Geographica: Science and Education Journal
GSEJ
Website: http://usnsj.id/index.php/geographica
Email: geographica_gsej@usn.ac.id

ANALYSIS OF SCALOGRAM AND CENTRALITY IN LABUHAN BATU REGENCY: IMPLICATIONS FOR SERVICE FACILITY DISTRIBUTION

AUTHORS INFO

Muhammad Najmul Fahmi
Student at Geography Education
State University of Medan
muhammadnajmulfahmi@gmail.com

Meilinda Suriani Harefa
Lecturer at Geography Education Department
State University of Medan
meilindasuriani@unimed.ac.id

Darwin Parlaungan Lubis
Lecturer at Geography Education Department
State University of Medan
darwinparlaunganlubis@gmail.com

Sendi Permana
Lecturer at Geography Education Department
State University of Medan
sendipermana@unimed.ac.id

ARTICLE INFO

ISSN: 2716-4837
Vol. 7, No. 1, June 2025
URL: http://usnsj.id/index.php/geographica

Suggestion for the Citation and Bibliography
Citation in Text: Fahmi, M. S. et al. (2025)
Bibliography:
Fahmi, M. N., Harefa, M. S., Lubis, D. P., & Permana, S. (2025). Analysis of Scalogram and Centrality in Labuhan Batu Regency: Implications for Service Facility Distribution. *Geographica: Science & Education Journal,* 7(1, June), 1-12.

Abstract

Spatial analysis is important for understanding how service facilities are distributed in a region and identifying key locations within that area. This study examines the layout of service facilities and trends in centrality in Labuhan Batu Regency, employing the Scalogram Method in conjunction with Centrality Analysis. The Scalogram Method evaluates the variations and access levels of service facilities to classify sub-districts according to their hierarchical positions, while Centrality Analysis determines important areas that greatly influence spatial dynamics and the delivery of services. The findings show significant variations in the ranking of services and regional importance, with Rantau Utara recognized as the primary service center, attaining the top scores in both the scalogram and centrality evaluations. In addition, Bilah Hulu and Rantau Selatan demonstrate significant spatial impact, enhancing their functions as secondary service hubs. In comparison, areas such as Panai Hilir, Panai Hulu, and Pangkatan are rated lower in terms of service order and importance, highlighting the need for enhanced infrastructure and improved distribution of services. The classification of centrality into four distinct categories creates an organized method for comprehending spatial impact, highlighting the distinctions between primary service centers and less central areas. These results emphasize the importance of fair regional development, indicating the need for specific policies to increase access to services, strengthen connections between regions, and promote balanced infrastructure development. By combining findings from the Scalogram and Centrality Analysis, this study provides valuable viewpoints for regional planning, presenting essential

suggestions to improve service distribution and promote spatial equality in Labuhan Batu Regency.

Keywords: Spatial Hierarchy; Regional Connectivity; Scalogram; Centrality

A. Introduction

Space configuration and service facility placement are important factors that impact regional development. Spatial planning is a development approach that is expected to create safe, productive spaces (Rasudin et al., 2008). While Centrality Analysis is useful for finding nodes of activity that serve as regional service hubs, the Scalogram Method is frequently used to rank service facilities according to their availability and diversity. When combined, these methods offer a basis for understanding spatial disparities and creating plans for fair development. In Indonesia, the spatial structure is formed based on the arrangement of settlement centers and infrastructure network systems that function to support the socio-economic activities of the community with hierarchical functional relationships (Law No. 26/2007). In regional studies conducted throughout Indonesia, the application of both approaches has grown in importance. The analysis of spatial structure aims to identify regional or area development problems related to spatial dimensions (Shara et al., 2018).

The distribution of service facilities in South Labuhanbatu Regency was investigated by (Lubis et al., 2023), who came to the conclusion that Kota Pinang serves as the primary central hub because of its accessibility and infrastructure density. Similar geographical dynamics were discovered by (Tambubolon et al., 2022), who examined North Labuhanbatu's spatial structure and determined that centrality was a major factor in establishing the priorities for spatial development. The association between service availability and functional regional roles was strengthened when (Safira et al., 2023) used a geospatial approach in Surakarta and discovered that the sub-districts with the greatest diversity of service types also had the strongest spatial influence.

This relationship is further supported by research by (Asmara et al., 2023), which demonstrates how variations in Samarinda City's service facility distribution influence the strength of spatial linkages between urban and rural areas. In another setting, (Mafenska et al., 2023) evaluated the degree of centrality in Sleman Regency and discovered differences between sub-districts with high centrality and those that were formally designated as growth centers in the regional spatial plan. These discrepancies suggest that the alignment of planned urban constructions with actual spatial patterns needs to be regularly assessed.

Comprehending spatial disparity has also been essential to more general studies of development. When (Wahyudin et al., 2022) looked at areas close to Indonesia's future capital, they found that public services are still highly unequally concentrated, with Balikpapan continuing to dominate as an urban service core. Similar to this, it was shown by (Rahayu et al., 2024) that large-scale infrastructure projects, such building international airports, can cause changes in village growth centers, resulting in spatial dynamics that don't always match those found in planning documents.

