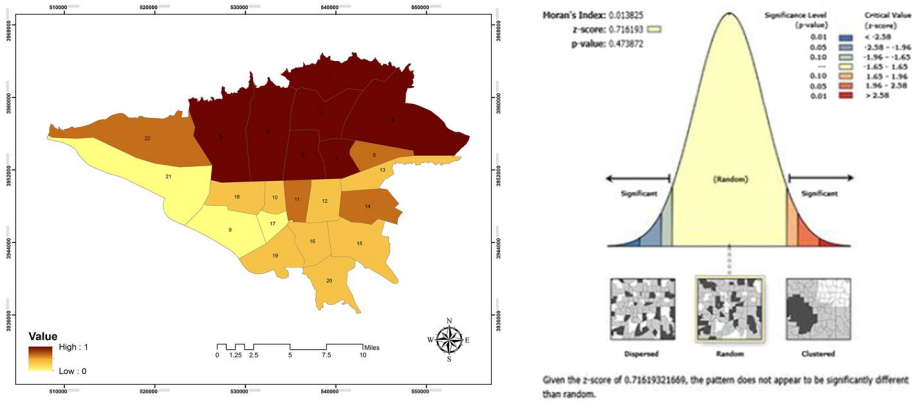


Fig. 12 Fuzzy mapping and spatial statistics of ANNI for accessibility to sport clubs

to this criterion. Although the need for more health services is evident, the access and distribution of health services in Tehran are appropriate. The results of the ANNI model show that the distribution pattern of the medical services index in Tehran is random. According to the numerical output, the ANNI is 0.93, and since its value is positive, the  $z$ -score is  $-0.74$ , and the  $p$  value is 0.45 (Fig. 11).

In regard to the access to sports for each district, stadiums in districts 21, 22, 5, 2, 3, and 1 have the most favorable access to this criterion of utilities. The south of the city does not have proper access to the stadium. Furthermore, the results of the ANNI model show that the distribution pattern of the sports stadium index in Tehran city is dispersed and scattered. According to the numerical output, the ANNI is 2.43, and since its value is positive and the  $z$ -score is 5.47 and the numerical value is higher than 1.65 with a  $p$  value of 0.00, it is concluded that the index is dispersed across the city of Tehran (Fig. 12).

Housing prices are very different from each other in districts of Tehran, as shown in Fig. 13 districts 1–7 have the highest value per square meter, and housing prices in districts 1, 3, and 2 are more expensive than the rest of the city. The reason for such a difference is that the north of Tehran has more architecture, a larger floor area, good amenities and recreation, and adequate facilities in the houses, in addition to a better climate and location compared to other districts in Tehran. In the past, these districts have consisted of

