

Analysis of Population Growth Trends Based on Geographic Information Systems in East Jakarta

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prama.ardha@esaunggul. ac.id **Abstract.** The increase in population is accompanied by equal distribution. In this context, population density of Jakarta is partly due to urbanization and long-term settlement. Therefore, this research is carried out to identify sub-districts experiencing the fastest population growth and the accommodated capacity. Population issues must be a central point of sustainable development allowing every resident and future generations to live healthily, prosperously, productively, and harmoniously with the environment. The relationship between population growth rate (PGR) and spatial aspects such as healthcare facilities, trade facilities, transportation facilities, government offices, education facilities, industry, and the availability of residential buildings from 2017 to 2022 is determined through Geographic Information System (GIS)-based analysis using statistical methods. The trend of PGR in East Jakarta sub-districts is high in the northwest and north, bordering Central and North Jakarta. Meanwhile, spatial aspects influencing high population growth are the availability of residential buildings and schools. Increased residential buildings and public schools in a sub-district due to the zoning policy in student enrollment are directly proportional to population growth.

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1. Introduction

Development is carried out through the development of Population Administration Information System that provides national, provincial, and city/regency-scale population data and information, serving as a reference in regional analysis (Indonesia, 2013). Based on the registration in December 2022 (table 1), population of Daerah Khusus Ibukota (DKI) Jakarta Province was 11.317.271 Indonesian citizens with an increase of 0,49%, 1,07%, 2,29%, 4,18%, and 8,64% in 2021, 2020, 2019, 2018 and 8,64%. Meanwhile, the largest population in 2021 is in East Jakarta, with an area of 185.337 km². Population is an important factor in influencing development in a region because of dynamics such as births, deaths, and movements. According to (Sudaryatno & Kamal, 2013), this situation leads to changes in the number, composition, structure, and growth. Population is a central focus in all geographical research because the concept is closely connected to natural resources, urban development prospects, and environmental quality (Shirazi & Kazmi, 2014). The presence of amenities in large cities positively impacts the migration of highly skilled labor to urban areas (Zhang, Zheng, Zhou, Shao, & Wu, 2021). Population growth affects the sustainable development of an area from a social and spatial point of view (Yaakub, Masron, Marzuki, & Soda, 2022)

A limited area with a very large population such as Jakarta will certainly cause many social and economic problems (Hermanto, 2021). According to data from the Central Statistics Agency of DKI Jakarta Province (figure 1), in 2022, Jakarta had 502.04 thousand poor people and the number has continued to increase. In terms of numbers, Jakarta ranks 13th out of 34 provinces, as reported in Figure 1. However, in terms of percentage, the poor population is 4.70%. Only

2022

	Table 1. Population of DKI Jakarta Province in 2022					
No	City		Indonesian citizens			
INO.	City	Man	Woman	Total		
1	Kepulauan Seribu	14.971	14.617	29.588		
2	Central Jakarta	571.920	564.904	1.136.824		
3	North Jakarta	939.951	924.520	1.864.471		
4	West Jakarta	1.301.632	1.284.698	2.586.330		
5	East Jakarta	1.188.470	1.191.213	2.379.683		
6	South Jakarta	1.638.590	1.626.109	3.264.699		
DKI Ja	akarta Provance	5.655.534	5.606.061	11.261.595		

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Source: (Dinas Kependudukan dan Pencatatan Sipil DKI Jakarta, 2023)

three provinces had a lower percentage of poor people than Jakarta in 2022, namely South Kalimantan (4.68%), Bali (4.66%), and Bangka Belitung Islands (4.47%). Population growth rate (PGR) positively affects poverty (Fauzi, Febriani, & Desmawan, 2022).

Regarding the social problems arising from the large population increase with limited land, the happiness index in Jakarta is still below the national index value of 71.49 (figure 2). This index is measured from three dimensions, namely life satisfaction, affect, and eudaimonia.