Other researchers have looked at regional development through the lens of access and human growth. (Putra and Utami, 2021) studied healthcare availability in Cianjur using the two-step floating catchment area method, showing gaps in services between sub-districts. (Gabriela and Utomo, 2023) also pointed out how access to infrastructure affects poverty rates on Java Island, emphasizing the impact of spatial access on economic results. The level of regional connectivity can be seen from the extent to which the regional network is able to facilitate the movement of goods and people (Rahmadhani, 2022). In the context of transportation planning, connectivity refers to the ease, time, or cost of travel between different transportation routes or modal systems (Lahuddin, 2020). These results align with (Windhani et al., 2023), who found that human skills and local economic success are closely connected to patterns of spatial distribution and connectivity.

Moreover, research on urban areas like Mebidangro by (Taufiq et al., 2019) stressed the importance of central cities in driving economic activity and regional growth, supporting the need for centrality analysis to identify spatial hierarchies. Regional development is an important process in efforts to improve the quality of life of the community and accelerate the economic growth of a region. Development is a process, which sometimes development performance still needs to be evaluated even though the process is still in its early stages or has not shown the desired results (Rustiadi et al., 2018). All these findings indicate that regional development is significantly affected by both the amount and location of service facilities, making empirical

spatial analysis crucial for effective planning.

In this context, Labuhan Batu Regency, with its varied regional traits, needs a detailed spatial evaluation. The differences in service availability, infrastructure distribution, and spatial impact among sub-districts have important implications for balanced growth. This study aims to look at the ranking of service facilities and the pattern of centrality in Labuhan Batu Regency using Scalogram and Centrality Analysis. By combining spatial measurement techniques and geospatial mapping, the study hopes to provide insights for fairer service distribution, targeted policy-making, and sustainable regional planning.

B. Methodology

1. Research Design

This study applies a quantitative spatial analysis method to examine the organization of service facilities and the centrality patterns in Labuhan Batu Regency through the use of the Scalogram Method and Centrality Analysis. The Scalogram Method is used to classify service facilities based on how easy they are to reach and how available they are, whereas Centrality Analysis highlights important areas in relation to spatial connections and the spread of services. (Safira et al., 2023). These analytical methods offer significant insights aimed at enhancing infrastructure strategies and ensuring fair service distribution (Nugroho et al., 2023).

The research employs a descriptive-analytical approach, combining geospatial data with statistical analysis to uncover spatial patterns and their impact on regional development (Hutomo et al., 2023). Data collection is conducted through secondary sources, including government records, geographic data repositories, and earlier studies pertaining to regional planning (BPS Labuhan Batu, 2024).

2. Instruments

This study utilizes various important instruments to aid in the spatial analysis of Labuhan Batu Regency. The primary tool used is ArcGIS 10. 8, which serves as the main software for creating geospatial maps, analyzing spatial relationships, and assessing the placement of facilities. ArcGIS 10. 8 offers advanced spatial calculations, including raster processing, network analysis, and geographic visualization all essential for revealing spatial patterns within the region (Safira et al., 2023).

In conjunction with ArcGIS, the Scalogram Method is utilized to organize service facilities based on their ranking and accessibility levels. This method arranges sub-districts according to the availability of important services, which helps in recognizing disparities and identifying areas that may benefit from improvement (Nugroho et al., 2023). Centrality Analysis enhances this approach by evaluating the significance of each sub-district within the spatial structure, highlighting key service centers and their links to surrounding areas (Lubis et al., 2023).

To strengthen the conclusions of the research, statistical data from BPS Labuhan Batu (Central Statistics Agency) is included in the assessment. These data sets offer important demographic and economic information that helps to explain the patterns in spatial interaction and the accessibility of service facilities (BPS Labuhan Batu, 2024). By integrating geospatial techniques, mathematical modeling, and statistical information, this study takes a comprehensive approach to evaluate the spatial dynamics in Labuhan Batu Regency.

Table 1. *Population and Facilities*

District	Population Count	Kindergarten	Elementary School	Junior High School	Senior High School	Public Hospital	Community Health Center	Clinic	Integrated Health Post	Mosque	Restaurant	Post Office	Cooperative	Market
Bilah Hulu	66516	10	48	8	3	0	3	5	74	121	19	1	42	787
Pangkatan	39285	6	28	4	2	0	1	3	49	45	12	0	22	28
Bilah Barat	41521	3	32	7	2	0	2	2	52	81	12	1	23	16
Bilah Hilir	61751	7	30	6	3	0	2	8	77	65	20	1	45	163
Panai Hulu	39299	4	22	6	3	0	1	0	47	50	8	1	29	79
Panai Tengah	43027	6	38	7	2	0	1	6	69	41	6	1	42	160
Panai Hilir	44509	4	29	9	4	0	2	0	50	25	7	1	31	50
Rantau Selatan	77936	12	23	7	4	2	1	6	47	61	65	0	66	493
Rantau Utara	99982	21	36	14	9	4	2	8	88	73	55	1	135	2.761

(Source: BPS Labuhan Batu Regency)

3. Technique of Data Analysis

The analytical procedure in this study takes a structured method that begins with data preparation. In this phase, spatial data is processed, standardized, and organized for analysis

utilizing ArcGIS 10. 8 (Hafsyah et al., 2023). Once the data is properly organized, the Scalogram Method is utilized to classify service facilities based on their ranking, accessibility, and functional significance (Devi et al., 2023).

Following the scalogram classification, a Centrality Analysis is conducted to assess the connections and significance of each sub-district within the spatial framework. This method emphasizes important service centers and evaluates their roles in promoting regional development (Safira et al., 2023). The results from these analyses are subsequently transformed into geospatial maps, using ArcGIS 10. 8 to illustrate patterns of spatial interaction and hierarchical structures (Nugroho et al., 2023).

