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Spatial Analysis of the Distribution of Educational Facilities in Central Lampung Regency, Lampung Province, Indonesia

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Abstract

The rapid population growth in Central Lampung Regency has increased the demand for equitable access to educational facilities. This study aims to analyze the spatial distribution pattern of educational facilities to determine whether their placement is clustered, random, or dispersed. The analysis uses the Average Nearest Neighbor (ANN) method, a spatial analysis technique that measures the average distance between each facility and its nearest neighbor to assess spatial patterns. A total of 397 educational facilities, including junior high schools, senior high schools, and Islamic boarding schools, were analyzed using shapefile data obtained from the official geoportal of the Republic of Indonesia. The ANN results show an index value of 0.520875 with a z-score of -17.1969, indicating that educational facilities are clustered in specific regions. This clustering can lead to accessibility challenges for populations in underserved or rural areas. Therefore, it is recommended that the local government and the Central Lampung Education Office prioritize the development of new educational facilities in sparsely served districts to ensure more balanced spatial access to education services.

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INTRODUCTION

Equitable access to educational facilities is a global priority in achieving nclusiveness and equitable quality education (Arkorful et al., 2020), as outlined in the United Nations Sustainable Development Goal 4. Around the world, disparities in the spatial distribution of schools often reflect broader socioeconomic inequalities, especially in rural or rapidly urbanizing regions.

In Indonesia, these challenges are particularly prominent in provinces outside Java, where infrastructure development tends to lag behind population growth. Unequal access to education remains a persistent issue, with students in remote or less-developed areas frequently facing long travel distances to reach educational institutions. Spatial planning that considers both demographic trends and geographic realities is therefore essential for ensuring balanced educational development.

Central Lampung Regency in Lampung Province exemplifies this issue. As the most populous regency in the province, with over 1.5 million inhabitants spread across an area of 4,559.57 km^2 (BPS Provinsi Lampung, 2025), it is experiencing significant pressure on its public services, including education. However, the current distribution of educational facilities across districts remains uneven, raising questions about

whether spatial accessibility has been adequately considered in educational planning.

Previous studies have analyzed the spatial distribution of schools in various Indonesian regions using methods such as the Average Nearest Neighbor (ANN). These include studies in Agam Regency (Jaslan & Ramadhan, 2024), South Solok (Fidani & Prarikeslan, 2019), and Pontianak City (Muazir et al., 2022), all of which provided valuable insights into spatial clustering or dispersion patterns. However, few if any studies have applied this spatial analytical approach to Central Lampung, despite its strategic position and demographic significance. This creates a clear research gap in understanding how educational infrastructure is spatially distributed in one of the province's key regions.

What sets this study apart is its focused application of the ANN method to educational facilities in Central Lampung, using recent geospatial shapefile data to derive statistically robust insights on spatial patterns. By explicitly quantifying clustering or dispersion, the study provides empirical evidence to inform local planning decisions.

Therefore, this study aims to analyze the spatial distribution pattern of educational facilities in Central Lampung Regency using the Average Nearest Neighbor (ANN) method to determine whether the current pattern is clustered, random, or dispersed.

RESEARCH METHODS

This research was conducted in Central Lampung Regency, Lampung Province, which spans an area of 4,559.57 km^2 (BPS Provinsi Lampung, 2025). The study aims to analyze the spatial distribution pattern of educational facilities using spatial statistical methods to support planning and policy decisions in the education sector. The data used in this research consist of the geographical coordinates of educational facilities, specifically junior high schools, senior high schools, and Islamic boarding schools, both public and private. These data were obtained from the official Indonesian geospatial portal (https://tanahair.indonesia.go.id/portal-web/) in shapefile (.shp) format and downloaded on February 2, 2025.

One method of identifying spatial patterns is through spatial analysis (Munawaroh et al., 2020). The Average Nearest Neighbor (ANN) is a spatial method in geography used to determine the distribution pattern of settlements. ANN can explain the distribution of location points by calculating distance, the number of location points, and the area size (Ghodousi et al., 2020; Valgunadi et al., 2023).

