https://jurnal.unimed.ac.id/2012/index.php/tgeo/article/view/47494
https://doi.org/10.24114/tgeo.v12i2.47494 (Vol. 12 No. 2 – 2023)
e-ISSN: 2622-9528 p-ISSN: 2301-606X

Spatial Structure Analysis in Regional Development Context at Samosir Regency

Sendi Permana*[1], Pukarda Jordan Siburian[2], Darwin Parlaungan Lubis[3], M Ridha Syafii Damanik[4], M Taufik Rahmadi[5], Vladimir Ryabtsev[6]
[1,2,3,4,5]Department of Geography Education, Faculty of Social Sciences, Universitas Negeri Medan, Indonesia
[6]Cherkasy Branch of Private Higher Education Establishment, European University, Ukraina.
e-mail: sendipermana@unimed.ac.id

Received:	Revision:	Accepted:
September 18, 2023	December 27, 2023	December 27, 2023

Abstract

Regional inequality or disparity is a natural consequence of development and an unavoidable stage. This happens because of differences in population, natural resource potential and geographical conditions in each region. This research aims to analyse public service centres, inter-district interactions, and settlement patterns in the context of regional development in the Samosir Regency. The study uses a descriptive method with a quantitative approach to analyse the centres of public services, inter-district interactions, and settlement patterns among districts in Samosir Regency using the tools of centrality index analysis, gravity model, and nearest neighbour analysis. The analysis results show that the public service facilities in Samosir Regency in 2021 include 517 units of educational facilities, 442 units of healthcare facilities, 561 units of religious facilities, and 2,418 units of economic facilities, with the service centre located in Pangururan District with a total availability of 1,081 units, which has the highest centrality value of 966.63. The most considerable inter-district interactions occur in Palipi District, with a total interaction of 11,671,532.31, while the minor interaction occurs in Simanindo District, with a total interaction of 749,250.15. The settlement pattern in Samosir Regency consists of 1 district with a random settlement pattern and eight other districts with clustered settlement patterns. In the development of the Samosir Regency, the influence of district interactions, service centres, and settlement patterns are essential factors to be considered.

Keywords: District, Service Center, Interaction, Settlement Pattern

INTRODUCTION

Spatial structure can be defined as the arrangement of settlement centres and network infrastructure facilities that support socio-economic activities of hierarchically functional relationships (Muta'Ali, 2015). Hierarchically, spatial structure has functional relationships and plays a vital role in planning, implementing, monitoring and evaluating regional development. Spatial structure analysis must be done because good planning that considers spatial structure will encourage sustainable regional development.

Spatial structure is related to service centres and infrastructure networks Field (Lahagina et al., 2015). The existence of this spatial structure can support both social and economic activities that are formed due to settlement centres, network systems, and infrastructure. As a result of the realisation of this spatial structure will form a combination in the city, both at a large scale and at a smaller scale.

The critical role of urban spatial structure is as a supporting area for education, trade, industry, and services. Spatial structure can have the function of directing infrastructure networks (Budihardjo, 1987). The purpose of spatial structure arrangement is to prevent development disparities by determining the growth centres (Safitri & Mayzonny, 2014).

Spatial structure is a reference used by regional development planners because the development of cities in Indonesia generally affects the shape and structure of

existing cities (Deng et al., 2009). A region with all its activities will continue to develop over time and will be influenced by the government field (Yin et al., 2011), especially in planning and implementing development.

Regional development refers to all efforts to create balanced and equitable development in all regions and sectors. Regional development aims to reduce development gaps and welfare inequalities between regions. This can be achieved by implementing various development programs that focus on improving the quality of life for communities across regions (Mahi, 2016).

According to the (OECD, 2016), regional disparities reflect differences in the intensity of economic phenomena observed in several regions within a country. Meanwhile, the (ILO, 2002) defines regional inequality as differences in economic performance and welfare between regions. According to (Sirojuzilam, 2005), Inequality occurs not only in the distribution of people's income but also in the development between regions within the territory of a country.

Inequality or disparity between regions is a natural consequence of development and an unavoidable stage. Differences in the potential of natural resources and geographical conditions in each region are the main factors that contribute to this phenomenon. As a result, each region has different potential in increasing development activities, leading to the formation of "developed areas" and "lagging areas". In addition to these factors, disparities can occur due to demographic differences, constraints in the movement of goods and services, the concentration of economic activity in a particular region, and the allocation of development funds between regions. Even though disparities in an area cannot be eliminated, efforts are needed to reduce the level of disparities. This aims to reduce the negative impact caused by the high level of disparity between regions (Ardani, 1992).

Regional disparity refers to differences between regions caused by uneven development. One solution that can be implemented to address this disparity is to maximise the development of service centres in each region (Muliana et al., 2018).

Regional disparities and spatial distribution of resources result from the uneven development process, where infrastructure construction is generally prioritised for areas with high population density (Restiatun, 2009). This leads to inequality between regions, where the spread of economic activities becomes uneven, impacting the disparity in growth and welfare improvement between regions. Therefore, regional development should be carried out based on the potential and characteristics of the resources available in the region. Economic development with regional development becomes an option for improving the community's welfare by using natural, human, technological, institutional, and physical infrastructure effectively, optimally and sustainably, which aims to equalise and reduce disparities between regions (Adisasmita, 2008).

(Getis, 2014) articulated that Christaller suggests that service centres, also known as central places, refer to cities that provide various products and services to the surrounding population. These service centres form a hierarchical system based on the range of the area and the population size (Muliana et al., 2018). Therefore, activity centres that continuously meet the various needs of the population should be located in a centralised place, such as areas or regions that allow maximum human participation, both as actors of service activities and as consumers of the products and services provided (Utoyo, 2007).

