

Study of Hierarchy and Service Facility Centers of South Labuhanbatu Regency

Darwin Parlaungan Lubis, Sendi Permana*, M. Taufik Rahmadi, Mahara Sintong,
Benedictus P. Turnip

Geography Education Department, Universitas Negeri Medan

*sendipermana@unimed.ac.id

Abstract

The regional hierarchy, which includes the functions targeted at each region, is an important consideration in regional planning. The implementation of this function is related to existing service facilities in each sub-district in terms of the growth dynamics of South Labuhanbatu Regency. The distribution of the population in the sub-districts of South Labuhanbatu Regency has resulted in an increase in the quantity of infrastructure, facilities and service facilities. This research was conducted to determine the availability of service facilities in South Labuhanbatu District and to examine the hierarchy and distribution of service centers. This research uses a quantitative descriptive research method using the centrality index analysis method, gravity analysis, and nearest neighbor analysis. Based on the study findings, it is known that the availability of service facilities in Labuhanbatu Regency is quite adequate, especially considering that Kota Pinang and Torgamba Subdistricts which have first order status already have quite complete and adequate facilities. In addition to the findings of the regional hierarchy analysis based on analysis of the centrality and gravity indices, the findings of the nearest neighbor analysis also show Kota Pinang and Torgamba Districts in the hierarchy. Service centers in Labuhanbatu Selatan Regency are located in Kota Pinang Subdistrict, which is the capital of the subdistrict, and Torgamba Subdistrict, which has the most availability of facilities and is supported by a large population and strong interaction strength.

Keywords: Regional Hierarchy, Service Facility Center, Gravity, Centrality Index, Average Nearest Neighbor

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*Corresponding Author

1. Introduction

The spatial structure system plan for South Labuhanbatu Regency needs to be considered when deciding on a city service center system plan and when planning the growth of the service center system. To ensure equal distribution of urban facilities and

infrastructure services across the region, urban service centers have been divided. According to the service volume and facility area, the distribution of service centers is hierarchical. The functions that need to be directed to each city are included in the urban hierarchy, therefore regional planning really needs to pay attention to this.

The implementation of this task is closely related to public interest facilities in various corners of the city, given the dynamics that occur in the development of South Labuhanbatu Regency. The number of facilities required in an urban environment should be calculated based on the area of impact of the city or population anticipated using this facility. Apart from that, the increase in the quantity of infrastructure and service facilities can also be linked to the distribution of the population in several sub-districts in South Labuhanbatu Regency. To find out the availability of social and economic facilities, this study will look at the hierarchy and distribution of service centers in South Labuhanbatu Regency and the acceptability of these places.

2. Method

The research methodology used is a quantitative descriptive method. The analytical method used is the Scalogram method, the Gravity and Average Nearest Neighbor method, the data collection technique is in the form of a documentation study using secondary data, and the results of the research are regional hierarchy analysis and the distribution of service centers in South Labuhanbatu Regency.

A. Research Location

The research location is South Labuhanbatu District with a focus on sub-district areas namely Kota Pinang District, Torgamba District, Kampung Rakyat District, Sungai Kanan District, and Silangkitang District. The reason for choosing the location is because South Labuhan Batu Regency is a newly developed area, and it is suitable to be analyzed through theory, especially Central Place. Central Place theory is considered quite compatible for the region rural areas whose urban functions are still limited, especially in areas that is developing. Therefore, although this central place concept is a old theory, but the concept is still relevant to implement (Otun et al, 2014; and Daldjoeni, 2017). South Labuhanbatu Regency is located at 1°2600 – 2°1255 North Latitude and 99°4000 – 100°2600 East Longitude, with an altitude below 100 m above sea level. The total area of South Labuhanbatu Regency is around 4.35 of the area of North Sumatra Province. The area of South Labuhanbatu Regency is 311,600 Ha which consists of 5 Districts, 52 Villages and 2 Definitive Sub-Districts. South Labuhanbatu Regency is bordered by Labuhanbatu Regency to the north, to the south by Rokan Hilir Regency, Riau Province and North Padang Lawas Regency, to the east by Rokan Hilir Regency, Riau Province, and to the west by North Padang Lawas Regency.