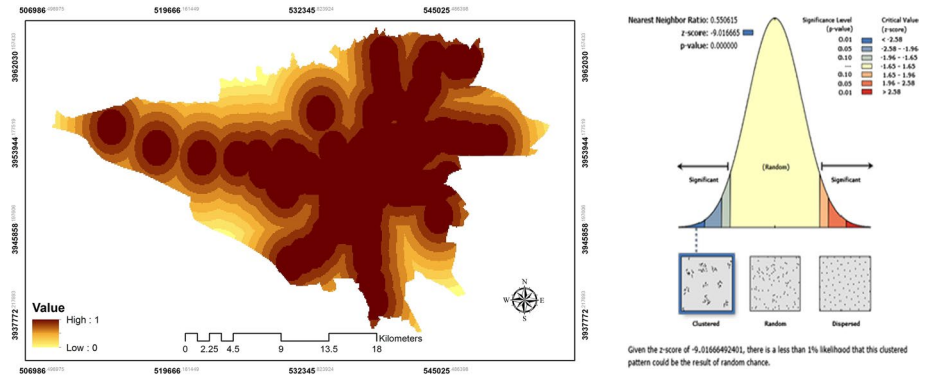


**Fig. 13** Fuzzy mapping and spatial statistics of Moran's for housing price

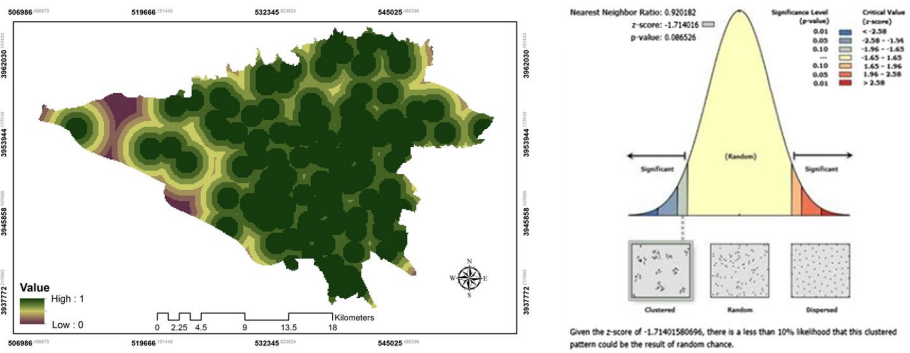
aristocratic neighborhoods and have been inhabited by affluent people, while the south of the city often includes cheaper neighborhoods than the north of the city. According to the Statistical Center of Iran (2016), the average selling price per square meter of residential infrastructure traded through real estate agencies in Tehran was 42,380,000 IRR (1402.29 US\$)<sup>1</sup> with an average area of 86 square meters and an average building age of 9 years. Also, the highest average sale price of one square meter of residential infrastructure traded among the 22 districts of Tehran is in district 1, with a price of around 89,649,000 IRR (2966.35 US\$), an average area of 145 square meters, and an average building age of 7 years. The lowest sale price is around 21,118,000 IRR (698.76 US\$) with an average area of 70 square meters and an average building age of 7 years and is located in district 18. Generally, the characteristics that distinguish the neighborhoods of Tehran and affect the housing price include the population density of the area, environmental factors, easy access to city infrastructure, the rate of crime and security in the neighborhoods, the culture of the inhabitants of the neighborhood; housing architecture, floor area, facilities in the houses; the landscape of the area, including greenery, cleanliness, and charm; literacy and education in the neighborhoods; and finally, the geographical location of the neighborhoods, such as slope and climate. The results of the Global Moran's *I* model also show that the distribution pattern of housing prices in Tehran is random. Base on the numerical output, Moran's *I* index is 0.01, and since its value is positive and the *z*-score is 0.71 and the numerical range is  $-1.65$  to  $1.65$  with a *p* value of 0.47, it is concluded that the distribution of this index in Tehran is random (Fig. 13).

Urban metro lines are another indicator under consideration, as they connect many parts of the metropolis and are one of the public utilities used by many citizens of the capital. The Tehran metro is Iran's largest inter-city transportation network, with more than 3 million people using it daily. As shown in the map below (Fig. 14), access to the subway in Tehran is in good condition. Surveys show that the subway lines are homogeneously distributed and that access to the subway in Tehran is in good condition only if the number of wagons increases. Although Tehran Metro lines are designed on a two-minute time difference, the delay is usually five minutes due to the shortage of nearly two thousand wagons

<sup>1</sup> US dollar equals 30,220 IRR of government (official) currency in 2016 (CBI, 2016).



**Fig. 14** Fuzzy mapping and spatial statistics of ANNI for accessibility to subway lines



**Fig. 15** Fuzzy mapping and spatial statistics of ANNI for local governments

and limited parking facilities. The results of the ANNI model show that the distribution pattern of the metro index in Tehran is clustered. According to the numerical output, the ANNI is 0.55, and since its value is positive and the  $z$ -score is  $-9.19$ , we can conclude that the index has a spatial statistic and this index in Tehran is clustered (Fig. 14).

