**Spatial analysis of urban poverty (Case study: Iran’s metropolises)**

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**Abstract**

According to the United Nation's Sustainable Development Goals (SDGs), poverty is one of the 17 main goals that should be eradicated by 2030. In this vein, it has become a global challenge that international organizations and governments in different countries are trying to identify and control. In addition, many studies have been conducted about its various dimensions, the causes of its formation, factors affecting its growth, and solutions to reduce it in different environments. However, no research has been accomplished to identify urban poverty in all metropolises of a country simultaneously. Thus, this research is trying to cover this gap and has studied all of Iran's metropolises to determine how much of the population and area of the country's metropolises are covered by poverty. The required indicators for this purpose have been selected based on available data from the country's last national census and international studies related to the issue. The Factor analysis model has been used for data evaluation, and the kernel density technique and Moran's spatial autocorrelation have been utilized for spatial analysis. Based on the results, 44% of the total population of Iran's metropolises and 24% of their area are covered by poverty cores. The findings of this research can be suitable for countries with similar conditions that need to identify the severity of poverty at the national and regional levels.

**Keywords:** Urban poverty, Spatial analysis, Metropolises, Iran.

1. **Introduction**

Cities have more suitable social and economic development, work opportunities, and services compared to rural areas (Vilar-Compte et al., 2021), and as hubs of social, cultural, scientific, and technological innovations attract large populations (Leal Filho et al., 2019). As a result of this population absorption, the urban population has increased dramatically (Zanganeh et al., 2015) and gone to the point where it is estimated that 6.2 billion people will live in cities in 2050, which will be 68% of the global population (Venerandi et al., 2015). Indeed, urbanization is becoming an irreversible phenomenon (Kuddus et al., 2020), affecting the urban population and scale and leading to changes in economic, social (Guan et al., 2018), and spatial structures. These changes occur because when the urban population grows, the local governments cannot simultaneously increase the capacity of services and infrastructure in all parts of cities. Therefore, facilities and services are concentrated in specific parts of cities, and inequality rises in various aspects and leads to expanded changes (Duque & Ibid, 2015). Consequently, these extensive changes caused by urbanization in developing countries, which has grown significantly in the last 50 years, created many problems (Gollin et al., 2016). These problems include rising death rates, diseases caused by pollution (Oduwaye & Lawanson, 2012), social inequalities, poverty, climate change, Etc. (Tan et al., 2016). However, among all these problems, poverty has been recognized as one of the most important crises (Egunjobi, 2014) because past studies show urban poverty is a multidimensional concept (Benevenuto & Caulfield, 2020) and has specific attributes and threatens the sustainability of cities in economic, social, cultural, environmental and security dimensions (Silva-Laya et al., 2020). In addition, this concept is connected to the degree of inequality (Ahluwalia et al., 1979) and confronts people with many limitations, including limited access to employment and income opportunities, lack of benefit from proper housing and services, unhealthy and violent environments, and lack of benefit from social security, health, and education services (Yarahmadi & Nikpour, 2021). Moreover, the noticeable point about poverty in urban studies is its spatial emergence in cities. The spatial emergence of poverty can be seen in the formation and expansion of poverty zones, dilapidated structures, inefficient structures, informal settlements, and marginalization with acute problems of poor immigrants, unemployment, violence, and insecurity. Therefore, the spatial analysis of poverty in developing countries helps local governments and planners design targeted programs to reduce and eradicate this phenomenon according to its distribution (Bemanian et al., 2011).

Iran is also one of the developing countries where urban poor areas have increased in the past decades with the increase in urbanization and the spread of urban poverty, but studying poverty has been raised mainly in the economic and health fields and has received less attention in geographical or urban studies. In contrast, social and economic developments, the rapid growth of the population, and its accelerated urbanization in recent decades have caused urban poverty, social inequalities, and a severe social class gap. Thus, fighting against it is considered one of the country's planning system's significant policies in both short-term and long-term strategies (Simler et al., 2003; Nikpour et al., 2021). Nevertheless, the implementation of poverty reduction policies will not have much success without determining its extent and dimensions. One of the noteworthy issues in formulating poverty reduction programs is knowing the extent of poverty prevailing in society and the factors affecting it. After determining the extent of poverty and its factors, one can clarify the goals and choose practical methods of implementing poverty reduction programs with more insight (Arzeromchiler, 2005). As a result, this research intends to investigate urban poverty in the metropolises of Iran, which, according to the latest official census of the country, has a population of more than one million people and has answered the following questions:

* How is the spatial distribution of poverty cores in Iranian metropolises?
* What percentage of the country's metropolises' population and area are in the poverty zone?
* Which metropolises have the most significant poor area and population?
* Which indicators play a more significant role in the formation of poverty?