The method explains the method information used in the research paper. Information on tools and materials used is also written in this section. The process of processing data in generating information is also explained in this section. The Novelty of this study includes infrequently used service buildings such as universities, auxiliary health centers, hotels and restaurants, as well as monasteries and temple religious facilities. and centrality index, like in Issabela, Rieneke, and Ricky's study in the publication Study of Tomohon City Service Centers Based on Hierarchy. Through settlement patterns in the research region, the nearest neighbor analysis approach can help analyze the service center area more precisely.

B. Data Source

The secondary data used is found in the publication of South Labuhanbatu Regency with the title South Labuhanbatu Regency in Figures for 2022 is used to calculate the Centrality Index analysis. The data used is the number of service facilities such as hospitals, schools, places of worship, shops, and recreation areas in each sub-district in South Labuhanbatu Regency.

Gravity analysis is calculated using secondary data from the Central Statistics Agency for South Labuhanbatu Regency in 2021, namely information on the area's population and the distance between the sub-district capitals., (Central Bureau of Statistics (BPS), 2021).

In the calculation of the nearest neighbor analysis, the data used is the data in the form of polygon-shaped settlement shapefiles which are converted into points in the arcgis application, the shapefile is then processed by the arcgis system automatically, while the residential shapefile data for South Labuhanbatu Regency residents are obtained from the Indonesian geospatial portal site.

C. Data Analysis Technique

1) Centrality Index Analytic

The Centrality Index Approach expresses the number of functional units present and spread throughout Labuhanbatu Regency South is used to determine the type facilities, the number of people served, and facility size.

The Centrality Value formula is:

$$C = t/T \quad (1)$$

Description:

C = weight of the functional attribute of a facility

t = total centrality value of 100

T = total number of attributes in the system

After the weight of each facility is obtained, the Centrality Index for each subdistrict is then calculated using the formula:

$$C = F \times Cf \quad (2)$$

Description:

F = number of each facility in each district

Cf = weight per facility

After the centrality index value is obtained, the next step is to determine the order/hierarchy and range/range using the following formula;

The formula to search Orde is:

$$k = 1 + 3,3 \log n \quad (3)$$

Description:

k = orde

n = sub-district total

The formula to search Range is:

$$t = (A - B)/k \quad (4)$$

Description:

t = range

A = highest centrality value

B = lowest centrality value

k = total orde

2) Gravity Analysis

Analysis gravity touch on the size and distance between two places, namely the center of regional growth and the surrounding area, to how far an area that is a growth center influences and interacts with the surrounding area (Daldjoeni, 2010). Carrothers Gravity Formula is:

$$i = P1 \times P2/J \quad (5)$$

Description:

i = magnitude of interaction between city/region i and j.

P1 = total population of city/region i (thousands of people).

P2 = total population of city/region j (thousands of people).

J = distance between regions i and j calculated from the distance between sub-district capitals (km)

3) Nearest Neighbor Analysis

The closest neighbor study or average by determining the magnitude of the nearest neighbor parameter or (T), nearest neighbor analysis is a technique used to study settlement distribution patterns determined by nearest neighbor analysis. The calculated values are compared using the continuous (parallel series) values of the nearest neighbor (T) parameters to create each pattern. As a result, it can be determined whether the pattern formed is a clustered pattern, a random pattern, or a uniform pattern. The variations in the pattern of distribution of settlements are:

- a) If the distance between two locations is short and more concentrated in a particular area, then the distribution pattern is said to be clustered with an index value $T < 0.7$
- b) If the distance between two locations is irregular and has an index value of $0.7 < T < 1.4$, then the distribution pattern is considered random
- c) If the average distance between two locations is almost or the same, with an index value close to one, then the distribution pattern is considered uniform (regular) with a value of $1.4 \leq T \leq 2.15$.

Settlement distribution data that has been digitized and transformed into settlement distribution points is needed to analyze settlement patterns in detail automatic.

3. Result and Discussion

A. Regional Hierarchy Based on Centrality Index Analysis

The Centrality Index analysis calculates the number of service facility units, so the estimate used is that the region that has the most service facility units is the region with the highest order and is designated as a service center, (Apriana & Rudiarto, 2020).