The result of the ANN analysis is an index that ranges between 0 and 2.15. The formulation for ANN is as follows:

$$ANN\ (R) = \frac{\overline{D}_0}{\overline{D}_E}$$

where $\boldsymbol{\overline{D}_0}$ is the average distance between each feature and its nearest neighbor, and $\boldsymbol{\overline{D}_E}$ is the expected average distance in a random pattern.

$$\overline{D}_0 = \frac{\sum_{i=1}^{n} d_i}{n}$$

and,

$$\overline{D}_E = \frac{1}{2\sqrt{p}},$$

with $\boldsymbol{p}$ representing the number of all points per square kilometer, using the formula:

$$p = \frac{n}{|A|}$$

where $\boldsymbol{n}$ is the number of features and **A** is the area or total land size (Widayanti & Yulita, 2024).

The z-score statistic can be calculated using the following formula:

$$z = \frac{\bar{D}_0 - \bar{D}_E}{\sigma_{\bar{D}_E}}$$

where $\boldsymbol{\sigma_{\bar{D}_E}}$ is the standard error of the average nearest neighbor distance under Complete Spatial Randomness (CSR), with the following equation:

$$\sigma_{\bar{D}_E} = \frac{0{,}26136}{\sqrt{n\rho}}$$

If the index is less than 0, it is considered a clustered pattern, meaning the points are grouped. If the index is greater than 0, it is considered a dispersed pattern, meaning the points are spread out. If the index approaches 0, the pattern is classified as random (Thompson et al., 2022; Vidanapathirana et al., 2022; Zhang et al., 2020).

RESULTS AND DISCUSSION

Central Lampung Regency is the most populous area in Lampung Province, with a total population of 1,525,088 people (BPS Kabupaten Lampung Tengah, 2025). The distribution of residents across sub-districts is uneven, with Terbanggi Besar District hosting the largest population (133,434 people), while Anak Ratu Aji District has the smallest (21,120 people). The distribution of the population in each district can be seen in Figure 1.