The central region has several functions: a residential area for the population, a service centre for the surrounding region, a trading hub for agricultural or industrial commodities, and

https://jurnal.unimed.ac.id/2012/index.php/tgeo/article/view/47494
https://doi.org/10.24114/tgeo.v12i2.47494 (Vol. 12 No. 2 – 2023)
e-ISSN: 2622-9528 p-ISSN: 2301-606X

a location for manufacturing industries (Rustiadi, 2009). This theory is based on several assumptions: the distance to the central region is crucial for consumers as they must pay transportation costs and time. The availability of goods is determined by the distance consumers travel in terms of cost and time.

According to (Muta'Ali, 2015), the Centrality Index is an analysis method used to identify the structure or hierarchy of service centres in a planning area. This index evaluates the variation and quantity of available service functions, the number of people receiving services, and the frequency with which these services are available. The Centrality Index also provides information on the region's geographical location strategy, including accessibility and transportation connectivity. Regions with a high Centrality Index indicate rapid development and serve as centres of activity or destinations for the community.

Settlement patterns and service centres are interrelated in the context of regional or city development. Settlement patterns refer to the arrangement or layout of dwellings and human habitation in a specific area. On the other hand, a service centre is a place or area that offers various services to the community, including trade, education, health, and security.

A well-designed and organised settlement pattern is crucial for the effectiveness and efficiency of service centres. Furthermore, service centres are vital in accelerating regional growth and development and facilitating people's mobility in accessing public services.

In regional or urban development contexts, planning settlement patterns and service centres must be well coordinated to achieve optimal development goals. Patterns of well-integrated settlements and service centres will facilitate public access to public services and contribute to improving the community's quality of life.

Samosir Regency has a unique distribution pattern of diverse community settlements, ranging from those located by the lake to those on the mountain's slopes. With the passage of time and the increase in population growth, the distribution pattern of settlements in Samosir Regency has also changed. This change is evident in the emergence of new settlements built around urban centres and the population growth in several villages previously inhabited by only a few people. Therefore, analysing the settlement distribution pattern in the Samosir Regency is necessary, particularly by employing the nearest neighbour analysis method.

According to (Utoyo, 2007), Spatial interaction refers to the relationship of mutual influence between two areas, which can give rise to new symptoms, appearances or problems. Factors that affect the strength of spatial interaction include regions that are complementary (regional complementary), the existence of an opportunity to intervene (intervening opportunity), and ease of transfer or transfer in space (spatial transfer ability). The concept of spatial interaction can be applied in development planning, such as in the location of service centres and infrastructure development.

Newton's theory of gravity is used as the basis for the concept of spatial interaction, which states that two objects with a certain mass will have an attractive force between them known as gravitational forces, then applied by (Reilly, 1929) to measure the strength of spatial interaction between two or more regions. According to (Reilly, 1929) in (Latifah, 2018), the strength of the interaction between two areas can be measured by considering population size and distance between the two regions.

Spatial interaction or spatial relationship is a reciprocal relationship between two or more regions that can lead to new phenomena, appearances, or problems because location or region is a factor that is considered in regional

economic studies. The interaction between them affects the development speed of the relevant region (Respati, 2015).

Samosir Regency is one of the regencies in the North Sumatra Province, Indonesia, encompassing a land area of approximately 1,444.25 km2. Geographically, Samosir Regency is positioned at coordinates 2°24' - 2°45' North Latitude and 98°21' - 99°55' East Longitude, with elevations ranging from 904 to 2,157 meters above sea level. This district has enormous potential for natural resources such as Lake Toba and attractive tourism potential. To advance regional development, the government of Samosir Regency has undertaken various initiatives, including infrastructure development, human resource enhancement, and others.

However, in regional development, it is essential to pay attention to the existence of good and well-structured public service centres. This public service centre is essential because it is where people can fulfil their basic needs and carry out their daily activities. In this case, Samosir Regency has several public service centres, including health, education, and trade centres.

Regional growth and development are intrinsically linked to the region's development activities. Development is necessary to stimulate the region's infrastructure, social aspects, and economy to achieve welfare for the society (Latuconsina et al., 2018).

This study aims to analyse public service centres, interactions between districts, and patterns of settlement distribution in the context of regional development in the Samosir Regency. This research uses several analyses, namely centrality index and gravity analysis, to see the gradation of the function of settlement service centres and the strength of interaction between Districts, which are directly proportional to the size of the population, as well as the nearest neighbour analysis to determine the distribution pattern of settlements related to the gradation of settlement service centres and geographical conditions in the research area.

RESEARCH METHODS

This research uses a descriptive method with a quantitative approach to obtain a more detailed picture of a situation under study based on data or information that has been collected. The collected data is then analysed to obtain the necessary information. The quantitative approach method was chosen because this study focuses on numerical data analysis and uses a mathematical formula (Cornelin et al., 2016).

Location

The research is located in the districts of Samosir Regency, North Sumatra Province, Indonesia. Geographically, Samosir Regency is situated at coordinates 2°24' - 2°45' N and 98°21' - 99°55' E, with an elevation ranging from 904 to 2,157 meters above sea level. The total area of Samosir Regency is approximately 2,069.05 km2, consisting of a land area of around 1,444.25 km2 (69.80%) and a lake water area of about 624.80 km2 (30.20%). Samosir Regency comprises nine districts, namely Pangururan, Simanindo, Ronggur Nihuta, Palipi, Nainggolan, Onan Runggu, Sitiotio, Sianjur Mulamula, and Harian. The area of Samosir Regency is bordered by Karo Regency and Simalungun Regency in the north, Toba Samosir Regency in the east, North Tapanuli Regency and Humbang Hasundutan Regency in the south, and Dairi Regency and West Pakpak Regency in the west.