Ultimately, the results that have been analyzed are linked to policy issues, providing valuable insights that may influence regional development strategies. Through the examination of spatial dynamics, service access, and the relationships between rankings, this study offers important insights into improving infrastructure development, resource allocation, and spatial equity in Labuhan Batu Regency (BPS Labuhan Batu, 2024).

C. Findings and Discussion

1. Findings

a. Scalogram Analysis

The results from the Scalogram Analysis show significant variations in the ranking of service facilities among different sub-districts in Labuhan Batu Regency. The analysis shows that Rantau Utara has the highest score of 13, highlighting its role as the primary regional center, which features advanced infrastructure and improved access to public services. The presence of essential facilities such as educational institutions, healthcare services, government offices, and business centers strengthens its dominant position.

In contrast, various sub-districts, including Bilah Barat, Bilah Hilir, Bilah Hulu, Panai Tengah, and Rantau Selatan, received a score of 12, indicating a fairly high level of service availability. These areas offer essential public services; however, their ability to provide these services is lower than that of Rantau Utara. The findings indicate that while these sub-districts operate as secondary service centers, there is still a requirement for improvements in infrastructure and better access to services.

In contrast, Panai Hilir, Panai Hulu, and Pangkatan obtained the lowest hierarchy scores, with each receiving a score of 11. This result indicates that these sub-districts provide fewer services in comparison to others, which may limit their ability to enhance regional access and economic activities. The lower scores suggest that these areas may lack essential infrastructure such as hospitals, schools, and government buildings, which could hinder their ability to become significant service centers. Investing in these areas through targeted funding and policy measures may contribute to a more equitable distribution of services throughout the region.

Table 2. *Results of the scalogram analysis*

District	Population Count	Kindergarten	Elementary School	Junior High School	Senior High School	Public Hospital	Community Health Center	Clinic	Integrated Health Post	Mosque	Restaurant	Post Office	Cooperative	Market	Total	Percentage
Rantau Utara	99982	1	1	1	1	1	1	1	1	1	1	1	1	1	13	**12,86%**
Bilah Hulu	66516	1	1	1	1	0	1	1	1	1	1	1	1	1	12	**12,32%**
Bilah Barat	41521	1	1	1	1	0	1	1	1	1	1	1	1	1	12	**12,32%**
Bilah Hilir	61751	1	1	1	1	0	1	1	1	1	1	1	1	1	12	**11,64%**
Panai Tengah	43027	1	1	1	1	0	1	1	1	1	1	1	1	1	12	**11,64%**
Rantau Selatan	77936	1	1	1	1	1	1	1	1	1	1	0	1	1	12	**11,64%**
Pangkatan	39285	1	1	1	1	0	1	1	1	1	1	0	1	1	11	**11,38%**
Panai Hulu	39299	1	1	1	1	0	1	0	1	1	1	1	1	1	11	**11,38%**
Panai Hilir	44509	1	1	1	1	0	1	0	1	1	1	1	1	1	11	**11,38%**

(Secondary Data Analysis 2025)

Table 3. *Order Classification*

District	Centrality	Group
Rantau Utara	12,86%	1
Bilah Hulu	12,32%	2
Bilah Barat	12,32%	2
Bilah Hilir	11,64%	3
Panai Tengah	11,64%	3
Rantau Selatan	11,64%	3
Pangkatan	11,38%	4
Panai Hulu	11,38%	4
Panai Hilir	11,38%	4

(Secondary Data Analysis 2025)

Thus, the processed data results are integrated into a map using ArcGIS 10.8.