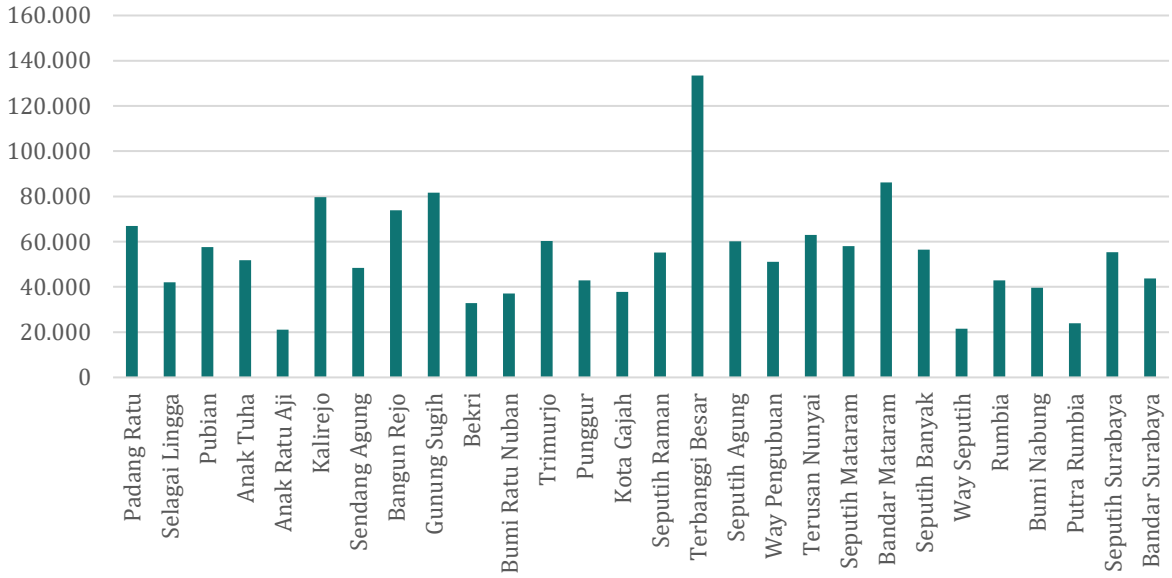

Figure 1. Population of Central Lampung Regency

This population size will affect the demand for educational facilities (Handayani & Wibowo, 2024). In theory, more populous areas should receive proportionally more infrastructure. This theory is in line with to Raharjo & Hayati (2022), a higher population will lead to a greater need for educational facilities. However, in practice, the spatial alignment between population density and educational facility distribution is often inconsistent.

Based on the data collected, the educational facilities in Central Lampung Regency total 397 units, consisting of junior high schools, senior high schools, and Islamic boarding schools. The distribution of these educational facilities can be seen in Figure 2.

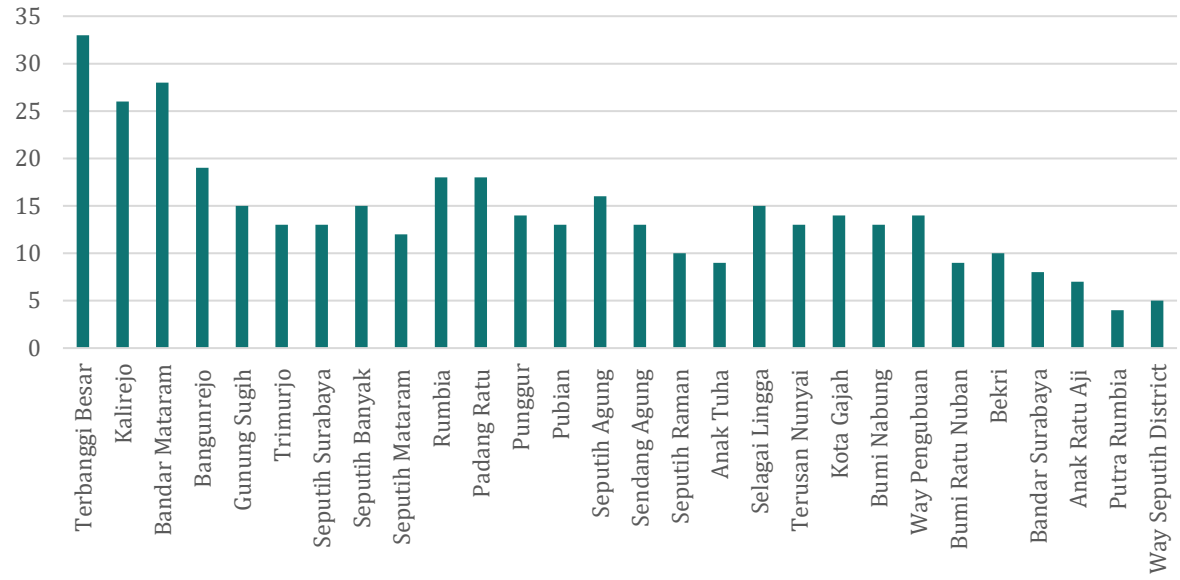

Figure 2. Number of Educational Facilities in Central Lampung Regency

From the figure 2, it is evident that the highest number of educational facilities is located in Terbanggi Besar District, while the lowest is in Putra Rumbia District. The map of educational facilities can be seen in Figure 3.

