Mapping of Pharmacies in Bandar Lampung Municipality: Nearest Neighbor Analysis and Overlay Approach

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ABSTRACT

Background: Pharmacies should improve people's quality of life by providing pharmaceutical services. In this case, the distribution and accessibility of pharmacy facilities play an essential role.

Objectives: This research aims to provide an overview of the distribution of pharmacies in Bandar Lampung municipality and analyze their distribution and accessibility.

Methods: Non-experimental research with descriptive methods was conducted using spatial analysis. All population pharmacies in Bandar Lampung were selected as a sample, and their location was pointed using the Garmin Global Positioning System (GPS). Arc-Gis software was used for data analysis. A nearest-neighbor analysis was conducted to get a distribution pattern, and the pharmacies' density was calculated to obtain accessibility data. The overlapping approach was carried out to determine factors related to pharmacy distribution patterns.

Results: Bandar Lampung municipality has 268 pharmacies spread across 20 districts. This research shows that the average density of pharmacies per 10,000 residents is 2.26. The highest pharmacy accessibility is in Sukarame, with a ratio of 4.07, and the lowest is in Bumi Waras, with a ratio of 0.62. The distribution of pharmacies is a clustered pattern (T value 0.55) and centralizes on collector roads, residential urban land use, and health facilities.

Conclusion: The distribution of pharmacies is odd. They are distributed in a cluster pattern.

Keywords: Global Positioning System; Nearest Neighbor Analysis; Pharmacy; Spatial Analysis

INTRODUCTION

Universal health coverage, particularly access to essential medicines and vaccines that are safe, effective, quality, and affordable for everyone, is a vital component of the Sustainable Development Goals (SDGs).[1,2] Pharmacies have a vital role in the health system, especially for pharmaceutical services that improve patients' quality of life.[3,4] However, the number of pharmacies is not proportional to the population. The pharmacies cluster into health service centers, shopping centers, transportation centers, and main roads.[5–8] The inequality of pharmacies will influence the SDGs goal.[1] Moreover, inequality creates a gap in the accessibility of pharmaceutical services.

Some studies showed a correlation between the distance of a pharmacy, the number of consumer visits, and the number of prescriptions.[8,9] The low accessibility of pharmacies causes additional expenses in the form of transportation costs for the community. Thus, the farther the pharmacy is, the smaller the number of visits and the number of prescriptions, and pharmacy's turnover will dwindle.[8,9] Furthermore, the uneven distribution of pharmacies influences business competition and the quality of pharmaceutical services.[10] In terms of service quality, additional competition pressures pharmacies to create innovation. On the other hand, greater competition interconnects with the violations of regulations existing.[10]

Pharmacy regulations in pharmacy distribution are needed to protect people in obtaining pharmaceutical services. Regulating the distribution of pharmacies is the authority of regional governments. Regional government must focus on public access and community needs. Those correlate with pharmacies' location[11,12]. Geographical location is key to excellent service and customer satisfaction.[7,13] Globally, several countries have implemented regulations regarding pharmacy distance, such as Portugal, England, Finland, and France. This regulation aimed at equalizing and improving health services.[6,14] This policy has been effect as well in various areas of Indonesia, such as Bogor and Bantul.[15,16]

Meanwhile, according to the Indonesian Food and Drug Authority report, the number of pharmacies in Lampung Province increases yearly. In 2018, this number reached 625 pharmacies; by 2020, it went up to 726 pharmacies or increased to around 16.16%.[17] With this trend, the number of pharmacies in Lampung province will continue to rise. The same situation occurs in Bandar Lampung, the number of pharmacies was 241 in 2018 and jumped to 253 pharmacies in 2020.[18,19] Unfortunately, no policy has been concerned about location requirements for pharmacy permits in Lampung Province, and lack of comprehensive data on pharmacy communities.