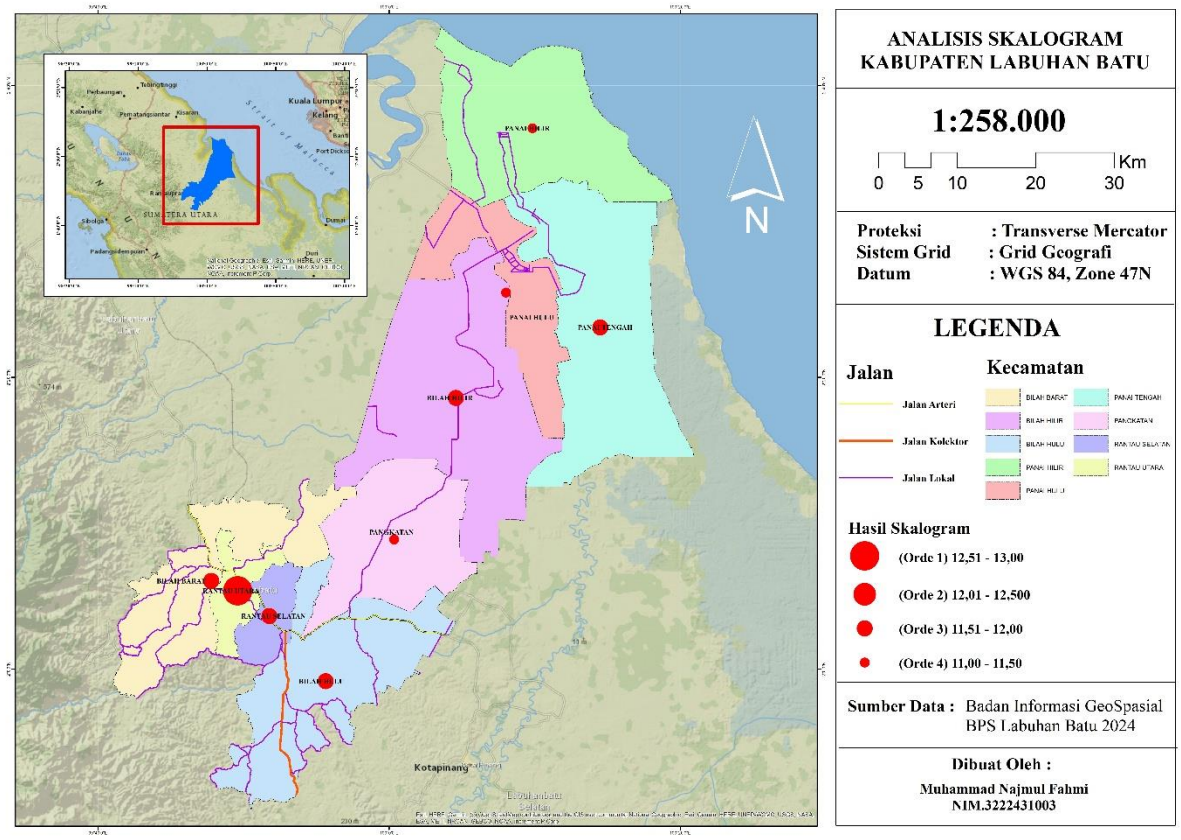

Figure 1. *Spatial Distribution of Scalogram in Labuhan Batu Regency*
(Source: Processed using ArcGIS 10.8 based on data from BPS Labuhan Batu, 2024)

Table 4. *Secondary Data Scalogram Analysis 2025 and RTRW Labuhan Batu Regency 2011-2031*

Analysis Results		Spatial Structure RTRW Document	
Hierarchy	**Region**	**Urban System**	**Region**
Order 1	Rantau Utara	PKW	Rantau Utara
Order 2	Bilah Hulu Bilah Barat	PKL	Aek Nabara (Kec.Bilah Hulu)
Order 3	Bilah Hilir Panai Tengah Rantau Selatan	PPK	Negeri Lama (Kec. Bilah Hilir) Pangkatan (Kec. Pangkatan Tj. Sarang Elang (Kec. Panai Hulu) Janji (Kec. Bilah Barat) LabuhanBilik (Kec. Panai Tengah)
Order 4	Pangkatan Panai Hulu Panai Hilir	PPL	Kec.Bilah Barat Kec.Bilah Hulu Kec.Pangkatan Kec.Bilah Hilir Kec.Panai Hulu Kec.Panai Tengah Kec.Panai Hilir

As an effort to verify and test the suitability of regional planning policies, the analysis conducted using the Scalogram method has been compared with the spatial structure listed in the

Labuhan Batu Regency RTRW document. The purpose of this comparison is to evaluate how much the empirical spatial results obtained from the study reflect the territorial structure that is normatively formed in the regional spatial planning document.

In Order 1, which is the highest level of hierarchy in the scalogram results, only one dominant sub-district was identified, namely Rantau Utara. This sub-district is also explicitly recognized in the RTRW document as the Regional Activity Center (PKW), indicating that there is harmony between the actual spatial data and the existing spatial plan. This confirms the dominant position of Rantau Utara as the main center of economic activity, government, and public services at the district level.

For Order 2, the analysis results show Bilah Hulu and Bilah Barat as areas with a fairly high service hierarchy. In the RTRW document, this area is grouped into the category of Local Activity Center (PKL), specifically referring to Aek Nabara in Bilah Hulu District. This means that the results of the scalogram strengthen the determination of Aek Nabara as the location of the local activity center, and show that Bilah Barat District has additional potential as a buffer area with a service structure that is almost equivalent to the local center.

Furthermore, in Order 3, it consists of areas that have a medium level of service, including Bilah Hilir, Panai Tengah, and Rantau Selatan. In the spatial structure of the RTRW, these areas are connected to the District Service Center (PPK), such as Negeri Lama in Bilah Hilir, as well as several other locations including Pangkatan, Tanjung Sarang Elang, and Janji in Bilah Barat, and Labuhan Bilik in Panai Tengah. This relationship shows that the spatial results are able to identify areas that are indeed planned as sub-district service centers, thus further strengthening the relevance of the scalogram method in mapping regional functions.

Meanwhile, in Order 4, which consists of areas with the lowest level of service such as Pangkatan, Panai Hulu, and Panai Hilir, the RTRW document classifies these areas in the Local Support Services (PPL) category. This covers most of the administrative areas: Bilah Barat, Bilah Hulu, Pangkatan, Bilah Hilir, Panai Hulu, Panai Tengah, and Panai Hilir Districts.
This conformity confirms that areas with low scalogram values are indeed designed in the RTRW for limited service functions or play a role as a supporter of the main activity center system.

This comparison shows a fairly high level of consistency between the results of spatial analysis and the spatial structure in the RTRW document, and shows that the scalogram method can be applied effectively to verify, evaluate, and even recommend adjustments to spatial planning based on actual conditions in the field.

b. Centrality Analysis

The Centrality Analysis provides additional insight into the variations in spatial importance among the sub-districts. Rantau Utara once more achieves the top position for centrality, earning a score of 126,997. 29, thereby confirming its role as the leading regional hub. This prominent centrality figure indicates that the sub-district plays a key role in connectivity, economic activities, and the distribution of services. The considerable impact of Rantau Utara is likely due to its favorable location, developed transportation networks, and large population, which establish it as an important center for regional interactions.