Stages Marshall centralities include:

1. Sub-districts in South Labuhanbatu Regency are classified ascending based on the

number and variety of facilities available there,

2. Based on which sub-district has certain facilities, the facilities are arranged in stages,
3. The frequency of each facility is used to determine the sequence of facilities,
4. The sub-district hierarchy are sorted based on the number of facilities owned by each subdistrict

Near centrality index analysis the same as the scalogram analysis, the difference in this calculation is that the analysis of the centrality index uses the analyzed data to determine the weight value for each facility so that the weight value for each facility in each sub-district is obtained. To obtain the value of the centrality index for service facilities in each sub-district, the weight calculation for each service facility is first performed using the following formula.

$$C = t/T \quad (6)$$

Information:

C = weight of the functional attribute of a facility

t = total centrality value of 100

T = total number of attributes in the system

After the weights of attributes for each facility are obtained, then a calculation is performed on the number of each service facility frequencies for each sub-district (F) multiplied by the service facility attribute weight (Cf) which can be seen in the following table.

Table 1. Educational Facilities Centrality Index Value

Sub-District	Education							
	Early Childhood education programs	Kindergarten	Elementary School	Junior High School	Senior High School	Vocational School	College	Training Institute
	0,7 F x C	0,8 F x C	0,4 F x C	1,02 F x C	2,1 F x C	4,3 F x C	50 F x C	1,4 F x C
Sungai Kanan	23,8	14,4	14,4	18	21	8,6	0	19,6
Torgamba	23,1	29,6	28,8	41	35,7	43	50	2,8
Kotapinang	18,2	17,6	15,2	13	12,6	12,9	50	12,6
Silangkitang	14,7	6,4	7,6	11	12,6	17,2	0	18,2
Kampung Rakyat	22,4	27,2	40	15	16,8	17,2	0	47,6

Table 2. Health Facility Centrality Index Value

Sub-District	Health Facility Centrality								
	Hospital	Drugstore	Clinic	Medicine Hall	Maternity Hospital	Integrated Healthcare Center	Public Health Center	Auxiliary Health Center	Polyclinic
	25 F x C	3,1 F x C	2 F x C	1,3 F x C	0 F x C	0,3 F x C	10 F x C	2,9 F x C	1,9 F x C
Sungai Kanan	0	18,6	10	39	0	20,1	20	20,3	11,4
Torgamba	25	24,8	22	14,3	0	33,9	40	31,9	38
Kotapinang	75	34,1	46	13	0	15,3	10	11,6	34,2
Silangkitang	0	0	12	10,4	0	9,9	10	11,6	0
Kampung Rakyat	0	21,7	16	23,4	0	18,3	20	23,2	17,1

Table 3. Centrality Index Value of Entertainment Facilities and Neccessity

Sub-District	Entertainment and Neccessity			
	Hotel	Lodging	Restaurant	Market
	16,7 F x C	25 F x C	1,6 F x C	0,2 F x C
Sungai Kanan	0	50	3,2	36,4
Torgamba	34	0	57,6	33,4
Kotapinang	51	50	28,8	13,4
Silangkitang	0	0	12,8	15
Kampung Rakyat	17	0	0	19,2

Table 4. Religious Facilities Centrality Index Value

Sub-District	Religious				
	Mosque	Church	Temple	Monastery	Pagoda
	0,5 F x C	0 F x C	33,3 F x C	0 F x C	0 F x C
Sungai Kanan	2	0	0	0	0
Torgamba	57,5	0	33	0	0
Kotapinang	13	0	66	0	0
Silangkitang	1	0	0	0	0
Kampung Rakyat	18	0	0	0	0

Table 5. Total Value of Centrality Index of Service Facilities in Each Sub-District

Subdistrict	Total Value of Centrality
Sungai Kanan	350,8
Torgamba	699,4
Kotapinang	613,5
Silangkitang	170,4
Kampung Rakyat	380,1

After the centrality index value of service facilities for each sub-district is obtained, to determine the order of the region, it is done by first finding the number of classes from each district with the following formula:

$$k = 1 + 3,3 \log n$$

$$k = 1 + 3,3 \log 5$$

$$k = 1 + 3,3 (0,7)$$

$$k = 1 + 2,31 \quad k = 3,31 \text{ rounded up to } 3$$

After the number of classes is obtained, the next step is to find class intervals using the following formula:

$$t = (A-B)/k$$

$$t = (699 - 170)/3$$

$$t = 519/3$$

$$t = 173$$

Description:

A = highest centrality value

B = lowest centrality value

k = orde

The highest and lowest total centrality values in the above computation can be found in table 5. The highest total centrality values are in Torgamba District with a total value of 699.4 and the lowest total centrality values are in Silangkitang District with a total value of 170.4. Region hierarchical order by result Marshall centrality index analysis can be seen in the following table:

Table 6. Range Hierarchy Region of Centrality Index Analysis

Range	173
Orde 1	170 - 346
Orde 2	347 - 522
Orde 3	523 - 689

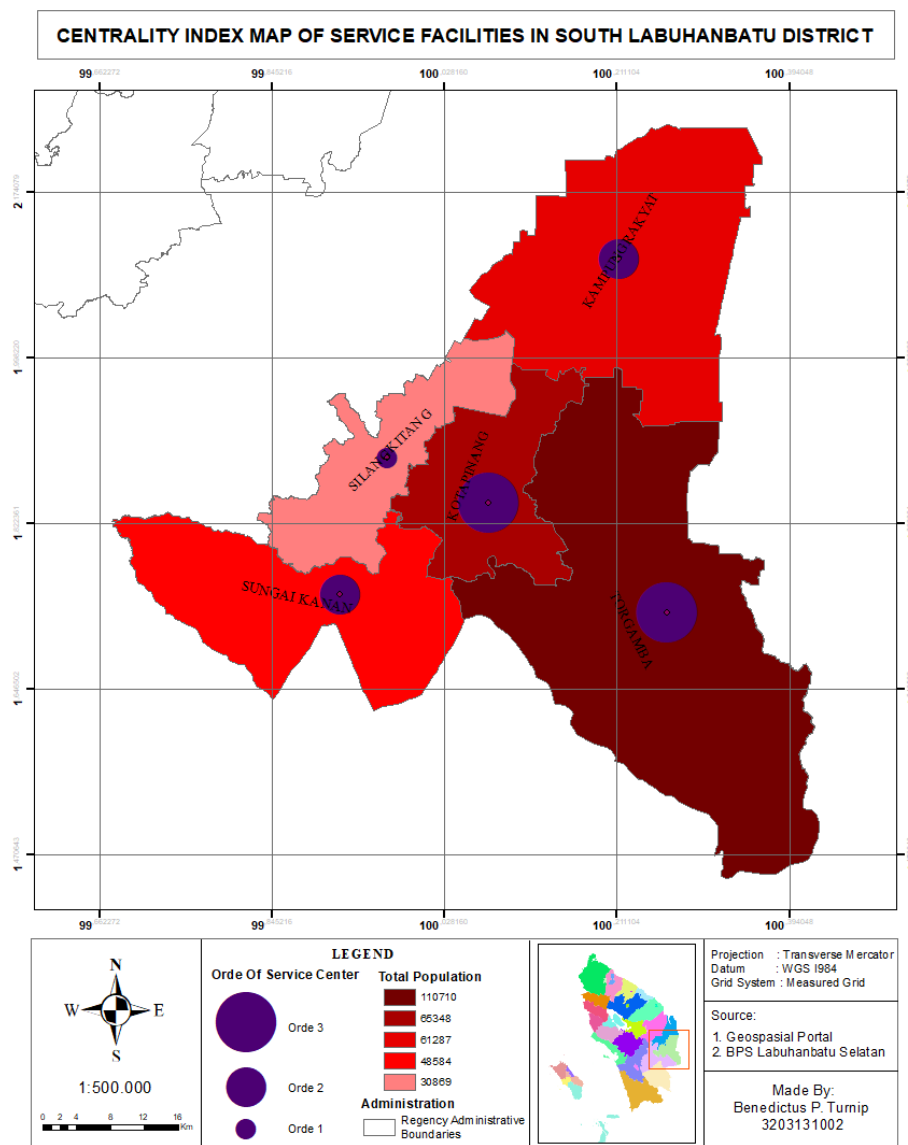


Figure 1. Hierarchical Map of Subdistrict Areas in South Labuhanbatu Regency Centralit Index Analysis

According to Figure 1. It can be seen that Kota Pinang and Torgamba have orde 3, Sungai Kanan and Kampung Rakyat have orde 2, and Silangkitang has orde 1. The results of the centrality analysis calculations are higher the order, the higher the centrality value, the higher the centrality value indicates the higher the order. There are also numerous facility kinds and the total number of inhabitants that can be served.