The density of pharmacies is a standard indicator in assessing pharmacy accessibility. A Geographic Information System (GIS) is computer-based information that can visualize pharmacy locations in the form of mapping, making it easier to analyze pharmacy distribution and public accessibility.[2,4,20] The nearest neighbor on the GIS can analyze the pattern of distribution. Several studies reported that the pharmacies tend to be concentrated on main roads, residential areas, and health/public services.[5-8] There are several supporting factors to consider when distributing pharmacies establishment. Overlay is a method for combining one map on top of another map.[21-23] Mapping analysis using an overlapping approach can explore supporting factors influencing the distribution pattern. Using spatial analysis with an overlapping approach can gather comprehensive factors in pharmacies distribution. Furthermore, this result is a reference for planning regulations in pharmacy permits.[24,25]

This research proposes an overview of the distribution of pharmacies in Bandar Lampung municipality and an analysis of public accessibility to pharmaceutical services. The description of pharmacy distribution can help regional governments make decisions regarding regulatory arrangements for granting new pharmacy permits.

METHODS
Study design
This study was non-experimental research with analytical descriptive methods using nearest neighbor analysis and overlay approach. The location of the research was in Bandar Lampung municipality and was conducted from July to December 2022.

Population and samples
The population consisted of active pharmacies in Bandar Lampung municipality. According to the Bandar Lampung health service report, there were 268 active pharmacies in August-September 2022. The samples determined by total sampling method. As a result of that, the entire population of existing pharmacies, 268 pharmacies, was a sample in this current study.

Study instruments
The pharmacy location was plotted to collect coordinates using the Garmin Global Positioning System (GPS) and analysis using Arc Gis software.

Collected Data
Bandar Lampung Health Service was the primary data source for pharmacies' names and locations. The Central Statistics Agency gathered the population of each district. A digital map representing Bandar Lampung Municipality was obtained from the Institut Teknologi Sumatera (ITERA) database.

Data Analysis
Accessibility calculated the ratio between the number of pharmacies and the population in each district. The distribution of pharmacies was carried out using the Nearest Neighbor Analysis. The nearest neighbor value

index (T) ranges from 0 to 2.15. Analysis of pharmacy distribution patterns using nearest-neighbor analysis produces three possible distribution patterns. First, the T value is 0 – 0.7, and then the distribution pattern is clustered. The second is the T value is 0.7 – 1.4, and then the distribution pattern is random (random pattern). Lastly, the T value is 1.4 – 2.15, and then the distribution pattern is uniform (dispersed pattern). Further analysis is done through an overlapping approach, with the map overlayed on maps of population per district, road class, land use, and community health center facilities.

RESULTS AND DISCUSSION

The Bandar Lampung Municipality covers an area of 197.22 km^2 and consists of 20 districts. It has a population of 1,184,949, with 50.93% male and 49.07% female. The population density is 6,008.26 people/Km^2. The highest population density is in Tanjung Karang Timur (21,563.57 people per km²), and the lowest is in Sukabumi (3,266.91 people per km²) (Table I).

The pharmacy density in Bandar Lampung is 2.26. This number means that every 10,000 residents in Bandar Lampung are served by 2 to 3 pharmacies. The International Pharmaceutical Federation (FIP) represents parameters for pharmaceutical workforce density of 1:10,000 population. This parameter is the most common for the description and planning of pharmaceutical services because this accounts for population growth as a measure of need and demand.[26,27] This parameter is in line with Indonesian regulation, SNI No. 03-1733-1989. This regulation regulates one pharmacy to serve 10,000 residents.[28] Based on these parameters, the ratio of pharmacies in Bandar Lampung has met the existing need. However, accessibility varies across 20 districts, ranging from 0.62-4.07 pharmacies per 10,000 residents (Figure I).

The largest distribution pharmacies are concentrated in the Sukarame and Way Halim districts, with 28 pharmacies for each district. The most minor pharmacies are Teluk Betung Timur, Bumi Waras, and Langkapura, with four pharmacies in each district. Compared to the ratio of pharmacies per 10,000 residents, Bumi Waras has the lowest ratio (0.62), and the most significant ratio is in Sukarame (4.07). Some districts, such as Bumi waras, Langkapura, and Teluk Betung Timur, do not meet the ideal ratio of 1 pharmacy per 10,000 residents. This ratio indicates unequal access to pharmaceutical service in each district. This situation will influence the access to pharmaceutical and the rational use of medicines.[29]