Following that, both Bilah Hulu and Rantau Selatan indicate centrality scores of 37,170. 29, classifying them as secondary hubs with significant effects on regional connectivity. These centrality ratings show that these regions act as middle points, linking farther sub-districts to important economic and service hubs. The presence of important infrastructures such as roads, trading centers, and government buildings greatly enhances their interconnection with the wider regional network.

At the lower end of centrality, Bilah Barat, Panai Hilir, and Pangkatan exhibit the lowest values, ranging from 1,693. 47 to 4,338. 71. These sub-districts show little impact within the broader spatial structure, suggesting lower accessibility and less effective integration of services. Their restricted connectivity may result from factors such as geographic isolation, underdeveloped transportation infrastructure, and a lower population density, which together reduce their importance in regional interactions.

Table 5. *Centrality Analysis Results*

District	Population Count	Kindergarten	Elementary School	Junior High School	Senior High School	Public Hospital	Community Health Center	Clinic	Integrated Health Post	Mosque	Restaurant	Post Office	Cooperative	Market	Centrality
Bilah Hulu	66516	7,30	137,28	5,44	0,96	0,00	0,45	1,90	409,22	680,02	38,76	0,07	182,70	35706,19	37170,29

Pangkatan	39285	4,38	80,08	2,72	0,64	0,00	0,15	1,14	270,97	252,90	24,48	0,00	95,70	1270,36	2003,52
Bilah Barat	41521	2,19	91,52	4,76	0,64	0,00	0,30	0,76	287,56	455,22	24,48	0,07	100,05	725,92	1693,47
Bilah Hilir	61751	5,11	85,80	4,08	0,96	0,00	0,30	3,04	425,81	365,30	40,80	0,07	195,75	7395,31	8522,33
Panai Hulu	39299	2,92	62,92	4,08	0,96	0,00	0,15	0,00	259,91	281,00	16,32	0,07	126,15	3584,23	4338,71
Panai Tengah	43027	4,38	108,68	4,76	0,64	0,00	0,15	2,28	381,57	230,42	12,24	0,07	182,70	7259,20	8187,09
Panai Hilir	44509	2,92	82,94	6,12	1,28	0,00	0,30	0,00	276,50	140,50	14,28	0,07	134,85	2268,50	2003,52
Rantau Selatan	77936	8,76	65,78	4,76	1,28	0,12	0,15	2,28	259,91	342,82	132,60	0,00	287,10	22367,41	37170,29
Rantau Utara	99982	15,33	102,96	9,52	2,88	0,24	0,30	3,04	486,64	410,26	112,20	0,07	587,25	125266,57	126997,26

(Secondary Data Analysis 2025)

The classification of four levels of centrality provides additional clarity to the understanding of spatial influence.

Table 6. *Classification of Centrality Analysis Group*

District	Centrality	Group
Rantau Utara	126997,26	1
Rantau Selatan	37170,29	2
Panai Hilir	37170,29	2
Panai Tengah	8522,33	2
Panai Hulu	8187,09	3
Bilah Hilir	4338,71	3
Bilah Barat	2003,52	4
Pangkatan	2003,52	4
Bilah Hulu	1693,47	4

Thus, the processed data results are integrated into a map using ArcGIS 10.8.