This research is expected to map population growth in each sub-district in East Jakarta. The novelty is to determine the relationship between spatial aspects and population growth in East Jakarta.

2. Methods

Research location

The location is in East Jakarta City with the largest area compared to others.

Spatial Statistic

Spatial statistic is used to analyze data that includes location information (Faiz, Rahmawati, & Safitri, 2013).

This method has been applied in various fields such as social sciences, economics, natural and environmental sciences, health, meteorology, and climatology. Spatial data contains information about the location and attributes of an object.

Pearson Correlation Formula

$$\mathbf{r} = \frac{\mathbf{n}(\Sigma \mathbf{x}\mathbf{y}) - (\Sigma \mathbf{x})(\Sigma \mathbf{y})}{\sqrt{[\mathbf{n}\Sigma \mathbf{x}^2 - (\Sigma \mathbf{x})^2] [\mathbf{n}\Sigma \mathbf{y}^2 - (\Sigma \mathbf{y})^2]}}$$

Explanation:

- r = Pearson coefficient
- n = number of paired stocks
- $\Sigma xy = sum of the products of paired stocks$
- $\sum x = sum of x scores$
- $\Sigma y = sum of y scores$
- $\Sigma x2 = sum of squared x scores$
- $\Sigma y2 = sum of squared y scores$

The mapping unit used is the administrative boundaries of each sub-district. For spatial parameters, spatial join analysis is performed with the sub-district data to obtain information.



Figure 1. Graph of the Lowest Percentage of Poor Population in Indonesia in 2022. Source: (Badan Pusat Statistik, 2022)



Figure 2. Happiness Index Graph of All Provinces in Indonesia in 2021 Source: (Badan Pusat Statistik, 2021)











Figure 5. Spatial Join Analysis

PGR

Population growth refers to all species and is often used informally to denote the demographic value of the world population (Purwadi, Ramadhan, & Safitri, 2019). Meanwhile, PGR is a measure used to determine rate of population growth in a specific area over a certain period. The concept of PGR is calculated as a percentage and represents the comparison between the increase in population and the initial size over a given period. Population growth over a certain period is calculated as the ratio between the final and initial population in the form of a natural logarithm (ln) using the following formula:

$$PGR = (ln (Pt / Po)) * 100$$

Explanation:

PGR = Population Growth Rate Pt = Final Year Population Po = Early Year Population

3. Result and Discussion Population of East Jakarta

According to the Department of Population and Civil Registration (Dukcapil) (Dinas Kependudukan dan Pencatatan Sipil DKI Jakarta, 2023), the criteria are divided into two categories, namely Indonesian Citizens (WNI) and Foreign Nationals (WNA). This research focuses on examining population with the criterion of Indonesian Citizens (WNI). The data inventory from the Jakarta Population and Civil Registration Office over 5 years, from 2017 to 2022 reported the following results.

Based on Table 2, population of East Jakarta has continued to increase at an average rate of 2.29%. This increase does not seem significant but the uniformity of the distribution should be determined across all sub-districts.

The results of the analysis show that the three sub-districts with the largest populations are located in Cakung District, specifically in Jatinegara, Pulo Gebang, and Penggilingan subdistricts, as showed in Table 3.

Population Growth in East Jakarta

Population growth can be observed through calculations from previous years. The three sub-districts with the highest average population growth from 2017 to 2022 are as follows.

The sub-districts with the smallest population growth are Bali Mester and Kebon Manggis, with an average of 136 and 488 people per year from 2017 to 2022, respectively. This low population growth could be due to several factors, including limited housing availability, environmental conditions, infrastructure, public facilities, and natural disasters.