Local governments, as policymakers and implementers of urban and rural programs and projects, have an important role to play in reducing economic and social inequalities and promoting development. As is evident in the clustering map of the local government organization, all districts are in a good position to meet this criterion. In some parts of districts 21, 22, 9, and 18, the number of these organizations is lower due to their duties and the lack of congestion. Although the distribution of the local government organization is uniform and proportionate, its effectiveness requires further effort. While informal local councils (council assistances) have been established in Tehran in recent years to communicate with the city council, these councils lack the power and resources needed to operate effectively and have no defined relationship with the city council and municipalities. On the one hand, there is a need to delegate local authority, and on the other hand, there is a need to create a district-level council to integrate neighborhood resources and their planning. The results of the ANNI model show that the distribution pattern of the local government's index in Tehran is clustered. According to the numerical output, the ANNI is 0.92, and since its value is

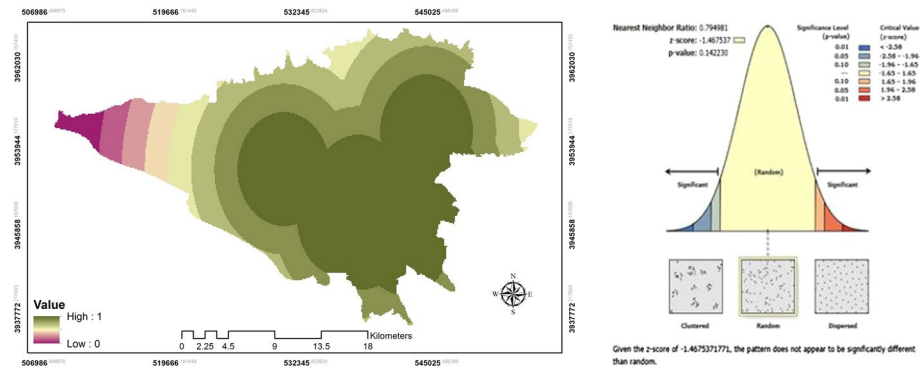


Fig. 16 Fuzzy mapping and spatial statistics of ANNI for accessibility to bus terminals

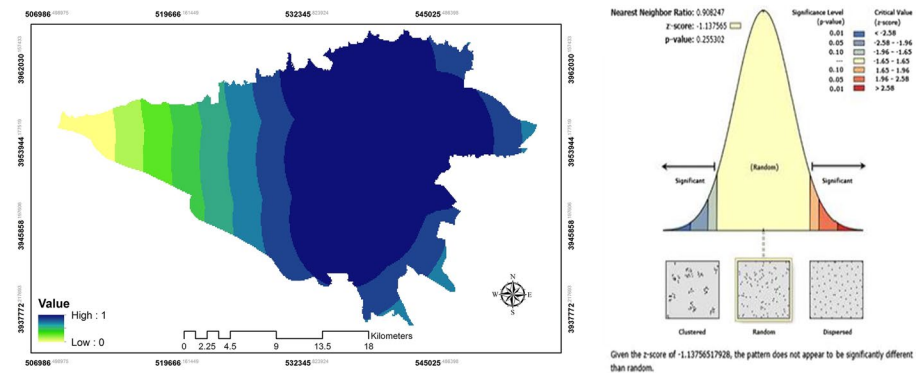


Fig. 17 Fuzzy mapping and spatial statistics of ANNI for accessibility to hotels

positive and the  $z$ -score is  $-1.71$ , we can conclude that the index has spatial statistics and this index is clustered in the city of Tehran (Fig. 15).

In terms of access to bus terminals, except for districts 21, 22, and 1, the rest of the districts are in good condition. West Terminal, South Terminal, East Terminal, and Beyhaqi Terminal are four terminals in Tehran. These four terminals have provided good coverage of Tehran’s districts, especially with access to fast transport lines such as city trains and express buses (BTRs). The results of the ANNI model show that the distribution pattern of the bus terminal index in Tehran is random. According to the numerical output, the ANNI is 0.79, and since its value is positive, the  $z$ -score is  $-1.46$ , and the numerical range is  $-1.65$  to  $1.65$ , the  $p$  value is 0.14, and thus not significant (Fig. 16).