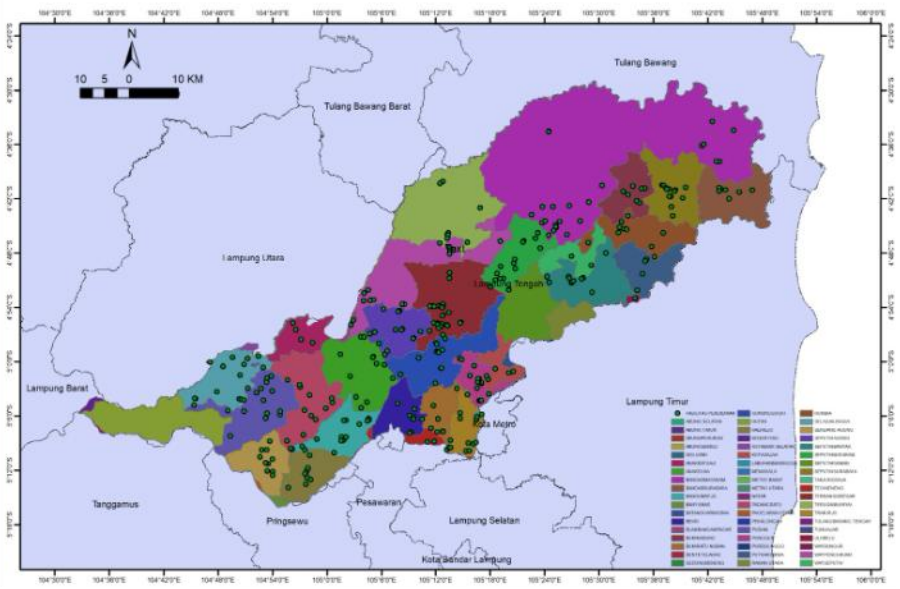

Figure 3. Distribution of Educational Facilities in Central Lampung Regency

From figure 3, it is evident that many of the educational facility points are located in the southern part of Central Lampung Regency. This indicates a mismatch between the population size and the number of educational facilities in Central Lampung Regency.

This result in long travel distances between the educational facility locations and residential areas. Therefore, this research is conducted to analyze the distribution pattern of educational facilities, which will provide information that can be used to determine suitable locations for establishing new educational facilities.

One method to identify such patterns is spatial analysis. Spatial analysis is an analysis related to the location or position of an object on the Earth's surface, such as

longitude and latitude. This location serves as the basis for calculations to determine the distance between objects, which allows us to understand the pattern of these objects (Clark & Evans, 1954; Riadhi et al., 2020). The Average Nearest Neighbor (ANN) analysis focuses on the size of the nearest neighbor parameter. The ANN ratio index is influenced by distance, the number of location points, and the area size (Brookman-Amissah et al., 2014) . The result of the ANN analysis will reveal three types of clustering patterns: clustered, random, and dispersed (Blazy & Łabuz, 2022).

The educational facility data that has been obtained is analyzed using the ANN method. This method determines the distribution pattern of points, and ANN is capable of explaining the distribution of location points by calculating the distance, the number of location points, and the area size. The result of the ANN analysis for educational facilities in Central Lampung Regency is shown in Figure 4. Figure 3.