Data

The centrality analysis method is used to analyse the service centres in Samosir Regency. The data used in this analysis is derived from secondary sources, such as the publication "Samosir Regency in Figures 2022" provided by the Central Statistics Agency of Samosir

https://jurnal.unimed.ac.id/2012/index.php/tgeo/article/view/47494
https://doi.org/10.24114/tgeo.v12i2.47494 (Vol. 12 No. 2 – 2023)
e-ISSN: 2622-9528 p-ISSN: 2301-606X

Regency and the Village Potential in 2021. The collected data includes the number of facilities available in each District in Samosir Regency, such as educational, healthcare, religious, and economic facilities.

Secondary data was obtained from the Central Statistics Agency of Samosir Regency in 2021 to calculate interactions between districts using the gravity model. This data includes the number of residents and the distance between District capitals in Samosir Regency.

The nearest neighbour analysis was used to obtain settlement patterns between Districts in Samosir Regency. The data used is secondary data obtained from the Indonesian Geospatial Portal by the Geospatial Information Agency. The analysed data included administrative and settlement shapefile data from each District in Samosir Regency.

Method

1. Centrality Method

   To identify the structure and hierarchy of service centres, the centrality index method was used, which involves analysing the number of service functions, the types of functions available in a region, the population served, and the frequency of the existence of these service functions (Riyadi, 2002) In this study, the centrality index method was used to determine Districts that have the potential to become service centres in Samosir Regency. Factors considered include the availability of educational, health, worship, and economic facilities in each District. This analysis assumes that the region with the most service facility units will become the Field's highest-level service centre (Mita, 2020).

2. Gravity Model

   The gravity model is used to quantify the intensity of interaction among districts in the Samosir Regency. This approach incorporates variables such as population magnitude and spatial separation between two areas as the fundamental components for computations.

   The gravity model applied in this method has several benefits, namely: (1) to measure the level of relationship between various regions, (2) determining the relative strength of economic activity centres, production, and distribution in the service, distribution, and transportation network system, and (3) aiding in the identification of central systems and its surrounding areas. The gravity formula used in this method is:

$$I12 = P1P2 / (J12)2$$

   With:
   I12: degree of interaction between regions 1 and 2
   P1: Total population in Region 1
   P2: Total population in Region 2
   J12: distance between region one and region 2

3. Nearest Neighbor Analysis

   The method used in analysing settlement distribution patterns is Nearest Neighbor Analysis, which involves calculating the nearest neighbour parameter (T). The goal is to determine whether the settlement patterns being analysed fall into clustered, random, or uniform categories. The calculation results of the T parameter values are compared with the T values associated with predetermined patterns so that the type of pattern formed can be identified, whether it is a clustered pattern, random pattern, or uniform pattern. There are several variations in the

distribution pattern of settlements, including:

a. The distribution pattern is clustered if the distance between one location and another location is close enough and tends to be concentrated in certain places, with an index value of T< 0.7
b. Random distribution pattern, if there is no regularity in the distance from one location to another, with an index value of 0.7< T < 1.4
c. Uniform distribution pattern (regular), if the distance between one location to another location is relatively the same, with an index value of 1.4 ≤ T ≤ 2.15

To analyse settlement patterns, the data needed is the distribution of settlements that have been digitised and converted into settlement distribution points.

RESULTS AND DISCUSSION

Service Center Analysis

The hierarchy of regions is a ranking system that can identify a region's activity centres. The hierarchy of a region is crucial because it determines how different levels of the region should be managed, as each level has different needs from its residents. (Buchori dan Astuti, 2015) state that in spatial planning, the hierarchy of regions is also useful for describing the spatial structure of a region.

Samosir Regency has 9 Districts, with differences in the distribution of facilities between one District and another. A total of 31 facilities were used in the analysis of service centres in Samosir Regency, categorised into educational, healthcare, religious, and economic facilities.

Figure 1. SMP Negeri 1 Sianjur Mulamula

Figure 2. Puskesmas Harian

https://jurnal.unimed.ac.id/2012/index.php/tgeo/article/view/47494
https://doi.org/10.24114/tgeo.v12i2.47494 (Vol. 12 No. 2 – 2023)
e-ISSN: 2622-9528 p-ISSN: 2301-606X

Figure 3. HKBP Pangururan

Figure 4. Pasar Souvenir Tomok

1. Educational Facilities

   The availability of educational facilities in Samosir Regency in 2021 amounted to 517 units, with the distribution as follows: Early Childhood Education (PAUD) - 147 units, Kindergarten (TK) - 12 units, Primary School (SD) - 196 units, Junior High School (SMP) - 35 units, Senior High School (SMA) - 13 units, Vocational High School (SMK) - 7 units, and Skills Training Institutions - 107 units.

2. Healthcare Facilities

   The availability of healthcare facilities in Samosir Regency in 2021 amounted to 442 units, with the distribution as follows: Hospitals - 2 units, Community Health Centers (Puskesmas) - 13 units, District Health Centers (Puskesmas Pembantu) - 35 units, Doctor's Practices - 17 units, Midwife's Practices - 14 units, Integrated Health Service Posts (Poskesdes) - 53 units, Village Midwife Posts (Polindes) - 61 units, Integrated Health Posts (Posyandu) - 226 units, Pharmacies - 14 units, and Clinics - 7 units.

3. Religious Facilities

   The availability of religious facilities in Samosir Regency in 2021 amounted to 561 units, with the distribution as follows: Mosques - 7 units, Surau Langgar - 5 units, Christian Churches - 386 units, Catholic Churches - 161 units, and Chapels - 2 units.