1. **Literature review**

**2.1. Definition and types of poverty**

Poverty is a complicated concept that is defined according to various disciplinary approaches and ideologies (Aiyedogbon & Ohwofasa, 2012). However, in its traditional definitions, income level was widely emphasized, and its institutional and social contexts were ignored, which caused many criticisms. Critics believed that instead of defining poverty as a state of income deprivation, historical, economic, political, and social relations should also be considered in connection with it because poverty is not a static phenomenon, and the factors that cause its creation and persistence should also be identified (Adams et al., 2020). Therefore, in 1999, it was recognized as a multidimensional concept (Chen et al., 2019), and now it involves more dimensions and is influenced by economic, social, and political characteristics and structures (Jitsuchon, 2001). Considering this phenomenon in various dimensions is because the damage caused by it is pervasive and long-term and threatens the stability of cities in many dimensions. Also, it causes various problems for societies as it manifests economic, social, and cultural underdevelopment and disrupts political stability, social solidarity, and nations' physical and mental health. Thus, studying it should consider all dimensions simultaneously (Gray & Moseley, 2005; Hasanzadeh, 2000). In addition to defining poverty and considering its various dimensions, awareness of the type is significant as poverty has different sorts. It is generally divided into relative and absolute poverty (Ghorbani & Dadazade Silabi, 2021). Absolute poverty considers people's ability to survive and subsist. Indeed, individuals do not have the minimum income required to provide their basic needs, such as shelter, food, and clothing. In comparison, relative poverty does not imply a lack of basic needs, but it is when households do not have what the average citizen is expected to have. This type is dominant in developing countries where people experiencing poverty live below the normal lifestyle. They have money for basic needs but not enough to change the quality of their lives, such as a special diet or participate in different social activities or annual vacations (Chirisa & Matamanda, 2016). In particular, poverty in different environments can have diverse types, complications, and outcomes because each place has unique characteristics. For example, the emergence and spread of poverty in urban environments are much different than in rural environments due to complex systems and relationships existing in cities (Zanganeh et al., 2015), and has become an entrenched, multigenerational reality in these environments (Baharoglu & Kessides, 2001). Therefore, it is necessary to consider its different approaches in these places. Regarding approaches, two economic and anthropological approaches are more attractive for researchers. The first one concentrates on income or consumption as a central base and also considers "other social indicators such as life expectancy, infant mortality, nutrition, the proportion of the household budget spent on food, literacy, school enrolment rates, access to health clinics or drinking water," which can classify deprived people against a standard index of material welfare. The second one regards local variation in the meaning of poverty and focuses on non-material deprivation and social differentiation. Indeed, this approach's great value is attached to qualitative dimensions like independence, security, self-respect, identity, close and non-exploitative social relationships, decision-making freedom, and legal and political rights (Masika et al., 1997).

**2.2. Poverty zones**

Today, many policymakers and urban managers are interested in identifying and determining urban poverty zones to improve human development. Therefore, analysis, growth, and spatial distribution of poverty in urban societies are significant (Khosravinejad, 2012). However, poverty zones in urban environments are not a new phenomenon in the history of urbanism and have been of interest in past societies. These settlements, in large dimensions and a complex form, with the entry of investment into its second stage and the collapse of the settlement system, were objectified in geographical areas. In fact, these regions were formed in countries where, on the one hand, the third sector of their economy, i.e., services, had significant growth. On the other hand, the agricultural sector, especially in their villages, had weakened. Nevertheless, today, these areas are known as places where people are exposed to a series of environmental and social issues, including the lack of infrastructure, lack of garbage collection, and pollutants in the air, food, and water, all of which affect human health in a short and long time. In addition, crowding in these areas increases the severity of damages caused by physical hazards such as fires, floods, and landslides. Also, poverty zones have a set of apparent characteristics like high unemployment, increasing crime, inefficient and unorganized structure, unstable housing, and lack of services and facilities (Mahdnejad, 2015). In general, poverty zones can be defined as densely populated residential neighborhoods whose housing conditions are unfavorable and below the standard level, and in terms of urban services and infrastructure, they are in a state of disarray. In other words, the supply of urban services does not fulfill their potential demand. The services that consist of various aspects such as educational, social, security, environmental, and economic (Meshkini et al., 2013). In this regard, spatial identification and analysis of these areas are essential and can improve their conditions and control their influencing dimensions on various social, economic, and security issues (Ghorbani & Dadazade Silabi, 2021) because if the poor population is spatially uniformly distributed in the urban environment, they naturally have to cope with only their small income, but this never happens in the real world. Poor people tend to live near other poor people and in neighborhoods with a high poverty rate. As a result of the concentration of poverty in one part of the city, social issues are also concentrated in that part. Therefore, the accumulation of poverty in a region causes poor people to suffer not only from their financial problems and hardships but also from the harmful effects and consequences of their harsh social environment (Ren, 2011). Indeed, poverty zones are a spatial manifestation of poverty in urban environments (Potter & Evans, 2005).

**2.3. Background and Indicators of urban poverty**

Many studies have been conducted concerning identifying and analyzing poverty in urban environments, which can clarify the complexities of poverty in different dimensions. For example, in a paper entitled "Spatial and Statistical Analysis of Urban Poverty for Sustainable City Development," the relationship between urban poverty and city structure is studied to control social inequalities better. This study aimed to investigate the impact of the relationship between the location of residential properties and poverty-stricken areas in a Polish city from 2008 to 2018. The results depict that the price of apartments in the primary market depends on their location in a poor area (Kisiała & Rącka, 2021). In another study about mapping urban poverty in an Indian mega-city, physical, financial, social, and human indicators were considered to investigate the spatial patterns of poverty in Delhi. Based on the findings, poverty has different distributions related to different indicators, and planners and policymakers should not only focus on poverty areas but also consider depriving programs for all parts of the city simultaneously (Baud et al., 2008). Another research entitled "Moving away from poverty: A spatial analysis of poverty and migration in Albania" analyzed the patterns of migration and poverty based on the combination of population and household census data. This study evaluated the two factors of poverty and location as influencing indicators for migration. Findings indicate that poverty is acting as a push factor for internal migration, although it is a constraining factor for international migration because of the high cost (Zezza et al., 2005). In another paper, a set of factors connected to poverty from economic, social, and political dimensions is considered, and by using spatial analysis techniques, the determinants structure of poverty was determined. One of the significant results of this research is that the policymakers should cede the programs related to poverty reduction to the local communities, and the impact of social and political forces on poverty should be investigated along with other economic, social, and structural factors (Rupasingha & Goetz, 2007). Furthermore, in a study entitled "Spatial Inequality and Urban Poverty Traps," spatial inequality patterns and social geography theories were studied, and the results show that urban poverty from a spatial aspect is usually formed in a specific form; this is not only due to geographic factors alone but also to social and political processes, relationships, and dynamics. This study argues that spatial inequality has more to do with physical proximity to services, infrastructure, and jobs than anything else (Grant, 2010).