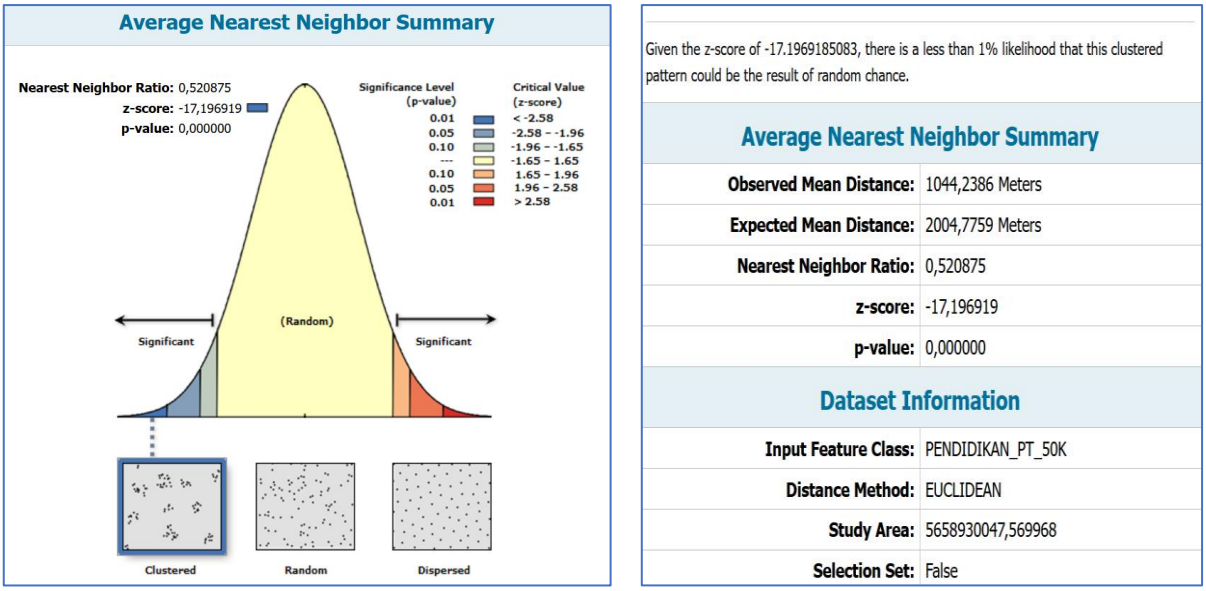

Figure 4. Results of Average Nearest Neighbor Analysis

The ANN analysis reveals a clustered distribution of educational facilities across Central Lampung Regency, with an ANN index of 0.520875 and a Z-score of -17.1969. This indicates statistically significant clustering, where schools are concentrated in specific areas rather than evenly dispersed.

Several factors contribute to this clustered pattern. Geographically, many settlements in Central Lampung are concentrated near roads and administrative centers, while the outlying areas are dominated by plantations or hilly terrain, which are less accessible and less densely populated. Socioeconomically, clustered school placement often follows zones with higher economic activity or urbanization. From a policy perspective, education infrastructure has historically been concentrated near urban growth areas and sub-district capitals, which receive greater political and budgetary attention.

Comparing these findings to similar studies highlights both similarities and distinctions. For instance, Muazir et al. (2022) also found that educational facilities in Pontianak City, especially higher education, tend to be concentrated in areas with high accessibility, which act as centers of city activity and main nodes of the road network. In contrast, Fidani & Prarikeslan (2019) reported the

distribution pattern of educational facilities which are relatively scattered (not centralized) in South Solok Regency, and topographic challenges are important factors influencing planning which tends to be decentralized to reach remote communities.

Similarly, Jaslan & Ramadhan (2024) in Agam Regency observed that while the location of schools in Agam Regency tends to follow population concentration, their distribution is also influenced by previously established regional spatial planning and infrastructure, reflecting the influence of historical planning and administrative policies. These comparisons suggest that regional context strongly shapes spatial patterns, and while Central Lampung shares urban-clustered tendencies with Pontianak, it lacks the decentralization strategy seen in South Solok.

These findings underscore that the distribution pattern of educational facilities in Central Lampung Regency is not solely determined by the need for equitable access to education, but is heavily influenced by geographical conditions, socioeconomic factors, and development policies that prioritize growth centers. The concentration of educational facilities in the southern and central regions reflects a planning tendency favoring areas that are more accessible and economically developed, while the northern and eastern regions remain underserved. In comparison to regions like South Solok, which has adopted a decentralization strategy to reach remote communities, Central Lampung still exhibits a centralized development pattern.

CONCLUSIONS AND SUGGESTIONS

The findings reveal a statistically significant clustered pattern, with educational facilities concentrated in certain districts. This pattern reflects an imbalance in spatial accessibility and may contribute to educational inequality, especially for communities in the northern and plantation-dominated regions.

From a policy perspective, local governments and the Department of Education should prioritize infrastructure expansion in underserved districts, where educational facility coverage is currently insufficient. In terms of methodology, while ANN provides useful insights into distribution patterns, it should be complemented by more nuanced approaches that consider accessibility, road networks, travel time, and facility quality.

Future research could integrate network analysis, service area mapping, or even spatial regression models to capture the multidimensional nature of educational accessibility. Moreover, similar studies should be extended to other regencies in Lampung Province or beyond, to support regional-level educational infrastructure planning based on spatial evidence.

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