B. Region Hierarchy Based on Gravity Analysis

Gravity analysis is used to calculate the strength of interaction between regions. This analysis is used to measure the strength of the linkages between the main activity centers and regional development centers and determine the strength of the domicile of each center of economic activity, production and distribution in the service network system, distribution, transportation, and determine the service network system. The

greater the gravity value indicates that the closer the relationship between the two areas is, this shows that the attractiveness of an area has an influence on its potential, (Yusliana, 2020). The results of calculating the distance and the number of residents using the gravity formula for each sub-district in South Labuhanbatu Regency.

Table 7. Total Population of Each District of South Labuhanbatu Regency

No	Subdistrict	Total Population(life)
1	Kota Pinang	65.348
2	Silangkitang	30.869
3	Sungai Kanan	61.287
4	Kampung Rakyat	48.584
5	Torgamba	110.710

Table 8. Distance Between Subdistrict Capitals in South Labuhanbatu Regency

Distance Between Subistrict Capitals	Kota Pinang	Silangkitang	Langga Panyung	Tanjung Medan	Aek Batu
Kota Pinang	0	50	31	26	24
Silangkitang	50	0	59	56	55
Langga Payung	31	59	0	40	39
Tanjung Medan	26	56	40	0	35
Aek Batu	24	55	39	35	0

Tabel 9. Calculation Results of the Strength of Inter-District Interaction in South Labuhanbatu Regency Based on Gravity Analysis

No	Subdistrict	Total Population	Interaction Power
1	Kota Pinang	65.348	22.765.116,22

2	Torgamba	110.710	22.595.337,11
3	KampungRakyat	61.287	13.927.628,89
4	SungaiKanan	48.584	9.701.529,95
5	Silangkitang	30.869	2.970.755,53

Based on the results of the analysis, it was found that the areas with the highest interaction strength were Kota Pinang and Torgamba Subdistricts, followed by Kampung Rakyat subdistricts with moderate interaction strength, and Sungai Kanan and Silangkitang Subdistricts with low interaction strength, if they were in the order of Kota Pinang and Torgamba Subdistricts of order 1, Kampung Subdistrict The people are of the 2nd order, and the Districts of Sungai Kanan and Silangkitang are of the 3rd orde.