Pharmacy density varies globally, being seven times higher in Europe than in Africa, and three times higher in high-income countries compared to low-income countries.[1,4,26,29,30] In Indonesia, West Java, East Java, and Central Java are the provinces with the most significant number of pharmacies[31], correlating with their larger populations.[32] Compared to other regions, Bandar Lampung's pharmacy density is lower than Yogyakarta's (2.52 per 10,000), and Malang's (9.90 per 10,000)[9,25] but higher than Banyumas (0.74 per 10,000), Pekalongan (0.77 per 10,000), and Kebumen (1.8 per 10,000).[7,9,24] Pharmacy density across regions generally correlates with the population size and economic indicators.[2,27,33] Regions with lower economic levels often have fewer pharmacies due to lower population income and fewer pharmaceutical workers.[2,26,27,34]

The Nearest Neighbor analysis shows a clustering pattern in pharmacy locations, with an index distribution value of 0.55 (Figure II.a). Pharmacies are closely spaced in some areas like Tanjung Karang Pusat, Tanjung Karang Timur, Tanjung Karang Barat, Way Halim, and Kedaton, while more spread out in districts like Teluk Betung Timur, Teluk Betung Barat, Teluk Betung Selatan, Sukabumi, and Rajabasa (figure II.b).

The study also reveals that geographic regions are the principal factor related to the density of pharmacies. Figure III.a illustrates that the number of pharmacies in each district sometimes does not align with population size. For instance, Sukarame and Way Halim, with medium populations (58,277 - 87,340 people), each have 28 pharmacies, while similarly populated Bumi Waras and Panjang have only 4 and 9 pharmacies, respectively. Kemiling, with the highest population (>87,340 people), has 22 pharmacies, while Enggal, with the lowest population (<58,277 people), has 6 pharmacies. Pharmacies tend to be located near collector roads, residential and urban land use areas, and close to health facilities. Specifically, 52.27% of pharmacies are near collector roads, 62.04% are in residential and urban areas, and 59,90% are in health facilities (Figures III.b, III.c, and III.d). The diverse topography of Bandar Lampung, ranging from coastal plains to hilly and mountainous areas, influences residential areas and, consequently, pharmacy distribution.

The pharmacy's location must be accessible to provide good services. They commonly will seek the nearest health services. The overlay analysis results in this study were in line with several previous studies.[7–9,24,25] Several factors, such as residential areas, allocation of health facilities, road networks, and topographic

Table I. Distribution of Population Density in Bandar Lampung Municipality in 2022

District	Population	Area (km²)	Population Density Per km²
Teluk Betung Barat	41761	11.02	3789.56
Teluk Betung Timur	54746	14.83	3691.57
Teluk Betung Selatan	43564	3.79	11494.46
Bumi Waras	64189	3.75	17117.07
Panjang	82120	15.75	5213.97
Tanjung Karang Timur	43774	2.03	21563.57
Kedamaian	58843	8.21	7167.23
Teluk Betung Utara	54419	4.33	12567.90
Tanjung Karang Pusat	56831	4.05	14032.34
Enggal	29113	3.49	8341.83
Tanjung Karang Barat	66616	14.99	4444.03
Kemiling	90007	24.24	3713.16
Langkapura	44275	6.12	7234.48
Kedaton	58264	4.79	12163.67
Rajabasa	58522	13.53	4325.35
Tanjung Seneng	63175	10.63	5943.08
Labuhan Ratu	53241	7.97	6680.17
Sukarame	68822	14.75	4665.90
Sukabumi	77099	23.6	3266.91
Way Halim	75568	5.35	14124.86
Bandar Lampung Municipality	1,184,949	197.22	6008.26