Table 2. P	opulation	in	East	Jakarta	between	2017	to	2022
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Years	Population
2017	2.946.594
2018	3.111.563
2019	3.182.004
2020	3.234.003
2021	3.264.699
2022	3.298.225

Source : (Dinas Kependudukan dan Pencatatan Sipil DKI Jakarta, 2018, 2019, 2020, 2021, 2022, 2023)



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Figure 6. Population of East Jakarta (a) 2017, (b) 2018, (c) 2019, (d) 2020, (e) 2021, (f) 2022

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Distri	icts	Sub Districts	Population
Caku	ng	Jatinegara	107.899
Caku	ng	Pulo Gebang	127.670
Caku	ng	Penggilingan	132.835

Table 5. Sub-districts with the Largest ropulation in 202	Table 3.	Sub-districts	with the	Largest F	opulation	in	202
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Source: (Dinas Kependudukan dan Pencatatan Sipil DKI Jakarta, 2022)

Table 4. Average	Population	Growth	Every	Sub-	district	2017	-2022

Districts	Sub Districts	Population Growth		
Duren Sawit	Pondok Kelapa	13.853		
Cakung	Pulo Gebang	22.034		
Cakung	Penggilingan	23.147		
Source: Analysis, 2024				

Based on the area, Bali Mester and Kebon Manggis subdistricts have a land area of 0,67 Km² and 0,79 Km², making the availability of residential land quite limited for new housing developments. These areas are primarily commercial and office zones, while Kebon Manggis also contains a military area.

PGR in East Jakarta

The PGR shows the speed or rate at which population in East Jakarta increased from 2017 to 2022. The highest PGR were in the Pondok Ranggon and Setu sub-districts. From 2017 to 2022, high PGR in East Jakarta was concentrated in the northwest area, bordering Central and North Jakarta. The sub-district with the lowest average was Bali Mester, which had the fewest residential buildings of 2.012.

Spatial analysis shows a correlation between PGR and the availability of residential buildings with a correlation value of 0,4. This correlation value is not very significant because some sub-districts experience relatively low PGR due to the availability of residential buildings and other spatial factors. For some sub-districts, the fewer residential buildings available decreases the PGR.

There is a discrepancy in the results regarding subdistricts with the highest PGR and population growth. This is because Penggilingan and Pulo Gebang have large populations, hence growth appears high when viewed in terms of absolute numbers. The calculation of PGR considers the absolute growth and the ratio of the previous population. Therefore, the sub-districts with the highest PGR are Pondok Ranggon and Setu.

Spatial Aspects of Population Growth in East Jakarta Health Facilities Aspect

This aspect of health facilities is divided into hospitals and PUSKESMAS (community health centers), which are among the most crucial public infrastructures for human life. The availability of hospitals near residential areas ensures that residents feel safer and more secure due to accessible



Figure 7. Population Growth in East Jakarta 2017-2022



Figure 8. PGR in East Jakarta 2018-2021

healthcare. According to spatial data inventory results, there are 52 public and private hospitals in East Jakarta. An analysis shows that some sub-districts lack hospitals, while others such as Kayu Putih, have up to five. As shown in Figure 9, the distribution of hospitals is uneven. Meanwhile, the distribution of PUSKESMAS is even across all sub-districts and meets the minimum health service standards with a coverage radius of 3.000 meters (3 km)(Badan Standarisasi Nasional, 2004).

Based on spatial statistical analysis, the correlation values are low, as shown in Table 5.

There is no correlation between the two aspects since health is not an attraction for population growth in East Jakarta. Based on the distribution, the health aspect of PUSKESMAS is evenly distributed in all sub-districts and is affordable. Furthermore, there is a complete range of services from inpatient care to good health clinics.

Trade Facilities Aspect

Trade is an economic activity in various facilities, both modern and traditional, such as malls and markets. The



Figure 9. Health Facilities Distribution in East Jakarta

Table 5. Correlation Values of Population Growth and Growth Rate with Health Facilities					
Correlation Value	Hospital	Public Health Center			
Average Population Growth	-0,03	-0,02			
Average PGR	-0,20	-0,05			
Source: Analysis, 2024					



Figure 10. Distribution of Trade Facilities in East Jakarta

availability of trade facilities can create job opportunities, attracting residents to live nearby. In East Jakarta, there are 16 malls and 35 markets. The sub-district with the highest number of markets is Palmeriam and the following is the distribution of trade facilities.