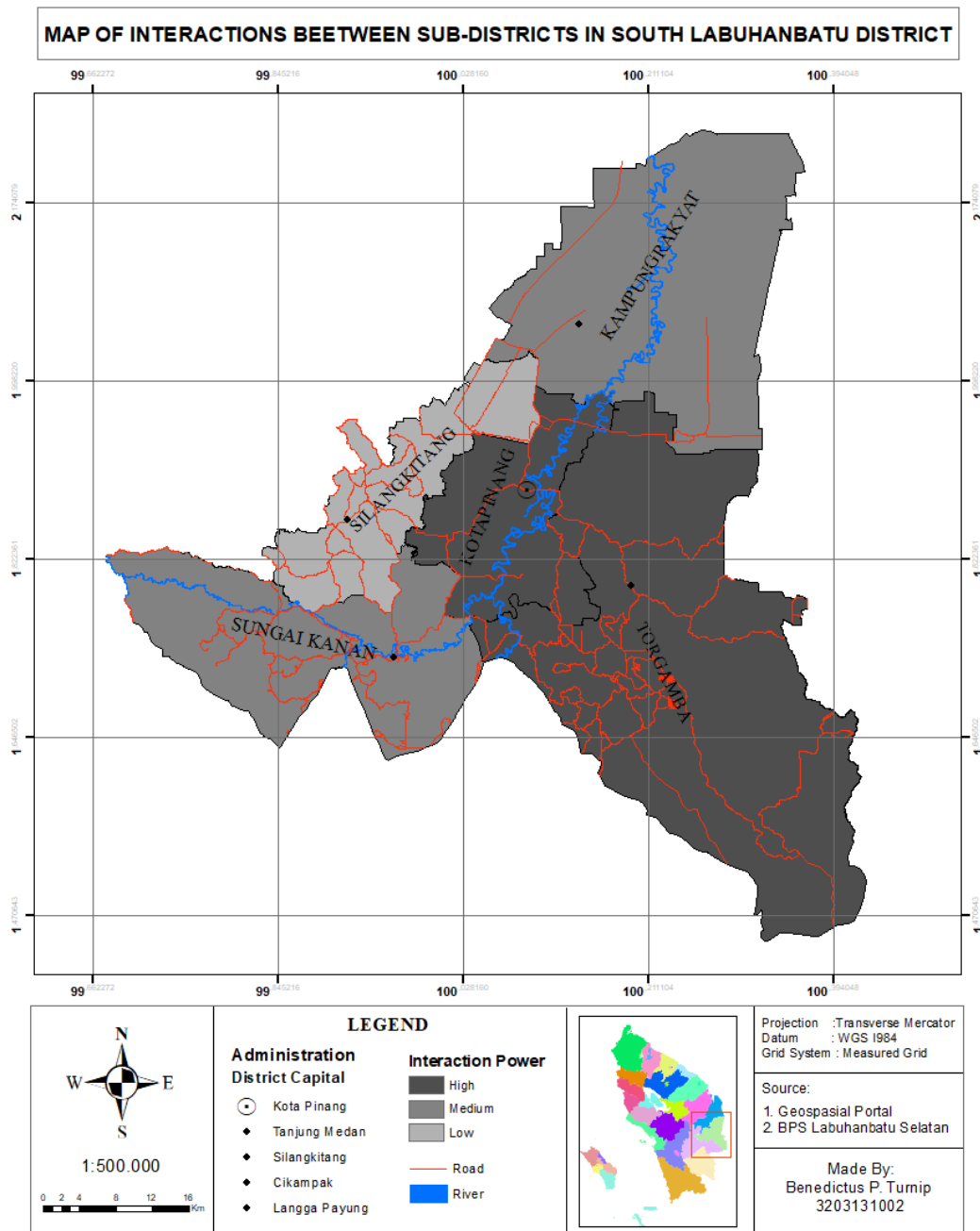


Figure 2. Hierarchical Map of the Gravity Analysis Area of South Labuhanbaru Regency.

According to Figure 2, the darker the color gradation, the stronger the interaction value of an area with other areas. The areas with the highest interaction strength are Kota Pinang and Torgamba sub-districts, followed by Kampung Rakyat sub-district with medium interaction strength, and Sungai Kanan and Silangkitang sub-districts with low interaction strength. If the Kota Pinang and Torgamba subdistricts are in order one, the Kampung Rakyat subdistrict is in order two, and the Sungai Kanan and Silangkitang subdistricts are in order three.

C. Region Hierarchy Based on Nearest Neighbor Analysis

The Nearest Neighbor Tool in the ArcGIS application converts settlement shapefiles into dots and is analyzed using the Average Nearest Neighbor tool in arcgis to find out the distribution patterns of settlements in South Labuhanbatu Regency. In order to determine the pattern of distribution of settlements based on a general benchmark, the T scale, nearest neighbor analysis is used. The ranges 0–0.7, 0.7–1.4, and 1.4–2.15 each show clustered, random, and uniform patterns. Next, the nearest neighbor ratio or NNR is obtained. By processing settlement data on the Average Nearest Neighbor Tools in ArGIS, we will automatically obtain settlement patterns in the form of curves and patterns in the Average Nearest Neighbor Summary.

Furthermore, after the NNA value is obtained, the settlement pattern of each subdistrict can be determined with the results of the analysis grouped based on the nearest neighbor parameter to describe the settlement pattern of sub-districts in South Labuhanbatu Regency. The pattern of distribution of settlements is based on a standard standard, namely the T scale. Where 0-0.7 is a clustered pattern, 0.7-1.4 is a random pattern, and 1.4-2.15 is a uniform pattern.

Table 10. Settlement Pattern Grouping for Each District in South Labuhanbatu Regency

No	Subdistrict	NNA	Settlement Pattern
1	Kota Pinang	0.656801	Clustered Pattern
2	Torgamba	0,657812	Clustered Pattern
3	Kampung rakyat	2,163118	Uniform Pattern
4	Silangkitang	0,600405	Clustered Pattern
5	Sungai Kanan	0,556393	Clustered Pattern

Based on the table above, it is found that Silangkitang District is the only subdistrict with a regular settlement pattern, the other sub-district is Kota District Pinang, Torgamba District, Silangkitang District, and Sungai Kanan District have a clustered settlement pattern.