4. Economic Facilities

   The availability of economic facilities in Samosir Regency in 2021 amounted to 2,418 units, with the distribution as follows: Hotels - 37 units, Cottages - 286 units, Restaurants - 340 units, Food Stalls - 714 units, Shops - 950

units, Shopping Complexes - 8 units, Markets - 31 units, Mini Markets/Supermarkets - 18 units, and Cooperatives - 31 units.

The first stage of the Marshall Centrality Index Analysis is to calculate the weight for each facility unit and calculate the Centrality Index (IS) for each facility unit in each district. Next, the IS of each facility unit will be totaled.

The next step is to identify the order based on the order sum formula developed by Sturges in 1926. This formula is used to determine the number of classes needed in the analysis. The formula used is as follows:

k = 1 + 3.3 log n
k = 1 + 3.3 log 9
k = 1 + 3.3 (0.95)
k = 1 + 3.134
k = 4.134 (rounded to 4)

Next, we need to determine the size of the interval for each class.

I = (T-t)/k
I = (966,63-119,14)/4
I = 847.49/4
I = 211.87

So that the hierarchical order of the service center is obtained by analyzing the Marshall Centrality Index as shown in Table 1 below.

Table 1. Range of service center hierarchy in Samosir Regency

RANGE	211,87
Hirarchy 1	754.76 – 966,63
Hirarchy 2	542.89 – 754.76
Hirarchy 3	331.02 – 542.89
Hirarchy 4	119.14 – 331.02

Source: Processed data, 2023

From the analysis of the Marshall Centrality Index, it was identified that there are Districts with the same order, as shown in Table 2.

Table 2. Classification of the order of each District of Samosir Regency

No	District	Hirarchy
1	Sianjur Mulamula	4
2	Harian	4
3	Sitiotio	4
4	Onanrunggu	4
5	Nainggolan	4
6	Palipi	3
7	Ronggur Nihuta	4
8	Pangururan	1
9	Simanindo	2

Source: Processed data, 2023

Furthermore, the service center hierarchy with the Marshall Centrality Index analysis is presented in the service center hierarchy map in Figure 5.

Based on the 2021-2026 Samosir Regency RPJMD, the activity center in Samosir Regency acts as a center for social, cultural, economic and administrative services for the people in the region. This Activity Center consists of several entities, such as Promotional Area Activity Centers (PKWp), Promotional Local Activity Centers (PKLp), Promotional Local

https://jurnal.unimed.ac.id/2012/index.php/tgeo/article/view/47494
https://doi.org/10.24114/tgeo.v12i2.47494 (Vol. 12 No. 2 – 2023)
e-ISSN: 2622-9528 p-ISSN: 2301-606X

Activity Sub Centers (Sub PKLp), and District Activity Centers (PKK).

According to the Samosir Regency Spatial and Regional Plan (RTRW), PKWp is located in Pangururan District, which is also the capital of Samosir Regency, with services covering the entire area of Samosir Regency. PKLp are located in Tele, with service coverage in Harian, Sitiotio, Sianjur Mula-Mula Districts, as well as Districts in Humbang Ha Anglean, Pakpak Bharat and Dairi Regencies which border the Samosir Regency. PKLp are also available in Onan Runggu, with services covering the Districts of Nainggolan, Onan Runggu and Tobasa which border the Samosir Regency. Sub PKLp are located in Parbaba, Rianiate, Nainggolan, Mogang, and Ambarita. PKK is located in Ronggur ni Huta, Sabulan, Boho Daily, and Sagala.

In the context of the policy that determines the capital city of Samosir Regency and strategic locations for several villages to serve the surrounding area, a hierarchy of service centers is formed. Pangururan District became PKWp, as a regional activity center with administrative/government service functions covering all Districts in Samosir Regency. In addition, this District also provides services for trade, education, health, agriculture, and transportation centers (BAPPEDA Kabupaten Samosir, 2021).