Concerning poverty indicators researchers in different fields study poverty from divers perspectives and measure it based on various indicators. These indicators can differ in each country because poverty is a multidimensional issue (Farhadikhah et al., 2018). However, the most common approach to measuring it is quantitative, using income or consumption to assess whether a household can buy a basket of essential goods at a given time. This basket ideally reflects local tastes and considers price differences in diverse urban areas in each country. Moreover, metric money methods are widely used because they are objective, can be used as a basis for a range of socioeconomic variables, and allow for adjustment for differences between households and within-household inequalities (Baharaoglu & Kessides, 2002; Chamhuri et al., 2012). Although many indicators are used to measure various dimensions of poverty in developing countries, almost all of them include health, education, and living standards (Vollmer & Alkire, 2022) because, according to the report Multidimensional Global Poverty Index (MGPI) from the United Nations, these indicators, along with many sub-indices, are recognized as the main framework for identifying poverty. Some of these sub-indices include standards in the fields of health, electricity, housing, cooking fuel, drinking water, property, years of education, school attendance, nutrition, and child mortality indicators (Alkire et al., 2021). However, poverty is not static or a monotonic, one-way process. Over time, some people build assets and move out of poverty, while others experience shocks and are pulled into poverty (Hallegatte et al., 2018).

In this regard, researchers, in addition to global indicators, use different indicators based on various perspectives and the existing conditions in their study area. For example, Dubey and Mahadevia, who studied the status of poverty in Indian metropolises for over two decades, used transportation factors as an effective indicator—based on their results, urban poverty and the size of the cities had an inverse relationship with new transportation systems. So, the construction of subway lines led to the expansion of poverty in metropolises (Dubey & Mahadevia, 2001). In addition, housing, known as a sub-index to identify urban poverty in global studies, has been examined in some studies in a broader way and with different dimensions. For example, a study titled "Spatial Analysis of Urban Poverty in Tehran Metropolis "is considered a main index along with economic, social, and educational indicators. According to this study's findings, which have been achieved through the factor analysis and application of the fuzzy VIKOR method, housing is the most influential factor in the spatial distribution of urban poverty in the Tehran metropolis and has a close and complicated relationship with economic conditions (Movahhed et al., 2016). Some researchers also consider cultural factors an effective indicator for identifying poverty; for example, in research entitled "Identification and spatial analysis of urban poverty zones, Case study: Zahedan City," cultural, physical, economic, and social dimensions are considered simultaneously, and the results of this research indicated that cultural factors affect the formation and development of poverty zones than other factors significantly (Zanganeh et al., 2015). In another study conducted in Kumasi, Ghana, researchers analyzed the expansion of poverty areas over five years. They considered factors such as income, cost of living, housing units, the presence of companies, access to social services, and immigration issues for nine city areas that have been investigated. Their findings showed that the level of education and economic and social status are very effective in the distribution of poverty (Poku-Boansi et al., 2020). As mentioned at the beginning of this section, researchers use different indicators to measure poverty based on different conditions and perspectives. In this research, taking into account the international and national indicators and the data available in the country's official census, 20 indicators related to economic, demographic, and housing issues were selected, shown in Table 1.

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| Table1  Urban poverty indicators | | |
| Dimension | Indicator | References |
| Economic | **Total unemployment**  The ratio of unemployed population to ten years old population and more | 1,2,3,4,5,8,26,27,28 |
| **Unemployment of men**  The ratio of unemployed men to ten years old population and more | 6,7,8,11,24,26,27,28 |
| **Unemployment of women**  The ratio of unemployed women to ten years old population and more | 6,7,8,11,24,26,27,28 |
| **Economic burden**  The ratio of the total population to the working population | 27,28,29,30,31,32 |
| **Population burden**  The ratio of the total population to the employed and unemployed population | 27, 28,29,30,31,32 |
| **Dependency rate (net)**  The total population minus the employed population and then divided by the employed population | 20,27,28,29,30,31,32 |
| ‌**Dependency rate (gross)**  Total population (0-14) and (+65) divided by population (15-64) | 20,27,28,29,30,31,32 |
| ‌**Dependency rate (UN)**  Total population (0-25) and (+65) divided by population (25-64) | 20,27,28,29,30,31,32 |
| Population | **Total illiteracy rate**  The ratio of illiterate individuals to total population (6years old and more) | 10,12,22,26,27,28,29 |
| **Male illiteracy rate**  The ratio of illiterate men to total population (6years old and more) | 6,10,11,12,13,22,24 |
| **Female illiteracy rate**  The ratio of illiterate women to total population (6years old and more) | 6,10,11,12,13,22,24 |
| **Percentage of women never married**  The ratio of never-married women to the number of women of marriageable age | 6,11,17,24,28 |
| **Percentage of men never married**  The ratio of never-married men to the number of men of marriageable age | 6,11,17,24,28 |
| **Divorce rate**  The ratio of men and women without spouses due to divorce to men and women with spouses | 17,18,21,23,26,28,29 |
| **Aging population**  The ratio of people over 65 years old to the total population | 9,19,20,25,26,27,28 |
| Housing | **Dilapidated housing**  The ratio of residential units with wood, brick, wood and clay materials to the total number of residential units | 14,15,16,28,29,30,31 |
| **Housing with 50 square meters and less**  The ratio of residential units with an infrastructure of less than 50 square meters to the total | 28,29,30,31, |
| **Rental housing**  The ratio of rental units to total residential units | 14,15,16,28,29,30,31 |
| **household size**  The ratio of population to the number of households | 28,29,30,31 |
| **Household density in residential unit**  The ratio of the number of households to the total number of residential units | 14,15,16,28,29,31 |
| 1. (John & Morufu, 2013), 2. (Xue & Zhong, 2003), 3. (Aiyedogbon & Ohwofasa, 2012), 4. (Egunjobi, 2014), 5. (Adelowokan et al., 2019), 6. (Kimani & Kombo, 2010), 7. (Okojie, 2003), 8. (Chen et al., 2006), 9. (Walker, 1980), 10. (Tarabini, 2010), 11. (Shrider et al., 2021), 12. (Awan et al., 2011), 13. (Antony & Rao, 2007), 14. (Chirisa & Matamanda, 2016), 15. (Medina et al., 2020), 16. (Zhao et al., 2021), 17. (Leopold, 2018), 18. (Arditti, 1997), 19. (Barrientos, 2002), 20. (Barrientos et al., 2003), 21. (Espenshade, 1979), 22. (Hofmarcher, 2021), 23. Hogendoorn, B., Leopold, T., & Bol, T. (2020), 24. (Jackson, 1996), 25. (Lloyd-Sherlock, 2000), 26. (Ghorbani & Dadazade Silabi, 2021), 27. (Nazmfar et al., 2020), 28. (Nikpour et al., 2021), 29. (Nikpour & Yarahmadi, 2021), 30. (Nikpour et al., 2021), 31. (Nikpour et al., 2020), 32.(Nikpoor et al., 2020). | | |