The clustered settlement pattern indicates that there are factors driving the community to build adjacent settlements such as surrounding a service facility, the easier it is for the community to access these facilities. The regular settlement pattern indicates that there are no factors that encourage people to build clustered settlements like the service facilities earlier, from these findings it indicates that service facilities in the sub-district of the people's village are still few and not accessible to the community. If hierarchized, Kota Pinang District, Kampung Rakyat District, Torgamba District, and Sungai Kanan District have a higher hierarchy/order than Kampung Rakyat District

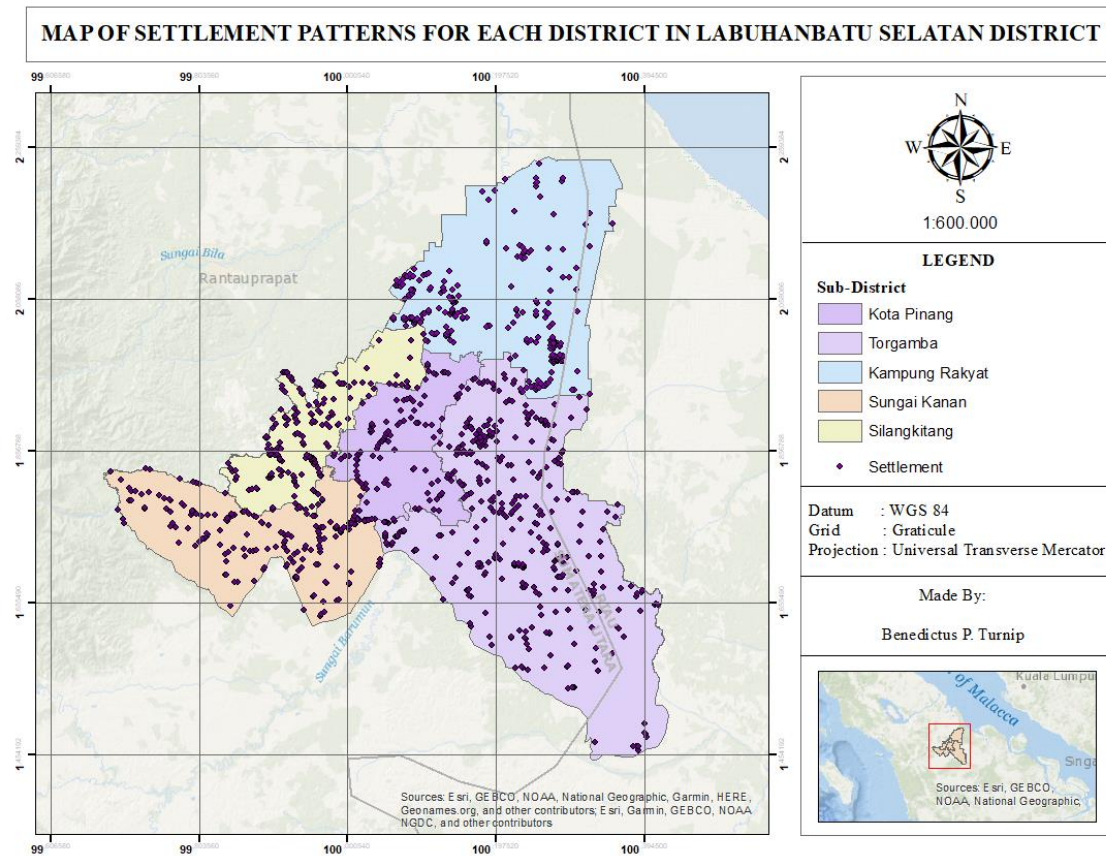


Figure 3. Map of Settlement Distribution Pattern of South Labuhanbatu Regency

Figure 3 depicts the pattern of settlement in each sub-district of South Labuhanbatu Regency. The Nearest Neighbor Analysis calculations in table 10 agree with the results on the map. The subdistricts of Kota Pinang, Torgamba, Silangkitang, and Sungai Kanan have clustered settlement patterns, whereas only Kampung Rakyat has a regular settlement pattern.