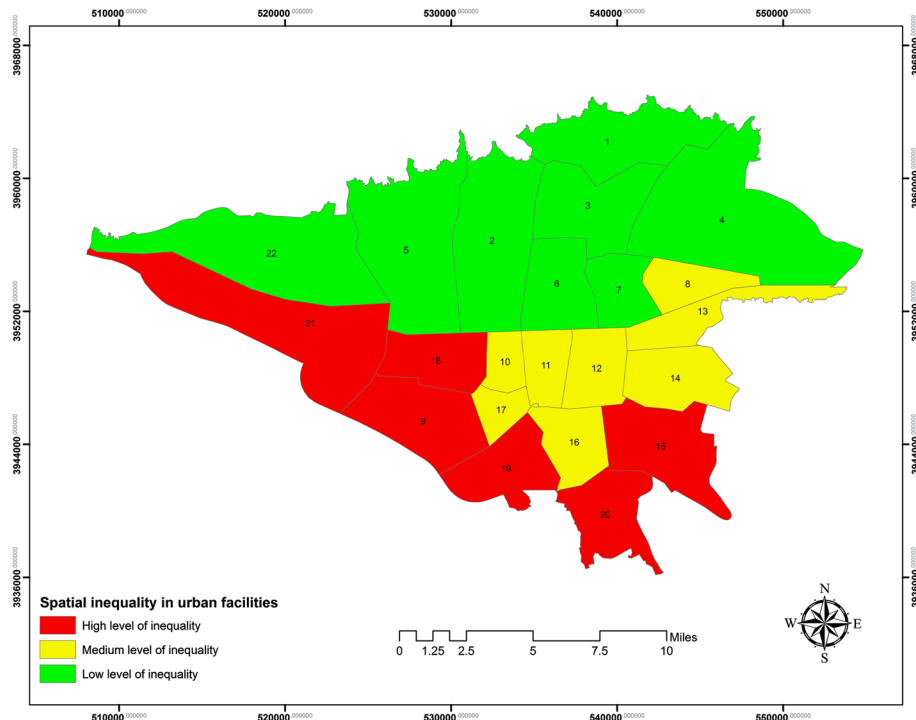
In examining the criterion of inequality in hotel accessibility in Tehran, as the map above shows, it is clear that the central districts of Tehran have high-value clusters and the exterior and marginal districts of Tehran relative to the districts Centers are of low value. In general, the distribution and accessibility of hotels in Tehran are convenient, but what is remarkable that the numbers of high-star hotels are very low. While Tehran as a metropolis and capital of Iran can be a major hub for attracting tourists, the lack of tourism infrastructure such as a hotel in the city is one of the reasons that usually does not make it a viable city (Fig. 17).

## 5.2 Integrating layers

To perform fuzzy integration and interurban spatial inequality analysis operations, fuzzy amenities were used, considering the wide capabilities of Arc GIS software in the fuzzy mapping problem. At this stage, using the fuzzy overlay menu, the constraint map and criterion maps are integrated by applying the corresponding weights as standard weights. The result of this integration is the final map. Finally, tracking of urban spatial inequalities from the amenities was identified in Fig. 18.

Spatial spectroscopy in Tehran and utilization of 14 criteria to gain access to urban facilities and tracking of urban inequality in Tehran metropolis showed that urban districts in terms of utilizing these criteria and facilities fall into three categories: The low-level districts, the middle-level districts, and high-level for different urban facilities are categorized as listed below in all levels.

Only 6 of the 22 districts of Tehran are in the high-end districts. In contrast, many of the population of about 6 million live in districts with moderate to low levels. It indicates that the distribution of urban facilities and welfare services at the capital level was as unequal and disproportionate. The imbalance and the significant difference between the physical development of the capital and the district welfare development are evident in the city. The unfair distribution of services and utilities in Tehran's 22 districts has led to a significant difference in the number of inhabitants of different neighborhoods of Tehran from urban settlements and has contributed to the "unequal opportunity" of citizens in the use of facilities.