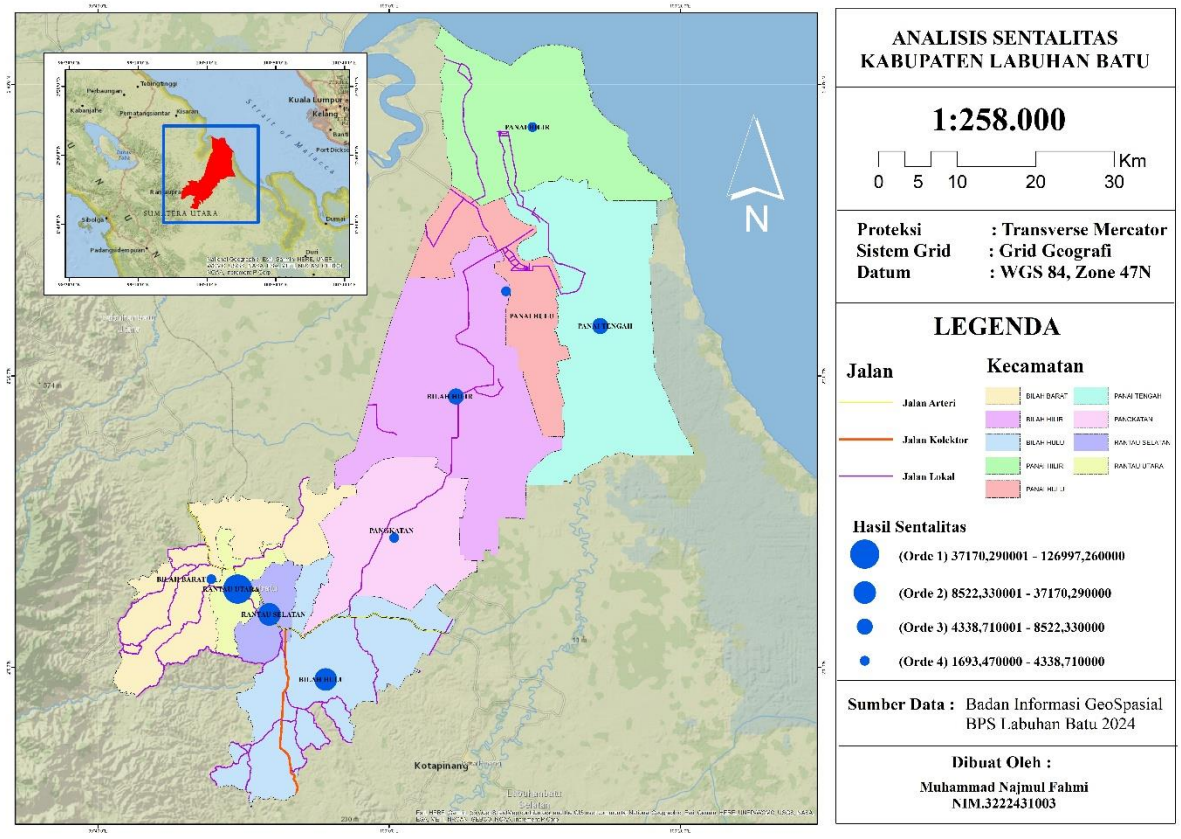

Figure 2. *Spatial Distribution of Centrality in Labuhan Batu Regency*
(Source: Processed using ArcGIS 10.8 based on data from BPS Labuhan Batu, 2024)

- Group 1 (37,170. 291 - 126,997. 260) includes Rantau Utara, Bilah Hulu, and Rantau Selatan, which are notable as significant centers for services and economic activities that enhance regional connectivity and accessibility.

- Group 2 (8,522. 331 - 37,170. 290) includes Bilah Hilir, which serves as a central hub, playing a crucial role in connecting less prominent regions with major service centers.
- Group 3 (4,338. 711 - 8,522. 330) includes Panai Hulu and Panai Tengah, which exhibit moderate spatial connectivity; however, improvements are necessary to strengthen their roles as centers for regional services.
- Group 4 (1,693. 470 - 4,338. 710) comprises Bilah Barat, Panai Hilir, and Pangkatan, indicating that these regions show low levels of spatial integration. Their lack of connection underscores the need for development strategies aimed at enhancing transportation systems and broadening access to essential services.

These classifications illustrate the regional variations in service availability and local effects, emphasizing the necessity of policy initiatives focused on enhancing infrastructure and improving service provision. The results are illustrated in Figure 1, which shows a combined map that integrates Scalogram and Centrality Analysis. This provides a complete perspective on the ranking of service facilities and the patterns of spatial influence across Labuhan Batu Regency.

Table 7. *Secondary Data Centrality Analysis 2025 and RTRW Labuhan Batu Regency 2011-2031*

Analysis Results		Spatial Structure RTRW Document	
Hierarchy	**Region**	**Urban System**	**Region**
Order 1	Panai Hilir Rantau Selatan Rantau Utara	PKW	Rantau Utara
Order 2	Rantau Selatan Panai Hilir Panai Tengah	PKL	Aek Nabara (Kec.Bilah Hulu)
Order 3	Panai Hulu Bilah Hilir	PPK	Negeri Lama (Kec. Bilah Hilir) Pangkatan (Kec. Pangkatan Tj. Sarang Elang (Kec. Panai Hulu) Janji (Kec. Bilah Barat) LabuhanBilik (Kec. Panai Tengah)
Order 4	Bilah Barat Pangkatan Bilah Hulu	PPL	Kec.Bilah Barat Kec.Bilah Hulu Kec.Pangkatan Kec.Bilah Hilir Kec.Panai Hulu Kec.Panai Tengah Kec.Panai Hilir

In an effort to understand the consistency between the results of spatial analysis and the direction of spatial planning stated in the RTRW document, a comparison was made between the results of the centrality analysis and the determination of the service center system in the RTRW. This approach is crucial to assess whether areas that are spatially highly connected have also received priority in regional development plans.

The results of the analysis show that areas such as Panai Hilir, Rantau Selatan, and Rantau Utara are included in Order 1, namely the group with the highest level of centrality. In the RTRW document, only Rantau Utara is explicitly designated as the Regional Activity Center (PKW). This indicates that Rantau Utara is not only strong spatially, but has also received policy legitimacy as the main center of regional development. Meanwhile, Panai Hilir and Rantau Selatan—despite having equal centrality strength—have not been included in the highest regional center level, so they have the potential to be evaluation materials in future policy revisions.

Then in Order 2, areas such as Rantau Selatan, Panai Hilir, and Panai Tengah have medium to high centrality values. The RTRW document groups strategic areas such as Aek Nabara (Bilah Hulu District) as Local Activity Centers (PKL). Although not in the exact same area, the high spatial position of Panai Hilir and Panai Tengah can strengthen the argument that these areas should be given more attention in the local system structure. This shows that there are a number of areas with high connectivity potential that have not been fully explored in formal planning.

Entering Order 3, areas such as Panai Hulu and Bilah Hilir are found, which in the RTRW structure are connected to areas such as Negeri Lama, Janji, and Labuhan Bilik which are categorized as Sub-district Service Centers (PPK). Here, there seems to be harmony between the mid-level spatial position and the direction of the spatial planning document. This means that service centers at the sub-district level are indeed in areas that have a moderate level of connectivity.

Meanwhile, areas in Order 4 such as Bilah Barat, Pangkatan, and Bilah Hulu, are in the lowest centrality position. Interestingly, all sub-districts in this order are also included in the Local Support Services (PPL) group in the RTRW. This means that areas with limited spatial influence are indeed planned to support the existence of the main center and are not used as the main activity center.