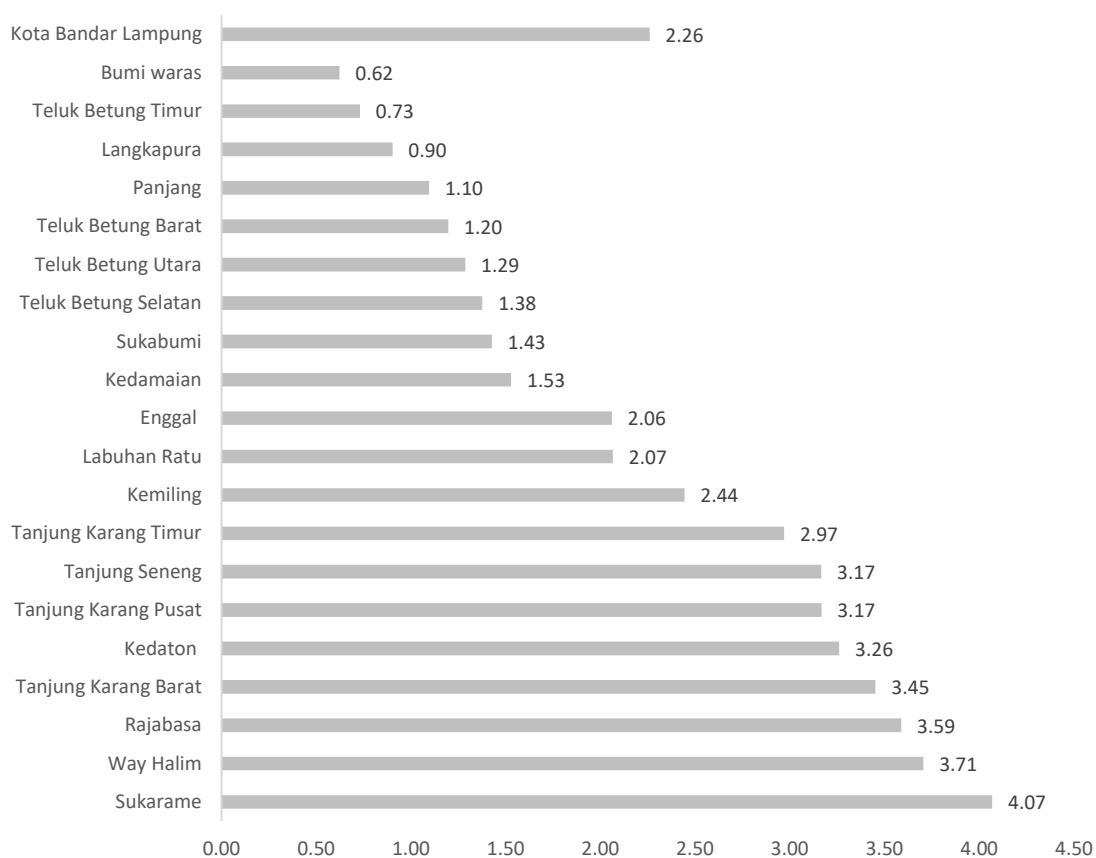*Source: Statistic Lampung Province accessed on 6 September 2022*

Figure I. The Density of Pharmacies Per 10,000 Population Per District in Bandar Lampung Municipality

conditions, lead to the uneven distribution of health services. The topographic conditions, such as relatively hilly and steep slopes, relate to the limited road network.[30] The distribution of pharmacies in the Banyumas Regency was dominant in urban areas and especially in districts around the capital of regency.[9] In Kebumen and Pekalongan, most pharmacies were in urban areas, located on the side of the arterial, collector, and local

(a)