Spatial statistical analysis of population changes and growth rates concerning trade facilities shows a low correlation. This is also supported by (Arsandi, Ismiyati, & Hermawan, 2017), where population growth tends to decrease due to several factors, including increasing land prices near the city center. Table 6 presents the correlation values for trade facility variables.

Transportation Facilities Aspect

Transportation facilities are crucial for the mobility of East Jakarta residents. Spatial connectivity can increase spatial and social equality (United Nations Development Programme (UNDP), 2016). Jakarta has a comprehensive public transportation system, including TransJakarta, Jaklingko, KRL, LRT, and MRT, serving as the primary modes of transport for residents. This research only focuses on the modes of transportation most widely used by the general public, namely KRL and Transjakarta.

Transportation factors are among the most important for forming residential systems, considering the level of development and the diversity of accessibility and spatial connectivity (Krylov, 2020). East Jakarta has 219 bus stops and 18 train stations as reported in Figure 11. The sub-districts with the most bus stops are Klender and Rawamangun, each with 17 stops. The highest number of train stations are in Cawang and Halim Perdanakusuma, with 2 stations each. Spatial statistical analysis shows no correlation between the number of bus stops and train stations with population growth and PGR. Table 7 presents the correlation values for these parameters.

Table 6. Correlation Value of Population Growth and Rates of Trade F	acilities
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Correlation Value	Market	Mall			
Average Population Growth	0,06	0,09			
Average PGR	-0,18	-0,01			
Source: Analysis, 2024					



Figure 11. Distribution of Transportation Facilities in East Jakarta

	Table 7. Correlation	Value of Populat	ion Growth and Rate	es of Transportation	Facilities
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Correlation Value Halte KRL Station							
Average Population Growth-0,070,74							
Average PGR -0,34 -0,19							
Source: Analysis 2024							

Table 8. Correlation Value of Population Growth and Rates of Government Institution

Correlation Value	Government Institution	
Average Population Growth	0.23	
Average PGR	0.02	
Source: Analysis, 2024		

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Government Offices Aspect

Government offices play a role in providing direct and indirect services to the public. The presence of government offices also attracts job opportunities, which can lead to population growth.

The highest number of government offices is found in Pulo Gebang, with a total of 11, including the East Jakarta State Administrative Court Office, Pulo Gebang Village Head Office, East Jakarta Mayor's Office, and others (figure 12). Spatial statistical analysis shows a low correlation between population growth and PGR. Government offices are not a primary reason for people to live in the sub-districts. Table 8 presents the correlation values for these parameters.

Educational Facilities Aspect

According to regulations of the Ministry of Education and Culture (Pemerintah Indonesia, 2021), new admissions of students are subject to a zoning system. Therefore, students are accepted into schools based on residential zones. In Jakarta, public schools are still highly considered by both middle and upper-class families. This is supported by (Telaumbanua, Harsono, & Soegiarto, 2024) stating that educational facilities and quality are very important for improving housing quality and social cohesion. An increasing number of scholars have concentrated on the impact of urban amenities on the development of population urbanization (Liao & Wang, 2019). The quality of education, facilities, and subsidies are factors attracting parents to move closer to the selected schools.

In East Jakarta, there are 571 public schools ranging from kindergartens to universities, as shown in Figure 13. The subdistricts with the fewest public schools are Setu and Palmeriam, each with 1. Spatial statistical analysis shows a relatively high correlation between population growth and the distribution of schools. Table 9 presents the correlation values between school distribution and PGR.