1. **Study area**

Iran is located in the northern hemisphere and the southwest of Asia. This country is the 17th largest in the world, with an area of about 1 million 874 square kilometers (Nami & Heydaripour, 2010). As shown in Table 2, according to the latest official census, Iran has about 80 million populations, 74% of whom live in cities, even though only 31% of the country's population were urban dwellers in the first census. As a result, the country's population growth, especially the urban population, can be observed during the census years. In terms of the number of cities, this process has been repeated, and it reached 1,245 cities in 2016 from 200 cities in 1956. What is more considerable in this research than other issues are the number of metropolises, in the first census, Tehran, with more than one million people, was the only metropolis in the country, but in 2016, the number of these cities reached 18.

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| Table 2  The number and population of metropolises in Iran | | | | | | | |
| Census Year | **The number of cities** | **The number of metropolises** | **Total population of the country** | **Urban population of the country** | **Urban population / total population of the country (%)** | **Metropolises' population / total population of the country (%)** | **Metropolises' population / urban population of the country (%)** |
| 1956 | 200 | 1 | 18954704 | 5953563 | 31 | 8 | 25 |
| 1966 | 271 | 1 | 25788722 | 9794246 | 38 | 10 | 28 |
| 1976 | 452 | 4 | 33708744 | 15854680 | 47 | 19 | 41 |
| 1986 | 496 | 9 | 49445010 | 26844561 | 54 | 25 | 47 |
| 1996 | 614 | 9 | 60055488 | 36817789 | 61 | 26 | 42 |
| 2006 | 1014 | 13 | 70495782 | 48259964 | 68 | 28 | 42 |
| 2011 | 1139 | 14 | 75149669 | 53646661 | 71 | 31 | 43 |
| 2016 | 1245 | 18 | 79926270 | 59146847 | 74 | 34 | 45 |

Source: General population and housing census (2016), Statistical Centre of Iran.

In terms of the definition of a metropolis, UN-Habitat has presented a metropolis as a city with at least 300,000 populations, which is an important economic, political, and cultural area for a country or a region. However, this definition differs according to each country's administrative, legal, political, economic, and cultural criteria (UN-Habitat, 2020).

In Iran, the criteria for determining metropolises are also different. The Supreme Council of Urban Planning and Architecture in 2008 announced that a metropolis is a city with a population of 500,000 or more, although because of the lack of a single legal definition, only cities with one million or more populations are eligible to use tax benefits. Indeed, cities with 500,000 are considered metropolises unofficially, and cities with 1 million populations and more are officially metropolises and can use the tax benefit law (Ministry of Roads and Urban Development, 2008). Based on this definition in the last official census of the country in 2016, Iran has 18 cities with 500,000 populations and more, of which nine cities have 1 million populations and more. In addition, Tehran has the largest, and Arak has the smallest population among these cities. During the census, Karaj had the highest population growth rate (8%), and Tabriz had the lowest (2.84%).

Considering different angles in the definition of metropolises in Iran, in this research, nine metropolises with a population of over one million people in the last census and officially using the tax law's benefits are considered the study area. (Table 3), (Fig 1)

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| Table 3  The population of Iran’s metropolises in 2016 | | | | | | | |
| Row | **Metropolis** | **Population** | **Growth rate** | **Row** | **Metropolis** | **Population** | **Growth rate** |
| 1 | Tehran | 8,693,706 | 2/95 | **10** | Urmia | 736224 | 4/06 |
| 2 | Mashhad | 3,001,184 | 4/28 | **11** | Rasht | 679995 | 3/09 |
| 3 | Isfahan | 1,961,260 | 3/52 | **12** | Zahedan | 587730 | 6/03 |
| 4 | Karaj | 1,592,492 | 8/14 | **13** | Hamedan | 554406 | 2/89 |
| 5 | Shiraz | 1,565,572 | 3/76 | **14** | Kerman | 537718 | 3/66 |
| 6 | Tabriz | 1,558,693 | 2/84 | **15** | Yazd | 529673 | 3/59 |
| 7 | Qom | 1,201,158 | 4/23 | **16** | Ardebil | 529374 | 3/53 |
| 8 | Ahvaz | 1,200,000 | 3/91 | **17** | Bandar-Abbas | 526648 | 5/81 |
| 9 | Kermanshah | 1,146,651 | 3/75 | **18** | Arak | 520944 | 3/69 |

Source: General population and housing census (2016), Statistical Centre of Iran.