(b)
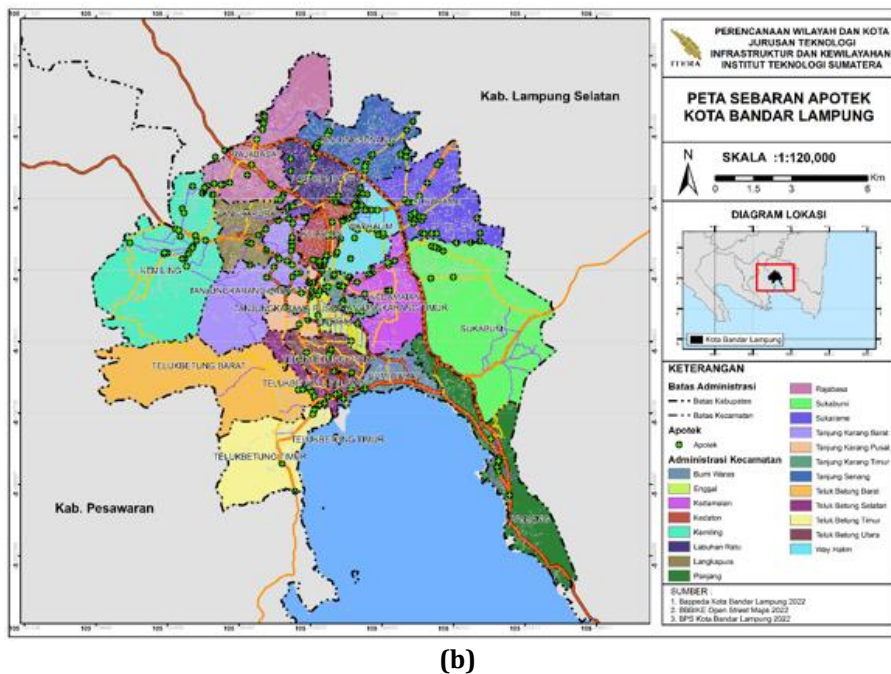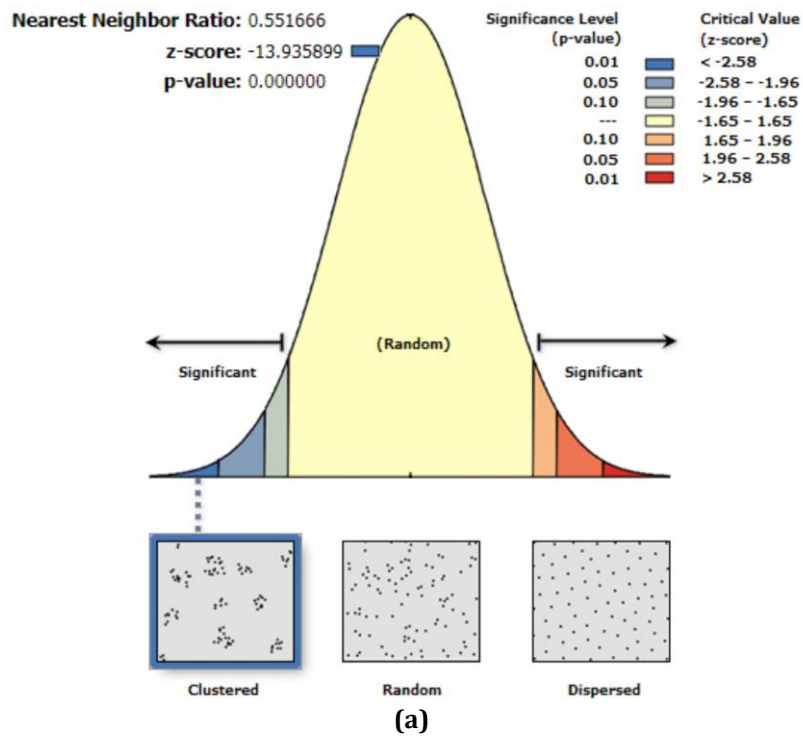
(a) The map of pharmacies distribution; (b) Analysis of Nearest Neighbor Spatial Distribution Patterns

Figure II. The Pharmacies Distribution in Bandar Lampung Municipality in 2022

highways, and tend to be near health service facilities and markets.[7,24] In Malang and Yogyakarta, pharmacies showed uniform results, but this distribution looks uneven and appears clustered in the border district areas.[8,9]
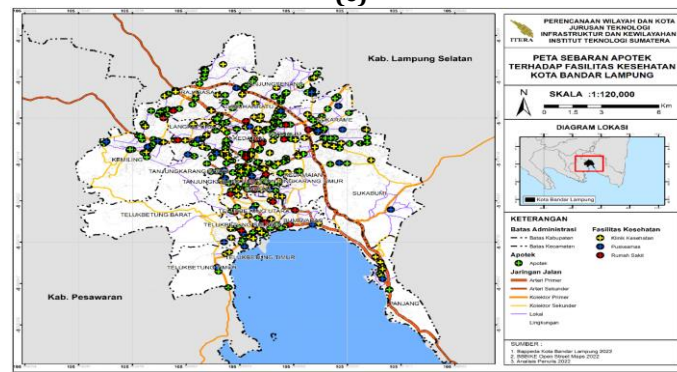
(a)