Overall, this comparison shows that most areas with high centrality values have been recognized in regional planning documents. However, there are also several areas with high centrality (such as Panai Hilir and Panai Tengah) that have not been reflected in formal policies, opening up discussion space for recommendations to strengthen the role of these areas in the structure of the future service center system.

2. Discussion

The findings from the Scalogram and Centrality Analysis highlight significant disparities in service access and spatial impact within Labuhan Batu Regency. The examination indicates that Rantau Utara acts as the primary service hub, essential for providing important infrastructure and community facilities. The existence of significant sub-districts such as Bilah Hulu and Rantau Selatan improves regional connections and the availability of services. However, the sub-districts classified as Order 1 and Order 2 exhibit a relatively lower position in the service hierarchy and centrality, indicating the need for focused development strategies.

The sub-districts with lower rankings, including Bilah Barat, Panai Hilir, and Pangkatan, face challenges concerning access to services and the presence of infrastructure. These areas require targeted development initiatives to improve their connectivity and enhance their involvement in regional activities. Strengthening service centers in these locations could help reduce spatial inequalities and promote equitable development throughout the region. Moreover, enhancing transportation networks and public facilities in Panai Hulu and Panai Tengah could greatly improve their geographical impact and accessibility to services.

The spatial disparities noted in this study highlight the need for equitable development throughout the region, making certain that less developed sub-districts obtain adequate funding for infrastructure. Improving the links between key service centers and nearby regions could promote a more equitable allocation of resources, while also tackling accessibility issues and encouraging sustainable growth. Policymakers must focus on enhancing accessibility, modernizing infrastructure, and increasing service facilities in lower-order sub-districts to ensure that all areas can participate in the advantages of regional development.

This study establishes an important foundation for regional planning and policy formation, offering valuable insights that guide strategies for improving spatial organization and elevating the service hierarchy within Labuhan Batu Regency. By integrating these discoveries into their planning strategies, local governments can develop more efficient methods to enhance service access, improve infrastructure, and guarantee equitable development throughout all sub-districts.

D. Conclusion

The assessment of Scalogram and Centrality in Labuhan Batu Regency shows significant differences in location concerning the ranking of service facilities and their effects on the region. The results from the Scalogram show varying levels of accessibility, with Rantau Utara being the main service center due to its comprehensive infrastructure and important facilities. Several sub-districts, including Bilah Barat, Bilah Hilir, Bilah Hulu, Panai Tengah, and Rantau Selatan, show a fairly strong access to services; nonetheless, their operational abilities remain lower than those of Rantau Utara. In contrast, Panai Hilir, Panai Hulu, and Pangkatan exhibit the lowest hierarchy rankings, indicating limited access to services and underscoring the necessity for further developmental efforts.

Information obtained from the Centrality Analysis highlights the existing geographic disparities in the region. Rantau Utara holds the highest centrality rating, affirming its position as an important center for both economic and administrative activities. This sub-district plays a crucial role in regional connectivity by connecting neighboring areas through a well-developed infrastructure system. Bilah Hulu and Rantau Selatan serve as important secondary centers with significant geographical influence. In contrast, other sub-districts, such as Bilah Barat, Panai Hilir, and Pangkatan, have lower centrality scores, which results in reduced regional connectivity. This, in turn, limits their influence on the distribution of economic resources and services.

The classification into four levels of centrality provides an organized method to understand spatial influence within Labuhan Batu Regency. Sub-districts in Order 1, which show

the lowest centrality scores, require targeted actions aimed at improving infrastructure and accessibility of services. Sub-districts in Order 2 and Order 3 demonstrate average connectivity, yet they still need targeted policies to enhance their importance within the region. Order 4 encompasses the sub-districts with the highest ratings, thereby enhancing the availability of robust service centers that can be leveraged for more effective regional integration and development efforts.

The findings emphasize the importance of equitable regional development to ensure fair access to services and better connections between remote areas and major centers. Policymakers ought to focus on improving infrastructure, expanding public services, and strengthening transportation systems, particularly in those sub-districts that are ranked lower. Moreover, thorough urban and regional planning strategies must seek to enhance service accessibility, enabling all sub-districts to engage in regional development and advancement.

The findings from this research provide important advice for developing future policies and spatial planning in Labuhan Batu Regency. Addressing the recognized disparities and implementing targeted development initiatives will create a fairer, more efficient, and sustainable regional structure, thereby improving economic and social outcomes for the community.

Acknowledgments

This research would not have been successful without the support and contributions from many people and organizations. First and foremost, I extend my sincere gratitude to my educators and professors at the State University of Medan. Their outstanding guidance, assistance, and expertise have greatly improved the advancement of this research. The significant discussions and constructive feedback they offered have been essential in shaping the analytical strategies and techniques employed in this work.

I am also thankful to my colleagues and fellow researchers who provided their support and participated in important discussions that helped improve the ideas presented in this paper. Their perspectives and team efforts have enhanced both the analysis and the real-world importance of the findings.

Additionally, I would like to recognize the support provided by Badan Pusat Statistik (BPS) Labuhan Batu. The extensive collection of data has been crucial for conducting the Scalogram and Centrality Analysis that is important for this research. The availability of demographic and economic data has enabled a comprehensive spatial analysis of service levels and regional impact in Labuhan Batu Regency.