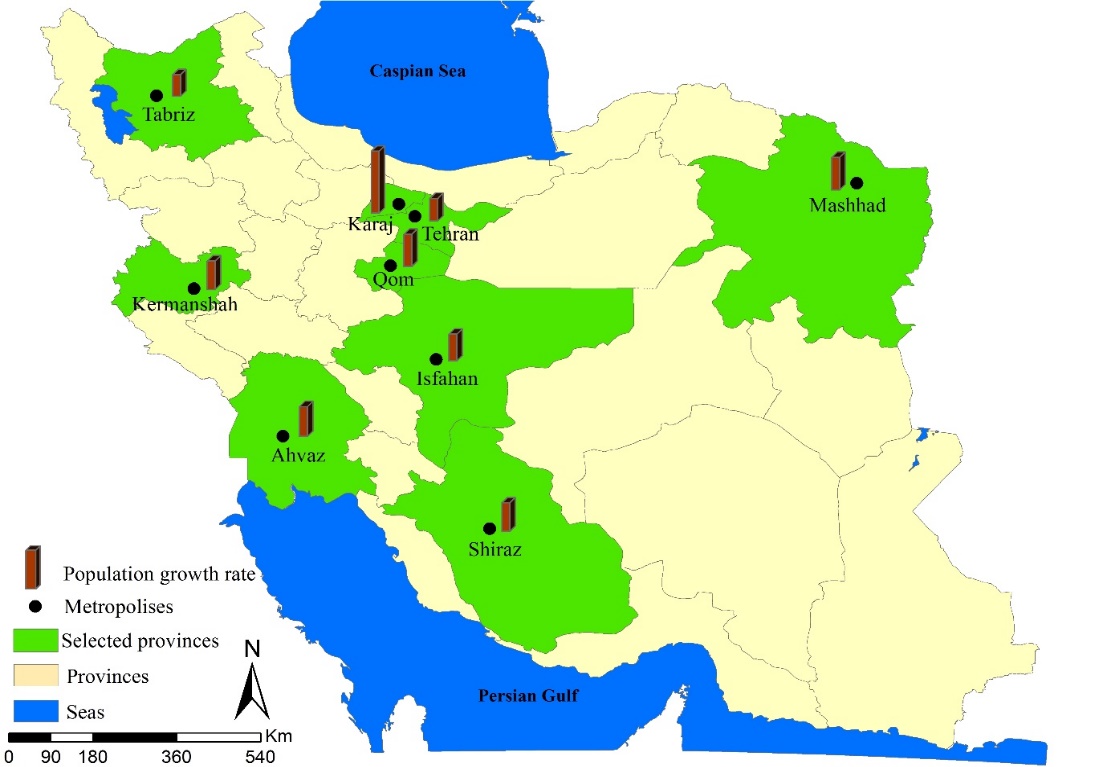


Fig.1. The location and population growth rate of Iranian metropolises. (Source: General population and housing census (2016), Statistical Centre of Iran).

1. **Methodology**

The current research is descriptive-analytical and carried out through several interrelated steps. In the first stage, required indexes for measuring urban poverty were selected based on past research related to the issue and existing data in the last official census of the country. In the next step, SPSS software and the Factor Analysis (FA) method were used to measure urban poverty in the chosen metropolises. Based on the results obtained in this stage, the number of factors of poverty in each city was determined, and the final amount of poverty was obtained from the total number of factors. In the third step, the data were transferred to the Arc GIS software environment to analyze and draw the poverty map. The kernel density method was used to depict the centers of urban poverty. This method divided city blocks into three main centers: first, second, and third. Finally, the local Moran statistic available in GeoDa software was used to identify the spatial pattern of poverty.

1. **Results and discussion**

**5.1. Analytical model**

FA is a multivariate statistical technique (Shrestha, 2021) that includes two types: exploratory and confirmatory (DeCoster, 2015). This technique reduces the amount of data and creates a new structure for data analysis and interpretation. Exploratory Factor Analysis (EFA) discovers an underlying structure of a relatively large set of variables. In this method, the researcher identifies many observed variables related to the subject but does not present any initial theory about hidden variables or their structure. Discovering the relationships between all variables and their structure is performed by EFA. Indeed, EFA extracts a few factors based on the correlation between these variables. The extracted factors are interpreted based on the variables and their meanings. However, in Confirmatory Factor Analysis (CFA), the researcher has assumed the structure of factors and variables in advance and is looking to confirm or reject them (Afshani et al., 2019). In this research, the EFA method has been used due to the large amount of data, the hidden and complex dimensions of the indicators, and the identification of the structure and influencing factors in urban poverty.

**5.1.1. Evaluation of Data Suitability for EFA**

In the first phase of performing EFA, the appropriateness of the data should be checked by performing the Kaiser-Meyer-Olkin (KMO) and Bartlett's tests. These tests determine whether large data sets can be reduced to a few latent factors. The KMO test shows that the variance of the set of variables is caused by a series of hidden and fundamental factors and not all variables. In addition, Bartlett's test helps discover a new structure according to the correlation between the variables and their factors. In order to check these points, if the numerical value of KMO is greater than 0.6 and the result of Bartlett's test has 95% confidence or more, then the data are suitable for factor analysis (Sadeghpour & Mouradi, 2018). According to the results in Table 4, the value of KMO for all metropolises is higher than the numerical value of 0.6, and Bartlett's statistic shows a suitable value, which indicates the appropriateness of data correlation.

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| Table 4  KMO and Bartlett's Test | | | |
| City | **KMO** | **Bartlett's Test** | **Sig** |
| Tehran | 0/711 | 737451/987 | 000/0 |
| Mashhad | 0/622 | 338055/023 | 000/0 |
| Isfahan | 0/763 | 585279/384 | 000/0 |
| Karaj | 0/724 | 232282/762 | 000/0 |
| Shiraz | 0/711 | 355839/460 | 000/0 |
| Tabriz | 0/841 | 534346/174 | 000/0 |
| Qom | 0/636 | 253692/963 | 000/0 |
| Ahvaz | 0/783 | 304249/936 | 000/0 |
| Kermanshah | 0/633 | 175945/497 | 000/0 |

The substantial point is that the tests mentioned in the previous section first ran once in the SPSS software, and based on the initial results, the values of the commonality of some variables in the commonality table and the extracted column were less than 0.4. Considering the point that when the contribution value of a variable is less than 0.4, that variable does not play a significant role in explaining the phenomenon, it is better to remove it from the calculations (Zebardast, 2015), variables with contribution values lower than 0.4 were removed from the analyses, and the tests were re-run again, and final results show in Table 4. The omitted indicators in each metropolis are shown in Table 5, indicating that the two indicators, "dilapidated housing" and "divorce rate," were deleted the most. In other words, these two indicators do not play much role in explaining

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| Table 5  Indicators excluded from factor analysis calculations | |
| City | **Removed Index** |
| Tehran | Dilapidated housing |
| Mashhad | Total illiteracy rate, Divorce rate, Dilapidated housing |
| Isfahan | Divorce rate, Dilapidated housing, Housing with 50 square meters and less |
| Karaj | Total illiteracy rate, Divorce rate, Dilapidated housing |
| Shiraz | Housing with 50 square meters and less |
| Tabriz | Divorce rate |
| Qom | Dilapidated housing, Divorce rate, Percentage of women never married, Total illiteracy rate |
| Ahvaz | Divorce rate |
| Kermanshah | - |

urban poverty in Iran's metropolises.