**Fig. 18** Classification of the district in Tehran based on accessibility to services

## 6 Discussion

Unbalanced distribution of service per capita and welfare in 22 districts of Tehran have caused a significant difference in the number of urban residents per capita in different neighborhoods of the capital and have created an “unequal opportunity” for citizens to use the facilities. The existence of underdeveloped and underdeveloped districts reflects spatial inequality and injustice, as well as the fact that the urban population is growing faster than the government can build the needed infrastructure.

The results of the study show the spatial and district inequality in Tehran. The least developed and underdeveloped districts of the city are mostly concentrated in the south and southeast of the city, while the moderate and relatively developed districts are located in the center and west of Tehran, whereas the most developed districts are located in the north of the city. This imbalance at the urban scale resulted in some socio-spatial inequality and polarization, so that the northern half of the city, which was the residence of the upper and middle classes, enjoyed a wide range of social and physical advantages over the southern half. This post-deployment space gap was exacerbated by a series of activities and the market was produced. The land and property pricing mechanism institutionalized the differences between urban areas. This pattern of north–south segregation reflects social stratification, with relationships increasingly defined as access to more financial resources and income. As Madanipour (1998, 1999) points out, socio-spatial heterogeneity between north and south of Tehran is the dominant feature of the spatial structure of Tehran metropolis. This pattern reflects the stratification of the income of a society in which social relations are increasingly defined by money.

Spatial inequality, especially in terms of spatial access to urban amenities, is highly correlated with the economic factors stimulating inequality. In emerging market economy countries such as Iran, New policies of urban neoliberalism are one of the important factors in locating and providing urban services by the private and public sectors (Rabiei-Dastjerdi et al., 2018). Therefore, neoliberalism policies have led to splintering urbanism in Tehran, and not only private sector facilities, but also most of the public sector facilities, ministry buildings, and government offices are located in the northern parts of the city. In an economic-political analysis, Yousefi and Farahani (2019) state the private sector based on market-oriented urban planning tends to invest in more affluent areas because it is an economically rational choice. Some facilities, such as the healthcare sector, depend on the foreign budget, i.e., patients; therefore, they also prefer to invest in areas that people can afford. Above all, the coexistence of the private and public sectors increases inequality, as highly skilled jobs prefer to work for the private sector, which offers better salaries and benefits.

Additionally, distinctive social strata have made it impossible for people in every city to live in one place, and people who are more socially and economically similar to each other are more likely to live close together than people who are not alike. On the other hand, the creep of the affluent and wealthy neighborhoods of central Tehran toward the north of the city imposed a kind of socio-spatial hierarchy on the north and south of the city, and Tehran’s social topography was in line with its natural topography.

Urban capitalist development is accelerated, complex, and changing. The weaker and more dependent capitalism leads to greater urban sprawl. Spatial segregation is proposed to explain urban spatial structures. Due to spatial inequality when class segregation appears in the city, there is a tendency to accumulate more capital at the desired location. The spatial separation of Tehran consists of several different factors: (1) various socioeconomic groups

of society, with different economic facilities for settlement and locating in urban spaces; (2) ecologically distinct urban space that creates variable values for residential functions; and (3) urban management policy makes it possible to distinguish these factors together with the economic situation that covers the separation of the society.

Urban plans have been effective in the intensification of spatial inequality in Tehran. In the fifth development plan (1972–1977), credits, programs, and special organizations for the development of Tehran were considered, as mentioned as the “great Tehran” plan. The plan coincided with government support and an abrupt rise in oil prices. Additional revenue from oil sales was injected into the country’s economy-dependent body and special attention was paid to the construction and development of Tehran. While facilities and amenities in the north of the city are far from the south of the city, there is a lot of difference and discrimination in this area. Ali et al. (2019a, b) in similar cases suggest that governments in the short term abandon their political incentives and act without prejudice to develop policies for infrastructure projects in the future. Also consider a standardized comprehensive planning process in the long run, so that all development projects without default are consulted by independent consultants and all relevant stakeholders are involved in the planning.