Industrial Aspect

Industry plays an important role in creating job opportunities and increasing population through the processing of raw materials into finished goods or services. According to (Nur'aidawati & Nurmasari, 2020), there is a simultaneous effect of population and industrial growth in South Tangerang based on multiple regression analysis. Inventory data for industry in East Jakarta shows that Jatinegara and Rawa Tante have the highest number at 41 and 38, respectively. Spatial statistical analysis shows a low correlation between population growth and the distribution of industries. Meanwhile, growth rate shows no significant correlation with industrial distribution. Table 10 presents the correlation values between industry distribution and PGR.



Figure 12. Distribution of Government Office in East Jakarta

Table 9. Correlation Value of Population Growth and Rates of Educational Facilities

Correlation Value	Educational Facilities
Average Population Growth	0,61
Average PGR	0,28
Source: Analysis 2024	

Source: Analysis, 2024



Figure 13. Distribution of Educational Facilities in East Jakarta

Correlation Value	Industrial Facilities	
Average Population Growth	0,25	
Average PGR	-0,003	
Source: Analysis 2024		

Residential Building Aspect

The relationship between the number of residential buildings and population growth is strong. Therefore, the increase in population requires a corresponding rise in residential buildings to accommodate growth effectively. This strengthens the relationship between the number of residential buildings and population growth, enhancing the living environment and convenience for residents. Furthermore, residential building costs are higher in high urban amenities areas (Beracha, Gilbert, Kjorstad, & Womack, 2018)

Rapid population growth increases the demand for land such as space for activities. The inventory data shows that the highest number of residential buildings is in Cakung Timur and Pulo Gebang, with 19.020 and 18.836 parcels, respectively. Statistical analysis reports a correlation between population growth and the number of residential buildings as shown in Table 11.

The correlation analysis between PGR and spatial parameters shows that the highest R2 value is for the number of residential buildings, followed by educational facilities. There is a relationship between population growth and the development of building and transportation infrastructure (Arsandi et al., 2017). Additionally, an increase in population growth affects access to primary needs, such as housing (Wimardana, 2016). Increased population can lead to a higher demand for living space, stimulating growth and development (Putra, Diaudin, Fahrudin, & Suwanan, 2022). Among other spatial factors, educational facilities have the highest correlation after the number of buildings. Jakarta has the KJP (Jakarta Smart Card) program, which provides educational assistance to residents at various educational levels, attracting newcomers to enroll the children. The central government, through the Ministry of Education and Culture, enforces Permendikbud No. 1 of 2021, requiring 50% of new student admissions to come from zoning areas. This enables many parents to relocate the children to be close to the desired schools. Therefore, the number of educational facilities can be a significant factor in attracting population growth in East Jakarta.

4. Conclusion

In conclusion, East Jakarta is the most populous area in the Province. Penggilingan and Pulo Gebang sub-districts showed the highest growth with an average of 23.147 and 22.034 people per year from 2017 to 2022, respectively. The highest PGR was in Pondok Ranggon and Setu with rate of 0,22 and 0,21, respectively. Spatial patterns showed that growth and PGR were concentrated in the northwest and northern parts of East Jakarta, adjacent to Central and North Jakarta. Meanwhile, spatial aspects with high correlations were the number of residential buildings and public schools. A higher number of residential buildings correlates with increased



Figure 14. Distribution of Residential Land Parcels in East Jakarta (Source: Dinas Cipta Karya, Tata Ruang dan Pertanahan DKI Jakarta, 2023)

Table 11. Correlation Value of Population Growth and Rates of Settlements

Correlation Value	Educational Facilities
Average Population Growth	0,88
Average Population Growth Rate	0,44
Source: Analysis, 2024	

attraction, and the zoning rules for public school admissions led to an increased population since parents moved closer enabling children to attend public schools. Schools attracted population growth because there were binding regulations that state students must be within the zoning radius. The lowest correlation value between population growth and health facilities was due to the even distribution of PUSKESMAS across all sub-districts. Further research could also be conducted on the impact of PGR and growth on the carrying capacity of residential areas, particularly in regions with a high number of educational facilities.

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