**5.1.2. Factor extraction**

After performing the above steps, the number of poverty factors in each metropolis was extracted. In this regard, there are several rules to determine the number of factors that should be extracted, although Kaiser's rule is used more than others (Henson & Roberts, 2006). According to this rule, the number of factors whose eigenvalue equals one or more than one should be extracted (Kaiser, 1960). Another criterion considered in determining the number of factors is the percentage of changes the extracted factors cumulatively explain. Most researchers believe that the number of factors should be extracted whose cumulative variance explains at least 60% of the changes in the data (Howard, 2016). In this research, the number of factors extracted in the cities have shown that they can explain the phenomenon of poverty well. Among the cities, Isfahan has the highest amount by identifying four main factors and explaining 82% of the variance. Tehran has the lowest amount compared to other cities by identifying five main factors and explaining 70% of the variance (Table 6).

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| Table 6  Factors extracted in each metropolis | | | | |
| City | **Number of components** | **Total Eigenvalue** | **% of Variance** | **Cumulative Variance** |
| Tehran | 1 | 3/123 | 17/384 | 17/384 |
| 2 | 2/597 | 14/429 | 31/778 |
| 3 | 2/465 | 13/692 | 45/469 |
| 4 | 2/304 | 12/801 | 58/271 |
| 5 | 2/179 | 12/106 | 70/377 |
| Mashhad | 1 | 3/668 | 21/575 | 21/575 |
| 2 | 2/265 | 13/322 | 34/897 |
| 3 | 2/198 | 12/929 | 47/825 |
| 4 | 1/881 | 11/067 | 58/893 |
| 5 | 1321 | 7/773 | 66/665 |
| 6 | 1/168 | 6/870 | 73/535 |
| 7 | 1/092 | 6/424 | 79/959 |
| Isfahan | 1 | 5/170 | 30/411 | 30/411 |
| 2 | 3/170 | 18/646 | 49/057 |
| 3 | 2/982 | 17/538 | 66/595 |
| 4 | 2/605 | 15/323 | 81/918 |
| Karaj | 1 | 5/141 | 30/243 | 30/243 |
| 2 | 3/454 | 20/315 | 50/558 |
| 3 | 2/604 | 15/318 | 65/876 |
| 4 | 2/384 | 14/024 | 79/900 |
| Shiraz | 1 | 3/879 | 20/417 | 20/417 |
| 2 | 3/462 | 18/223 | 38/640 |
| 3 | 2/831 | 14/898 | 53/537 |
| 4 | 2/494 | 13/125 | 66/662 |
| 5 | 1/382 | 7/274 | 73/935 |
| 6 | 1/187 | 6/249 | 80/185 |
| Tabriz | 1 | 8/243 | 43/382 | 43/382 |
| 2 | 4/139 | 21/784 | 65/166 |
| 3 | 2/639 | 13/887 | 79/053 |
| Qom | 1 | 3/125 | 19/531 | 19/531 |
| 2 | 3/066 | 19/161 | 38/692 |
| 3 | 2/711 | 16945 | 55/637 |
| 4 | 2/132 | 13/323 | 68/960 |
| 5 | 1/551 | 9/691 | 78/651 |
| Ahvaz | 1 | 5/692 | 29/956 | 29/956 |
| 2 | 2/601 | 13/687 | 43/643 |
| 3 | 2/176 | 11/453 | 55/096 |
| 4 | 1/687 | 8/879 | 63/976 |
| 5 | 1/682 | 8/854 | 72/830 |
| 6 | 1/149 | 6/048 | 78/878 |
| Kermanshah | 1 | 2/995 | 14/977 | 14/977 |
| 2 | 2/840 | 14/199 | 29/176 |
| 3 | 2/783 | 13/917 | 43/093 |
| 4 | 2/197 | 10/984 | 54/077 |
| 5 | 1/257 | 6/283 | 60/360 |
| 6 | 1/071 | 5/357 | 65/717 |
| 7 | 1/054 | 5/271 | 70/988 |

**5.1.3. Effective indicators in poverty rate**

In this section, the score of factor loadings in the previous phase was used to specify effective indicators of urban poverty in each metropolis. In this regard, only three indicators in each city with the highest value were selected as influential indicators, as shown in Table 7. According to the results, among all the indicators used in the research, three indicators, including population burden, economic burden, and dependency rate (net), were most repeated and gained the highest value as effective indicators.

|  |  |  |
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| Table 7  Top three Effective indicators in each metropolis | | |
| City | **Effective indicators** | **Factor loading** |
| Tehran | Dependency rate (net) | 0.95 |
| Economic burden | 0.919 |
| Population burden | 0.876 |
| Mashhad | Economic burden | 0.97 |
| Dependency rate (net) | 0.981 |
| Population burden | 0.974 |
| Isfahan | Household density in residential unit | 0.826 |
| Dependency rate (gross) | 0.769 |
| Population burden | 0.700 |
| Karaj | Percentage of women never married | 0.988 |
| Population burden | 0.982 |
| Dependency rate (net) | 0.981 |
| Shiraz | Household density in residential unit | 0.849 |
| Dependency rate (UN) | 0.824 |
| Household size | 0.772 |
| Tabriz | Population burden | 0.944 |
| Household size | 0.891 |
| Household density in residential unit | 0.887 |
| Qom | Dependency rate (gross) | 0.982 |
| Household density in residential unit | 0.804 |
| Rental housing | 0.793 |
| Ahvaz | Aging population | 0.952 |
| Percentage of women never married | 0.949 |
| Dependency rate (gross) | 0.939 |
| Kermanshah | Dependency rate (net) | 0.875 |
| Economic burden | 0.863 |
| Population burden | 0.849 |