## 7 Conclusion

The geographical perspective of social justice of the city is synonymous with the equitable spatial distribution of facilities and resources between different urban areas and their inaccessibility because their unequal distribution sounds repetitive will lead to social crises and complex space problems. Therefore, conscious action of urban management in the spatial distribution of social interest in order to reduce spatial inequality and improve the quality of life and by improving the quality of life and achieving urban sustainability requires an analytical understanding of the status quo.

The importance of writing this paper was to explore and to investigate the spatial distribution of service facilities to reduce spatial inequality while improving the quality of the physical environment and the quality of life for the residents of the city of Tehran in order to attain a more sustainable city. By utilizing our analytical understanding of the status quo, we expect it leads urban managers to address the diverging inequalities in the city by allocating resources with the most desirable and egalitarian outcomes.

This study identified the level of inequality in access to urban facilities. To do this, by investigating 14 urban facilities using the spatial analysis model included autocorrelations and fuzzy overlay, it was determined that the city of Tehran is classified into three clusters. The first cluster is the northern part of the city included 1, 2, 3, 4, 5, 6, 7, and 22 districts, which has a high level of access to urban facilities, the second cluster identified the city central areas included 8, 10, 11, 12, 13, 14, 16, and 17 districts that has a medium level, and the third cluster also covers the southern part of the city included 9, 15, 18, 19, 20, and 21 districts, where there is a high level of inequality of urban facilities.

In Tehran, especially in recent years, the relative inequality has reduced in many cases—including some facilities and services of the city. However, not all the cases follow the same pattern. The policies of the municipality and the government for the development of urban space in line with the quality of life in the more prosperous neighborhoods are more successful and the rate of citizen participation in this area has been more, but the



development of these spaces in slums in central and southern areas has been faced with obstacles. However, the pattern of land use deployment in Tehran also shows that industrial workshop, transport, warehousing, and commercial land uses that cause environmental quality decline are mainly located in the south, southwest, southeast, and central areas of this city. In addition, the distinctive features of the inhabitants, neighborhoods, and areas are also divided by physical and natural facilities including drainage, sewage, electricity, streets, buildings, and everything else in the cities.

Beyond the above-mentioned results, this study offers several macroperspectives from our point of view. First, government facilities and services tend to invest in affluent areas. This is reasonable for the private sector but the public sector and urban management must ensure an equal distribution of facilities for all citizens. Urban management in Tehran has semigovernmental nature and is affected by the private sector. Therefore, the policy influences of neoliberalism can be concluded in this section. In other words, urban management institutions, under the pressure of advocacy groups, have become a channel for land use change that harms the level of sustainability in urban areas. Besides, lack of proper enforcement and oversight leverage for urban management has doubled the negative effect and as a lever for benefiting from a certain social class, it usually ignores the welfare of the majority and public rights. On the other hand, this has led to social segregation.

Second, Tehran faces various challenges and obstacles. Most of these challenges are due to a poor preparation process, the approval of the detailed plan, and the lack of integrated urban management. The process of approval and announcing the detailed plan is too long that after presenting a plan to the municipality to implement, it is very far from the current situation of the city. The reason is the lack of urban development laws and regulations in Iran. These problems in the process of preparation and approval in the implementation of detailed and even comprehensive plans can have a significant impact on the optimal performance of urban management in ensuring sustainability in Tehran.

Third, the criteria of spatial distribution in this study may help urban managers, planners, and policymakers to have a better understanding of urban facilities in Tehran. Therefore, this study in the field of spatial inequality can be useful in preparing future comprehensive plans of the city.

**Acknowledgements** We would like to express our gratitude to Kristin Anderson of the University of Oklahoma, the USA for the English language editing of the paper. The authors would also like to thank the anonymous reviewers for their constructive comments, which have been very helpful in improving the paper. This work was supported by the Iran National Science Foundation (INSF).

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