D. Analysis of South Labuhanbatu Regency Service Center

According to the findings of a regional hierarchy study using Centrality Index, Gravity and Average Nearest Neighbor studies, the first areas are Torgamba District and Pinang City. According to gravity analysis, the central business district or the capital is a market area or a location that attracts movement, and an area of interest or market is a place that is often the destination of movement (Tarigan, 2005). Based on the results of the Gravity analysis to determine the order 1, 2, or 3 areas based on the strength of the interaction of the towing region with other surrounding areas, where the results of the attraction or interaction strength are obtained from calculating the distance of the sub-district capital to other sub-district capitals, it can be easily seen that the area which has the strongest interaction strength is the area that is in the district center. The results of the gravity analysis in South Labuhanbatu Regency show that Kota Pinang District, which is in the middle of the administrative area of South Labuhanbatu Regency, has the highest interaction strength of the other sub-districts. another, however, Torgamba District, which

is also hierarchical 1, has a special case, where the interaction strength of the sub-district is influenced by the distance of the sub-district capital which is located closer to the sub-district border and the district capital, this is the weakness of the Gravity analysis in determining service facilities, because it does not link other factors such as population, distribution of settlements, and number of facilities and infrastructure leading to service facilities.

The Nearest Neighbor analysis shows that only the kampung people sub-district has a regular settlement pattern, while other sub-districts have a clustered settlement pattern, the results of the analysis show that service centers can be developed in the kampung people sub-district, because a regular settlement pattern indicates the absence of certain facilities which are the driving factors for settlements being built grouped, the construction of a settlement pattern will automatically attract the community and build settlements in the vicinity, so it is necessary to build service facilities in the people's village sub-district in terms of increased quantity and improved quality. The centrality index analysis has advantages in determining regional service centers because it is easier to find areas with service facilities that have high accessibility or function as connection centers between regions in the service network, (Wansaga et al., 2020). The South Labuhanbatu Regency service center is located in the district capital, namely Pinang City District, the district capital as the service center. Torgamba and Pinang Districts which have the highest centrality index, it is certain that the people of Pinang City and Torgamba can access service facilities in these sub-districts, as well as service facilities in Pinang and Torgamba Districts that can still serve people from other sub-districts. Kampung Rakyat sub-district and Sungai Kanan sub-district are ranked 2nd, but service facilities are less spread out and not yet centralized. Meanwhile, the Silikitang sub-district has an order of 3 which indicates that the facilities are still very few and not yet centralized, making it difficult for the people of the sub-district to access. , saclogram, and centrality index, Torgamba sub-district which is hierarchical/order 1 also needs to be considered, in fact Torgamba Sub-district is the most extensive sub-district among the other 4 sub-districts, which is 1,515.96 km², but followed by the largest population, namely 110,710 people. The number of available service facilities in Torgamba Subdistrict shows that the district government is creating a new regional growth center in Torgamba Subdistrict by building many service facilities in the subdistrict.

4. Conclusion

Based on the gravity analysis method, it was found that there were 2 areas with the highest interaction strength, namely Kota Pinang District with an interaction strength of 22,765,116.22, and Torgamba District with an interaction strength of 22,595,337.11, while the area with the lowest interaction strength was Sungai District. Kanan with an interaction strength of 9,701,529.95 and Silangkitang District, with an interaction strength of 2,970,755.53, this shows that Torgamba District has the potential to developing due to aspects of population size and distance between districts. Results centrality index analysis shows educational service facilities in the district South Labuhanbatu totaling 772 units, health facilities totaling 579 units, facilities entertainment and commerce totaling 844 units, and religious facilities totaling 186 units, Kota Pinang District as the center services with the availability of facilities of 357 units with interaction strength of 22,765,116.22 this is in accordance with the status of Kota Pinang District as the capital sub-district, but the Torgamba sub-district is the one have

service facilities available the most amounted to 709 units with strength interaction of 22,595,337.11 shows Torgamba District has great potential bigger to grow. Analysis The nearest neighbor also shows that People's Village District still lack of service facilities, that thing can be seen from the pattern of community settlements regular, so it needs to be done improvement in the construction of facilities on the district. Based on the results the research, the district government Labuhanbatu south can do policy by realizing service facility development avoid disparities between districts, and service facilities can serve all community in Labuhanbatu Regency South. One way that can be done is to make a layout plan District area space as a guideline facility construction and can help better decision making in terms of planning, development, and service network management whole. Also in implementation construction of district government facilities also need to review things that can interfere with development like dots weak that cannot be reached by society, Repair and improvement steps, analysis environmental problems and impacts, etc. thus expected development more equitable and optimal service facilities so as to meet the needs of all community in Labuhanbatu Regency South.

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