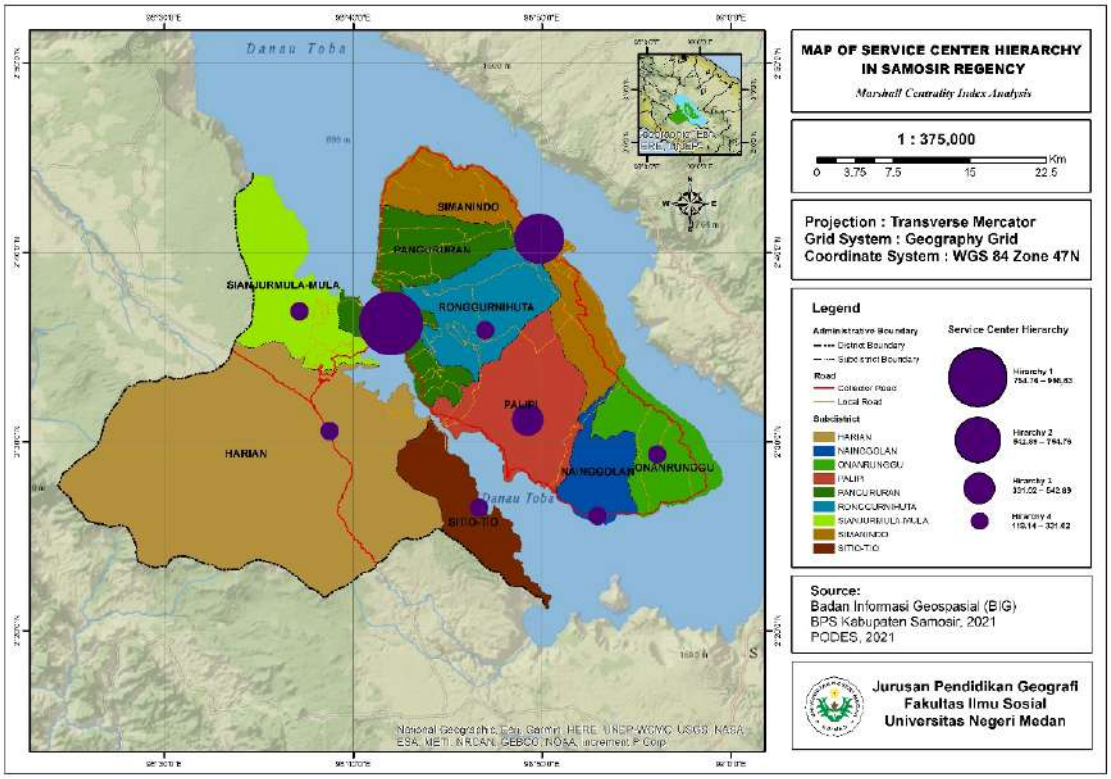

Figure 5. Map Of Service Center Hierarchy In Samosir Regency

One of the crucial factors in regional development is the spatial aspect, which involves the proper placement of service facilities to ensure the delivery of the best possible service to the people who need it (Padangarang, 2008).

According to (Setiawan, (2016) the availability of good service facilities, including their location, quality, and quantity, is closely linked to the level of community welfare. The availability of adequate service facilities is crucial for ensuring the smooth and successful development of any area, whether urban or rural. These facilities play a pivotal role in shaping the future growth and economic

prosperity of a region, particularly in newly developed areas.

The analysis of service centers in Samosir Regency is crucial in development planning to ensure targeted development priorities and effective budget allocation. Samosir Regency is one of the regencies in North Sumatra Province that has abundant potential for development, both in the tourism and agricultural sectors.

(Adisasmita, 1994) argues that it is imperative to allocate essential services and facilities to areas characterized by significant population concentrations or regions and market areas substantial enough to sustain economic activities. This strategic placement is crucial as it influences location economies, scale economies, and urbanization economies. To achieve broader social and geographical equity in economic development, investments should follow a decentralized concentration pattern. Consequently, these investments should be directed to specific locations with strategic settlements that cater to the surrounding communities through the provision of necessary facilities.

In the development planning of Samosir Regency, a service center analysis can assist in determining the location and types of public services that need to be provided. Service center analysis can provide the necessary information to identify the needs of the community and the types of public services that should be provided in a particular area.

Through the presence of a well-designed and accurate service center analysis, it is expected that the development in Samosir Regency can be carried out effectively and efficiently, with a focus on meeting the needs of the community and improving their quality of life. This can foster the creation of a sustainable and prosperous regional development for the people of Samosir Regency.

Spatial Interactions Analysis

Spatial interaction is the flow of movement that occurs among service centers, whether it be in the form of goods, money, population, or other entities. The existence of relationships between one region and another is crucial because through these interregional interactions, a cooperative relationship can be established, allowing them to complement each other and enhance the economic growth rate of their respective regions (Saerofi in Nurfatimah, 2013)

In measuring the level of interaction between Districts in Samosir Regency, the gravity model calculation method is used. This gravity method involves calculating the population and the distance between the Districts.

The following is data on distances between Districts in Samosir Regency and data on the population of Samosir Regency used in the calculation of the gravity model.

Table 3. Distance between Districts of Samosir Regency

District Capital	Sianjurmula-mula	Harian	Sitiotio	Onnrunggu	Nainggolan	Palipi	Ronggur Nihuta	Pangururan	Simanindo
Sianjur Mulamula		6	36	48	38	30	32	14	62
Harian	6		38	50	40	32	34	16	64
Sitiotio	36	38		24	14	6	40	22	70
Onanrunggu	48	50	24		10	18	52	34	82
Nainggolan	38	40	14	10		8	42	24	72

https://jurnal.unimed.ac.id/2012/index.php/tgeo/article/view/47494
https://doi.org/10.24114/tgeo.v12i2.47494 (Vol. 12 No. 2 – 2023)
e-ISSN: 2622-9528 p-ISSN: 2301-606X

District Capital	Sianjurmula-mula	Harian	Sitiotio	Onnrunggu	Nainggolan	Palipi	Ronggur Nihuta	Pangururan	Simanindo
Palipi	30	32	6	18	8		34	16	66
Ronggur Nihuta	32	34	40	52	42	34		18	66
Pangururan	14	16	22	34	24	16	18		48
Simanindo	62	64	70	82	72	64	66	48	

(Source: BPS Kabupaten Samosir, 2022)

Table 4. Population between Districts of Samosir Regency in 2022

District	Population in 2022
Sianjur Mulamula	10070
Harian	9467
Sitiotio	8219
Onanrunggu	11190
Nainggolan	12977
Palipi	18372
Ronggur Nihuta	9755
Pangururan	34607
simanindo	23039
Total	137696

(Source: BPS Kabupaten Samosir, 2022)

Based on the calculations and data processing carried out, the magnitude of regional interaction for each District is obtained as follows:

Table 5. Amount of regional interaction for each District

No	Districts	Population	Total Interactions
1	Pangururan	34607	8631750.06
2	Sianjur Mulamula	10070	4991267.75
3	Harian	9467	4403944.34
4	Sitiotio	8219	5692450.87
5	Onan Runggu	11190	2751297.72
6	Nainggolan	12977	6797905.74
7	Palipi	18372	11671532.31
8	Ronggurnihuta	9755	1586637.86
9	Simanindo	23036	749250.15

(Souce: Processed Data, 2023)

From the calculation of the magnitude of the interaction using the gravitational model theory formula, it was found that the highest total District interaction was from Palipi District with a total interaction of 11671532.31. Meanwhile, the smallest interaction was from Simanindo District with a total interaction of 749250.15.