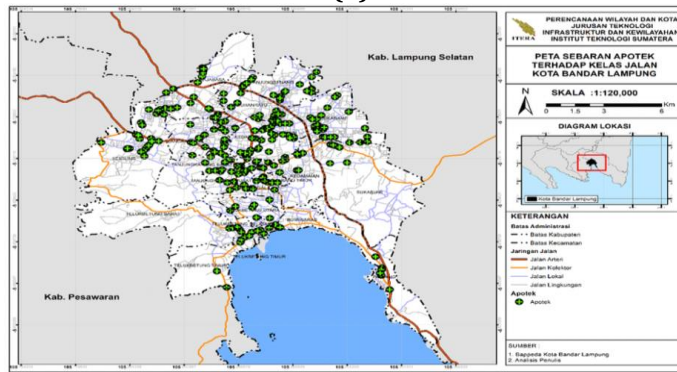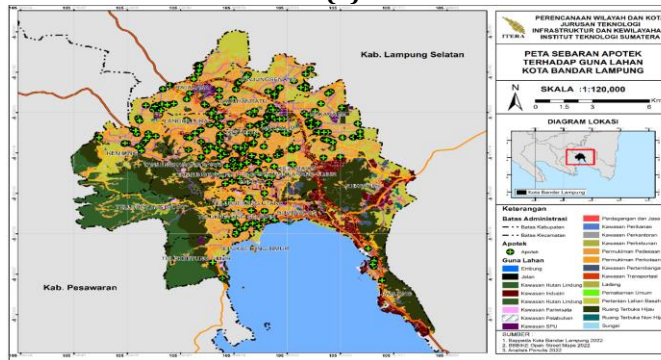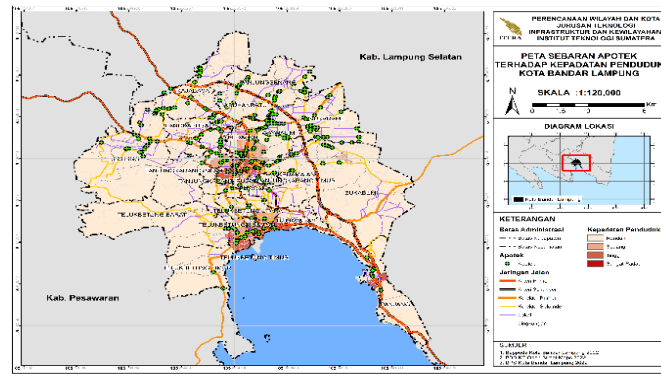**(b)**

(c)

(d)

Figure III. Map of Pharmacy Distribution in Bandar Lampung Regency in 2022

(a) Map of the distribution of pharmacies against the population; (b) Map of the distribution of pharmacies by road class; (c) Map of pharmacy distribution relative to land use; (d) Map of the distribution of pharmacies to health facilities

Ensuring equal access to health services, including pharmacies, is essential for reducing morbidity rates and ensuring proper medication use. The regional government of Bandar Lampung needs to improve public accessibility to pharmaceutical services. Regulations should consider pharmacy density to maintain business viability and service accessibility. Establishing pharmacies involves considering the pharmacist's role, which has expanded beyond managing supplies to providing comprehensive pharmaceutical care.[12]

Establishing a pharmacy is related to the pharmacist's location and role in pharmaceutical care.[35] The role of pharmacists has overgrown in recent years, with broader boundaries, not only managing pharmaceutical supplies but also emphasizing providing pharmaceutical care.[26,36] This research focuses on spatial data, highlighting the need for further studies on the role of pharmacists and other factors affecting pharmacy distribution inequality. Additionally, pharmaceutical services are provided not only by pharmacies but also by public and private health centers and hospitals, which were not considered in this study, representing another limitation.

CONCLUSION

The accessibility to pharmacy service is 2.52 per 10,000 residents, which means this is in accordance with existing regulation. However, the distribution of pharmacies is uneven. Pharmacies distribute following a cluster pattern and concentrate on collector roads, residential and urban land uses, and health facilities. The role of the Bandar Lampung government is key in regulating the distribution of pharmacies.

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STATEMENT OF ETHICS

This research obtained ethical permission from the Malahayati University Health Research Ethics Commission with No. 3005/EC/KEP-UNMAL/XII/2022

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