**5.2. Spatial analysis**

**5.2.1. Urban Poverty Cores**

After reducing the volume of data through FA, the obtained data and information have transferred to the GIS environment, and the Kernel Density Estimation (KDE) method has been used to depict the cores of urban poverty as a continuous surface. KDE is one of the most well-known approaches to estimating a data set's underlying probability density function and, due to the flexibility of its nonparametric nature, is a popular approach for data drawn from a complicated distribution (Chen, 2017). In addition, it is one of the important spatial analysis functions in the geographic information system environment, as it can draw the density of a geographical complication in a region in a spatial image. This function is used in many planning and can depict an area and a smooth surface according to the variable area and type at the regional level. It is also one of the suitable tests for displaying linear and especially point data continuously (Fazelniya et al., 2012). Furthermore, this method is used for many studies due to its visual aspects, high availability and accuracy (Sargazi et al., 2021). Based on the findings related to this method, three types of poverty cores have been formed in Iran's metropolises, which include: The main core of poverty which has the highest poverty concentration and is illustrated in red; The secondary core of poverty, with a lower concentration than the first core, is depicted in orange, and the tertiary core has a lower concentration of poverty than the first and second cores, shown in green. Figure 2 shows these poverty cores in Iran's metropolises.

C:\Users\ARG\Desktop\Graphic1.tifFig.2. Urban poverty cores in Iran's metropolises

According to this map, cities, including Tehran, Isfahan, Karaj, Ahvaz, and Kermanshah, have several main and robust cores. However, Mashhad, Shiraz, and Tabriz cities have only one poverty intense center. Moreover, Qom seems to be in the early stages of forming a main core. In terms of geographical distribution, the cores of poverty in the cities of Tehran, Isfahan, and Shiraz have primarily formed in the central and middle areas, although the cities of Mashhad, Karaj, Tabriz, Qom, Ahvaz, and Kermanshah have created in marginal and edge contexts. By considering the dynamic character of poverty and based on the map of urban poverty cores, it is possible to identify the process of developing poverty in each metropolis. The stages of development are as follows: 1) Cores with 3rd degree of poverty are created. 2)The intensity of poverty in these cores increases, and they become 2nd degree. 3)They became the most severe concentration of poverty and created 1st-degree cores. The noteworthy point in the map of urban poverty cores is that different centers are continuously surrounded by each other, which means that the first-level cores are formed. The second core is created around them immediately. Finally, the third core covered the previous two cores. After identifying the urban poverty cores in each metropolis, in Table 8, their population and area also have been calculated to determine the amount of population and the area affected by poverty in each metropolis. According to the findings, Isfahan has the most area in the first and second poverty cores, and Mashhad in the third center. In comparison, the lowest area is allocated to Qom, Tabriz, and Mashhad, respectively. Regarding population, Isfahan has the highest population in the first and second cores, while Qom has the highest population in the third core. Moreover, the lowest population of poverty centers settles in Qom, Mashhad, and Shiraz, respectively.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 8  The area and population in each of the poverty core | | | | | | | | | | | | |
| City | **Poverty Core 1** | | | | **Poverty Core 2** | | | | **Poverty Core 3** | | | |
| Population | % | Area | % | Population | % | Area | % | Population | % | Area | % |
| Tehran | 334612 | 4 | 682 | 1 | 725426 | 8 | 1611 | 3 | 1799238 | 21 | 5043 | 11 |
| Mashhad | 41306 | 1 | 155 | 1 | 468496 | 16 | 1358 | 9 | 1223759 | 41 | 4719 | 30 |
| Isfahan | 120876 | 6 | 673 | 3 | 439278 | 23 | 2434 | 11 | 623728 | 32 | 4451 | 20 |
| Karaj | 43342 | 3 | 123 | 1 | 168714 | 11 | 539 | 5 | 468075 | 30 | 1887 | 18 |
| Shiraz | 30669 | 2 | 241 | 2 | 136144 | 9 | 817 | 5 | 472235 | 31 | 2685 | 17 |
| Tabriz | 45803 | 3 | 101 | 1 | 45259 | 3 | 105 | 1 | 115131 | 7 | 292 | 2 |
| Qom | 13801 | 1 | 24 | 0 | 93981 | 8 | 277 | 4 | 561267 | 47 | 1584 | 23 |
| Ahvaz | 44292 | 4 | 138 | 1 | 184504 | 16 | 765 | 8 | 467908 | 40 | 2180 | 24 |
| Kermanshah | 53351 | 6 | 178 | 3 | 145618 | 15 | 664 | 11 | 331299 | 35 | 1516 | 25 |

Concerning the total area of all cores of poverty, the most significant area is related to the cities of Mashhad and Kermanshah, and the lowest area belongs to Tabriz and Tehran. In general, poverty cores occupy significant areas of all metropolises, for example, in Mashhad (39%), Kermanshah (38%), Isfahan (34%), Ahvaz (33%), and Qom (27%) of the city area is located in urban poverty centers. Regarding the total population, the highest poverty is settled in Isfahan and Ahvaz, and the lowest is in Tabriz and Tehran. In addition, a significant share of the population in each metropolis is put in the poverty class; for example, in Isfahan (61%), Ahvaz (60 %), Mashhad (58 %), Qom (56 %), and Kermanshah (56 %) of the city population is allocated to poverty cores. By comparing the ratio of the area and population covered by the poverty cores in Iran's metropolises, it has been determined that the highest proportion of the urban poverty area is allocated to Mashhad while the lowest is in Tabriz. Concerning the poverty population, Isfahan has first place with 61%, and Tabriz has last place with 13%. (Table 9) (Fig.3)

Fig 3. The total percentage of poor area and population in Iranian metropolises.