The strength of interaction in each District is then divided into three classes based on the level of interaction strength. Details of the interaction strength groupings can be seen in Table 6.

Table 6. Results of the analysis of the strength of the interaction between the Districts of Samosir Regency

Interaction Level	Range
Low	749250.15 - 4390010.87
Middle	4390010.87 - 8030771.59
High	8030771.59 – 11671532.31

(Adopted by: Sugiyono, 2016)

Based on the level of interaction of each District, there are three Districts that have low interaction, namely Onan Runggu District, Ronggurnihuta District, and Simanindo District. There are four districts with moderate interaction, namely Sianjur Mulamula District, Harian District, Sitio-tio District, and Nainggolan District. Meanwhile, there are two districts with high interaction, namely Pangururan District and Palipi District. The strongest interaction between Districts in Samosir Regency occurred in Palipi District with a total interaction is 11,671,532.31. After the magnitude of the interaction is obtained, then it is processed and included in the map. The Interaction Map of Samosir Regency can be seen in Figure 6.

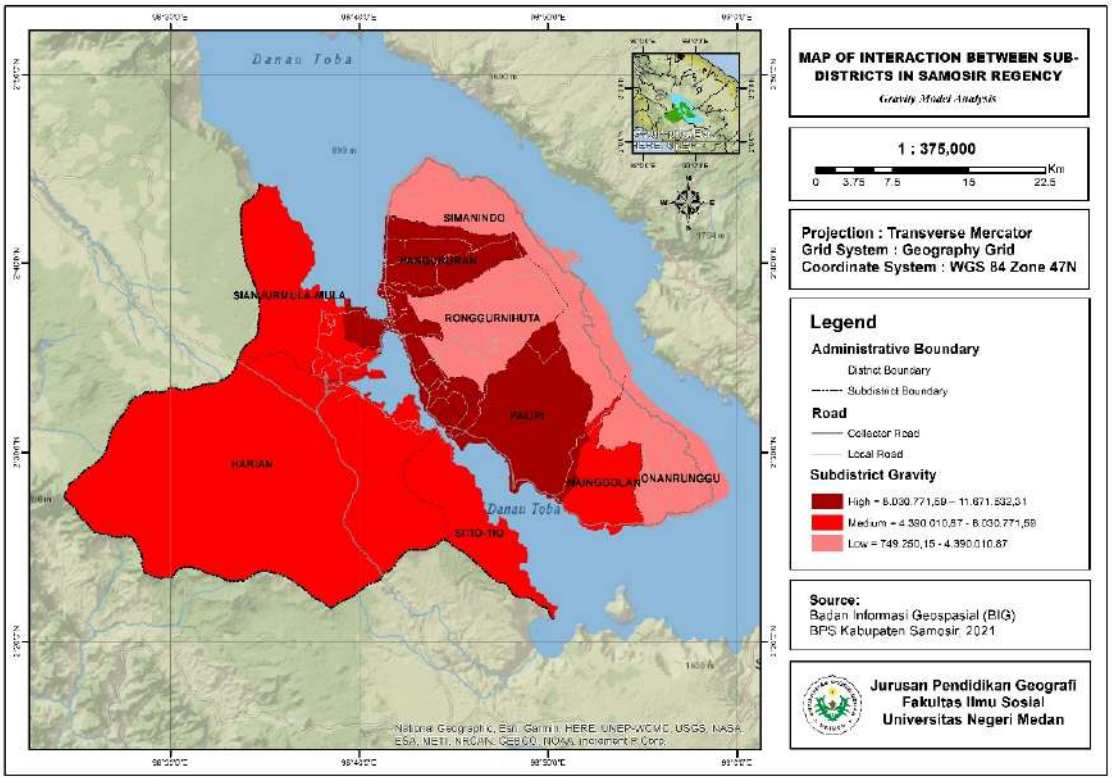

Figure 6. Map Of Interaction Between Districts In Samosir Regency

Spatial interaction refers to the movement of people, goods, or information over space that results from a decision-making process. It involves reciprocal relationships that influence each other between two or more areas, leading to new symptoms, appearances, or problems. (Utoyo, 2007) This concept includes all movements or mobility in a space or area caused by human behavior, such as travel to work, migration, the flow of goods and services, information, movement of students for educational reasons, and activities involving the use of public facilities and the dissemination of knowledge (Haynes, K. E., & Fotheringham, 2020).

https://jurnal.unimed.ac.id/2012/index.php/tgeo/article/view/47494
https://doi.org/10.24114/tgeo.v12i2.47494 (Vol. 12 No. 2 – 2023)
e-ISSN: 2622-9528 p-ISSN: 2301-606X

The strength of spatial interaction is influenced by three main factors: regional complementarity, intervening opportunity, and spatial transfer ability. (Kharisma & Triwardani, 2018) It has various applications, including development planning, locating service centers, and developing transportation infrastructure.

Spatial interaction between Districts in Samosir Regency has a close relationship with regional development. As a district that has the potential to be developed, Samosir Regency needs a good and sustainable regional development strategy.

In regional development, spatial interaction between Districts can affect infrastructure, public service, economic and social development in an area. Spatial interactions between Districts can strengthen relations between communities, improve transportation and information accessibility, and open up opportunities for cooperation in various fields.

Sustainable regional development must pay attention to spatial interactions between Districts. In this case, local governments can plan and develop infrastructure that can facilitate interaction between Districts, such as roads, bridges and public transportation. Local governments can also improve public services in remote areas so that people in those areas can enjoy the same services as people in other areas. According to (Adisasmita, 2011) transport is a means of connecting regions production and market or often said to bridge producers with consumers. The role of transportation infrastructure is very important, namely as a means connection between parties who need each other.