Ultimately, I need to acknowledge the ongoing support from my family and friends, whose steadfast encouragement has motivated me during this academic journey. Their belief in my skills has been essential in overcoming challenges and maintaining the dedication required to complete this research. This project represents teamwork, and I sincerely appreciate everyone who contributed to its success. I hope that these results will significantly contribute to the areas of geography and spatial analysis, promoting better regional planning and the creation of policies.

E. References

Asmara, N. P., & Aprianti, Y. (2023). Analisis Pusat Pertumbuhan dan Wilayah Hinterland di Kota Samarinda. Agri-Sosioekonomi, 19(3), 1289–1302.

Badan Pusat Statistik (BPS) Labuhan Batu. (2024). *Statistik Daerah Kabupaten Labuhanbatu Tahun 2024*.

Devi, N., Pratama, A., & Suryanto, B. (2023). *Analysis of Service Facility Hierarchy in Regional Development Using Scalogram Method*. Journal of Spatial Planning, 12(3), 125-139.

Gabriela, P., & Utomo, A. P. (2023). *Spatial Analysis of the Effect of Social Infrastructure and Economic Infrastructure on Poverty in Java Island*. Seminar Nasional Official Statistics. Retrieved from https://prosiding.stis.ac.id/index.php/semnasoffstat/article/view/1672

Hafsyah, R., Widyaningsih, T., & Lestari, H. (2023). *Regional Centrality and Service Distribution in Urban and Rural Areas of Indonesia*. Indonesian Journal of Geography, 55(2), 98-112.

Hutomo, R., Ananta, F., & Wijaya, S. (2023). *Implications of Centrality Analysis for Spatial Planning and Facility Distribution: A Case Study in Sumatra*. Journal of Geospatial Studies, 11(1), 45-61.

Lahuddin, L. (2020). Analisis Penentuan Pusat-Pusat Pertumbuhan Ekonomi Wilayah (Studi Pada Surabaya, Sidoarjo, Gresik, Mojokerto Dan Jombang). Buletin Ekonomika Pembangunan, 1(1).

Lubis, D. P., Permana, S., Rahmadi, M. T., Sintong, M., & Turnip, B. P. (2023). *Study of Hierarchy and Service Facility Centers of South Labuhanbatu Regency*. Jurnal Pendidikan Geografi, 10(2). Retrieved from https://ppjp.ulm.ac.id/journal/index.php/jpg/article/download/16604/9447

Mafenska, N. P., & Pramono, W. T. (2023). Analisis Kecamatan Pusat Pertumbuhan dengan Wilayah Hinterland di Kabupaten Sleman. Universitas Muhammadiyah Surakarta.

Nugroho, A., Adi, M. S., & Nurjazuli, N. (2023). *Spatial Analysis of Environmental Conditions in The Incidence of Leptospirosis in Kebumen Regency*. Jurnal Kesehatan Lingkungan Indonesia, 22(2). Retrieved from https://ejournal.undip.ac.id/index.php/jkli/article/view/50812

Pemerintah Kabupaten Labuhanbatu. (2011). *Rencana Tata Ruang Wilayah (RTRW) Kabupaten Labuhanbatu Tahun 2011–2031*. Dinas Cipta Karya dan Tata Ruang Kabupaten Labuhanbatu.

Putra, M. I. J., & Utami, N. D. N. (2021). Measuring Spatial Healthcare Facilities Accessibility Using Two-Step Floating Catchment Analysis (2SFCA). International Conference on Planning in the Era of Uncertainty.

Rahmadhani, V., & Arum, W. (2022). Literature Review Internet of Think (IOT): Sensor, Konektifitas dan QR Code. Jurnal Manajemen Pendidikan dan Ilmu Sosial, 3(2), 573-582.

Rasudin, N. (2008). Rencana Tata Ruang Perkotaan Berdasarkan Undang-Undang Nomor: 26 Tahun 2007. Jurnal Industri dan Perkotaan, 12(22), 1754-1762.

Rustiadi, E. (2018). Perencanaan dan pengembangan wilayah. Yayasan Pustaka Obor Indonesia.

Safira, L., Adityasari, M., & Kurniawan, R. 2023. *Applying Scalogram and Centrality Analysis to Assess Service Accessibility in Regional Development*. Spatial Economics Review, 14(4), 203-218.

Shara, A. R. I. D. (2018). Analisis Konektivitas Wilayah di Kota Denpasar. Media Komunikasi Geografi, 19(1), 42-50.

Tampubolon, C. N., Budiasa, I. W., & Widhianthini, W. (2022). *Analisis Penentuan Pusat Pertumbuhan Ekonomi dalam Pengembangan Wilayah di Kabupaten Labuhanbatu Utara, Provinsi Sumatera Utara*. Jurnal Agribisnis dan Agrowisata, 11(1). Retrieved from https://jurnal.harianregional.com/jaa/full-89739

Taufiq, M., & Kombaitan, B. (2019). Urban Area Entities in Affecting Regional Development: A Case Study for Mebidangro. Jurnal Wilayah dan Lingkungan, 7(3), 153–165.

Wahyudin, Y. (2022). Analisis Desa/Kelurahan Pusat Pertumbuhan Wilayah Sekitar Calon Ibu Kota Negara Indonesia. Forum Ekonomi, 24(1), 195–203.

Windhani, K., Purwaningsih, Y., Mulyaningsih, T., Samudro, B. R., & Hardoyono, F. (2023). *Human Capital and Regional Economic Growth in Indonesia: A Spatial Analysis Approach*. Indonesian Journal of Geography, 55(3). Retrieved from https://jurnal.ugm.ac.id/ijg/article/view/88241