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| --- | --- | --- | --- | --- | --- | --- |
| Table 9  The total population and area of Iran’s metropolises | | | | | | |
| City | **population** | **Area (Hectares)** | **Population of Poverty** | **%** | **Area of Poverty** | **%** |
| Tehran | 8,693,706 | 47572 | 2859276 | 33 | 7336 | 15 |
| Mashhad | 3,001,184 | 15919 | 1733561 | 58 | 6232 | 39 |
| Isfahan | 1,961,260 | 21898 | 1183882 | 61 | 7558 | 34 |
| Karaj | 1,592,492 | 10292 | 680131 | 43 | 2549 | 25 |
| Shiraz | 1,565,572 | 15930 | 639048 | 41 | 3743 | 23 |
| Tabriz | 1,558,693 | 12810 | 206193 | 13 | 498 | 3 |
| Qom | 1,201,158 | 6931 | 669049 | 56 | 1885 | 27 |
| Ahvaz | 1,200,000 | 9251 | 696704 | 60 | 3083 | 33 |
| Kermanshah | 1,146,651 | 6110 | 530268 | 56 | 2358 | 38 |

Source: General population and housing census (2016), and findings of the authors.

**5.2.2. Spatial pattern of urban poverty**

This section investigated the distribution pattern of poverty in Iran's metropolises using spatial autocorrelation. In definition terms, "Spatial autocorrelation analysis examines whether the observed value of a variable at a particular point is significantly dependent on the values of the variable at neighboring points or not." In this vein, Moran's I is a measure of spatial correlation statistics designed to test this dependence (Darand et al., 2017). This method generally discovers "the patterns and the levels of spatial clustering among neighboring districts" (Tsai et al., 2009,13). This tool compares the resemblance of every object to its neighbors and presents a general view of the variable spatial pattern through an average of all comparisons. However, Local Moran's I explores which objects are similar or different to the objects in their neighborhood and considers more details. In the local Moran statistic, the map and the distribution diagram of complications are divided into four clusters, showing the local correlation pattern between the regions and their neighbors. The High-High cluster represents areas where poverty is spatially self-correlated, and other poor blocks surround an inferior block. The High-Low cluster represents areas where a poor block is surrounded by other blocks that do not have poverty. The Low-Low cluster display the absence of poverty in a region and its neighboring regions. Finally, the Low-High cluster illustrates the areas where other poor blocks surround a non-poverty block (Nikpour et al., 2022). In this study, Local Moran's I tool was utilized to determine the pattern of poverty distribution, and based on the results (Fig. 4, Fig. 5), the poverty clusters in the cities of Isfahan, Tabriz, Tehran, Shiraz, and Qom consist of one or two extensive clusters. However, these clusters do not follow a regular spatial pattern despite their formation in cities such as Mashhad, Karaj, Ahvaz, and Kermanshah. They are seen in a scattered form throughout the city. Moran's scatter diagram in Iran's metropolises shows many urban blocks within the High-High cluster. This situation indicates that many city blocks in the vicinity of each other have caused the formation of poverty clusters. This graph shows that many urban blocks in Isfahan and Tabriz are located in the High-Low area. The location of the blocks in this range indicates that some urban poor blocks are in the neighborhood of non-poverty blocks; Therefore, they could not form a cluster and became single-celled (non-clustered). Based on this diagram, it was found that several urban blocks, especially in Tabriz and Isfahan, are in the Low-High range; this shows that the number of non-clusters of poverty in these two cities is higher than in other cities. Finally, there is the Low-Low cluster; except for Isfahan and Tabriz, other cities have almost

the same situation. The location of the blocks in this cluster shows that several blocks without poverty have formed a cluster in the vicinity of other blocks without poverty.

C:\Users\ARG\Desktop\Graphic2.tifC:\Users\ARG\Desktop\b.tifFig.4. Urban poverty clusters based on Moran's autocorrelation test

Fig.5. Spatial distribution diagram of urban poverty

1. **Conclusion**

In recent decades, the issue of poverty and its measurement has found a special place in the development policies of the world, especially in developing countries. Poverty has a complex and multidimensional nature and measures in developing countries based on different perspectives, including lack of opportunities, inability to eliminate basic needs, lack of social services, low income, inequalities, and marginalization. Considering the significant extent of poverty in Iran's metropolises, identifying the cores of poverty to reduce poverty and improve the welfare of society is essential.

This research considers three physical, social, and economic dimensions of 20 indicators to investigate urban poverty at nine metropolises in Iran. The results show that the geographical distribution of the studied indicators confirms the existence of social-spatial heterogeneity between the blocks of Iran's metropolises. The distribution pattern of slums has formed a cluster pattern. In this way, poverty clusters have created different but concentrated cores in each city scattered in different parts of that city. According to the results, poorest neighborhoods are compatible with the marginalized parts, the old and worn-out textures of the metropolises. The spatial reflection of poverty among urban neighborhoods shows significant spatial imbalances in the mother cities in three dimensions. It confirms that neighborhoods and urban areas in each metropolis are rapidly moving toward geographic inequality and social polarization as a significant percentage of the population and the area of the country's metropolis is covered by poverty. The outcomes have indicated that, on average, 44% of the total population of Iran's metropolises and 24% of their area are covered by poverty cores. In addition, among all the indicators used to measure the poverty areas, the indicators of population burden, economic burden, dependency rate (net), household density in a residential unit, and unemployment have the most significant impact on the spread of poverty in Iran's metropolises.

Comparing the consequences of this research with previous studies in this field displays the formation and concentration of poverty in the central areas of the cities and the speed of urban poverty, which is expanding rapidly.

The main reasons for the emergence of this phenomenon are the declining trend of the country's economic growth due to extensive international sanctions in recent years, unfavorable policies of the country's administration in the field of reducing poverty and inequality, and individual characteristics of the poor people (education, divorce rate, celibacy rate, Etc.) that led to poverty has become more prominent in the main cities of the country, and its spatial extent is increasing day by day.

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