In addition, spatial interactions between Districts can affect the economic sector in a region. Good spatial interaction can open opportunities for cooperation in the economic sector between Districts, such as in the trade and tourism sectors. This can increase people's income and encourage economic growth in Samosir Regency as a whole.

The network of connections between settlements in a region shapes the flow of information and resources, enabling villages to access the inputs they need to enhance their agricultural output and market their products. Spatial proximity plays a significant role in these interactions. The closer the settlements are to each other, the more frequent and intense their interactions become. This dynamic exchange of knowledge, goods, and services fosters agricultural productivity and economic growth within the region (D.A., 1985).

In regional development planning, local governments can pay attention to spatial interactions between Districts as an essential factor in determining the direction of sustainable regional development. With an excellent regional development strategy, it is hoped that development in Samosir Regency can run effectively and efficiently, emphasising the linkages and integration between existing areas. This can encourage the creation of sustainable and quality regional development for the people of Samosir Regency.

Settlement Distribution Pattern Analysis

According to Law No. 1 of 2011 on Housing and Settlements, a settlement is a part of a residential environment consisting of more than one housing unit with public infrastructure, facilities, and utilities, and supporting activities for other functions in urban or rural areas. Housing is a collection of houses as part of a settlement, both urban and rural, equipped with public infrastructure, facilities, and utilities as a result of efforts to fulfil a decent home.

The definition of settlement according to Hadi Sabari dalam et al.(Ariyanti, Rieke, M. Musiyam, 2017) can be interpreted as a formation, either artificial or natural, with all its

completeness that is used by humans as individuals or groups to live, either temporarily or permanently in order to carry out their lives.

The nearest neighbour analysis method is used in the ArcGIS application to analyse the distribution patterns of settlements in the Samosir District. This method converts settlement pattern data into points and then analyses using the Average Nearest Neighbor method. This nearest-neighbor analysis aims to determine the distribution pattern of settlements based on a given scale, with T as the parameter used. When T<0.7, the distribution pattern is classified as clustered, if 0.7>T<1.4, the distribution pattern is classified as random, and if 1.4≤T≤2.15, the distribution pattern is classified as uniform. Next, the Nearest Neighbor Ratio (NNR) is calculated. By processing settlement data using the Average Nearest Neighbor Tools in ArcGIS, we can automatically obtain patterns of settlement distribution in the form of curves and view these patterns in the Average Nearest Neighbor Summary. NNR values can be found in Table 7.

Table 7. Classification of Settlement Distribution Patterns with NNR values

No.	Districts	NNR	Settlement Pattern
1.	Harian	0.419449	Clustered
2.	Simanindo	0.466028	Clustered
3.	Sianjur Mulamula	0.541066	Clustered
4.	Palipi	0.503814	Clustered
5.	Pangururan	0.561929	Clustered
6.	Ronggurnihuta	0.883861	Random
7.	Nainggolan	0.575950	Clustered
8.	Onanrunggu	0.607940	Clustered
9.	Sitiotio	0.496420	Clustered

(Source: Processed Data, 2023)

Furthermore, after obtaining the NNR value, the settlement pattern of each District can be determined. The analysis results are grouped based on the nearest neighbor parameter to describe the settlement patterns of Districts in Samosir Regency. The distribution pattern of settlements in Samosir Regency is based on the standard reference value T. Clustered settlement pattern occurs when T < 0.7, a random pattern occurs when 0.7 < T < 1.4, and a uniform pattern occurs when 1.4 ≤ T ≤ 2.15.

The calculation results in Table 7 show that in Samosir Regency there are 9 Districts. Of these Districts, Ronggurnihuta District is a District with a random pattern, while Harian District, Simanindo District, Sianjur Mulamula District, Palipi District, Pangururan District, Nainggolan District, Onanrunggu District, and Sitiotio District have a clustered pattern. Existing cluster settlements, one of which is in Pangururan District, can be seen in figure 7. Therefore, it can be concluded that overall the distribution of settlements in Samosir Regency tends to have a clustered pattern can be seen in Figure 8. The figure shows the pattern of settlements in each District in Samosir Regency based on the results of the data processing that has been done.

https://jurnal.unimed.ac.id/2012/index.php/tgeo/article/view/47494
https://doi.org/10.24114/tgeo.v12i2.47494 (Vol. 12 No. 2 – 2023)
e-ISSN: 2622-9528 p-ISSN: 2301-606X

Figure 7. Existing Settlements in Pangururan District in 2022

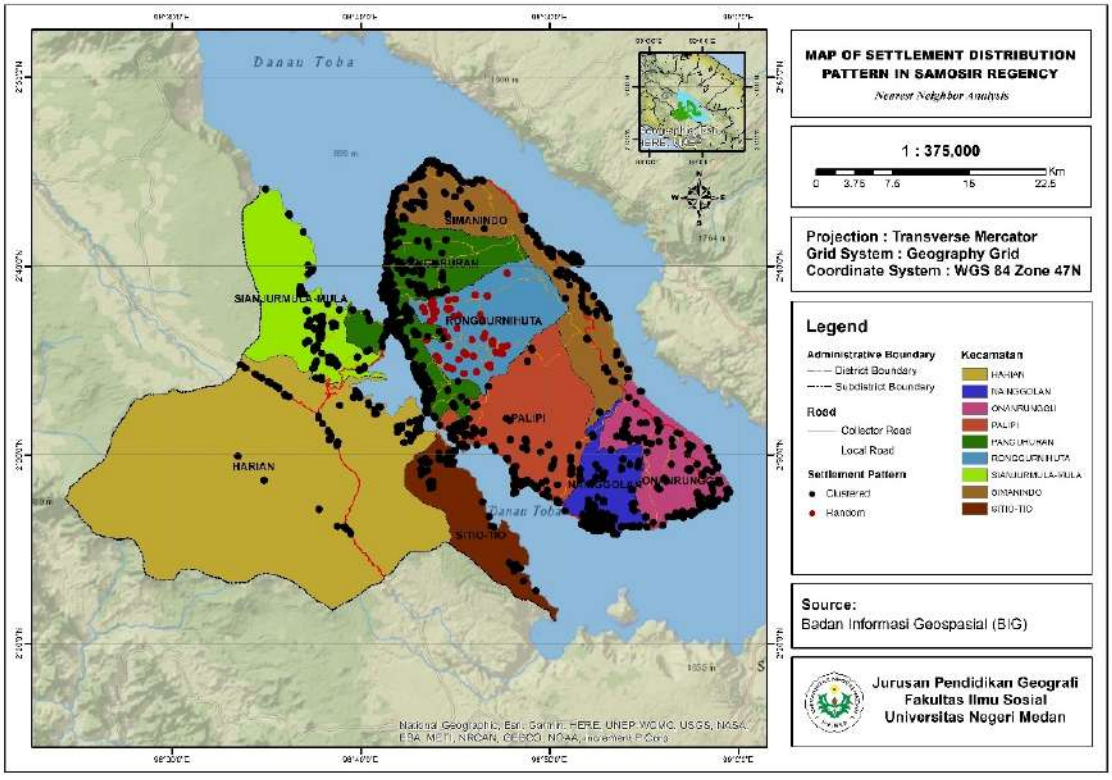

Figure 8. Map of Settlement Distribution Pattern in Samosir Regency

The distribution of settlements is crucial to understand as it can serve as a guide for future settlement development. This enables the existing settlements to not only focus on one specific area but to be evenly distributed, resulting in balanced development in terms of both physical and socio-economic aspects. According to (Marpaung & D., 2019), settlement planning is expected to be able to realize the spatial quality of the environment with regional morphology to achieve a balance between spatial, functional, and social integration

The growth of settlements aligns with the growth of an area, where the more appealing a region becomes as a settlement location, the greater its potential for development. The high number of settlements in an area indicates that it has made progress in terms of physical development, such as having complete public facilities, as well as socio-economic development. This makes the region highly

attractive for residents to choose as their place of residence. If the land has adequate physical, social, and economic facilities, it can be effectively developed as a settlement (Wulandari & Setyo, 2020).

The clustered settlement pattern in Samosir Regency is primarily aligned with roads and the lake's periphery. The pattern of clustered settlements in Samosir Regency is associated with roads and the edge of the lake. This pattern shows that the agglomeration of settlements on the outskirts of Lake Toba is related to fisheries and tourism potential. According to (Jayadinata, 1986) The form of settlement that has developed will form a settlement pattern through the spread of dwellings due to geographical conditions. (Tower, 2005), emphasizes that residential location preferences have an impact on changes in residential elements, such as facilities, accessibility, to spatial patterns of housing.

This is the main reason why many clustered settlements are concentrated in several Districts located on the edge of Lake Toba, except Ronggurnihuta District which is not directly adjacent to the lake. The settlement pattern following the roads and surrounding the lake demonstrates that easy accessibility, available infrastructure, and thriving economic acvities are attractive factors for residents to build homes in the area. According to (Rapoport, 2016) settlements are formed through a long continuous process in functional places based on patterns of human activity both caused by the influence of physical and non-physical conditions. According to (Budihardjo, 1987) preferences for residence will always develop according to the dynamics of behavior and social and economic conditions of a person.

Settlement patterns are closely related to regional development in Samosir Regency. Concentrated settlement patterns around specific urban centers or service centers can strengthen the connectivity between the region and development centers. Service centers can also play a role in driving economic growth in Samosir Regency. Service centers have a crucial role in attracting investments and creating job opportunities for the local community. Settlement patterns that concentrate around urban centers and service centers can help boost economic growth in Samosir Regency.

The development of settlements should also be oriented towards the quality of the residential environment, which can be addressed by physical capabilities including residential buildings, facilities, and supporting infrastructure to accommodate and fulfill the needs and activities of its inhabitants. Settlements, as spaces used by humans for dwelling, should be constructed by satisfying elements that support the creation of conditions that enable people to organize their lives (Rifda et al., 2014).

A good settlement pattern must consider several aspects, including the correlation between settlements and infrastructure, accessibility, land availability, environmental quality, as well as the social and cultural aspects of the local community. In this case, the Samosir Regency government needs to pay attention to the existing settlement patterns when planning regional development. According to Rondinelli (2019) deployment concentration of investment in settlements that have the same size and characteristics. Different is one of the important elements in the integration of urban areas and their hinterlands

CONCLUSION

Based on the centrality analysis shows the availability of educational facilities in Samosir Regency in 2021 totaling 517 units, 442 health facilities, 561 worship facilities, and 2,418 economic facilities, with the service center being Pangururan District with 1081 available facilities whose centrality value the highest is 966.63, this is in line with the status of this District as the capital of Samosir Regency.

Based on the Gravity Model, the largest total District interaction was in Palipi District with a total interaction of 11671532.31 and the smallest interaction was in Simanindo District with a total interaction of 749250.15. This shows that Palipi District has the potential to develop because this District has potential attractiveness from the aspect of number population and distance between districts.

Based on the Nearest Neighbor Analysis, the settlement pattern of Samosir Regency consists of 1 District with a random pattern, namely Ronggurnihuta District, and 8 Districts with a clustered pattern, namely Harian District, Simanindo District, Sianjur Mulamula District, Palipi District, Pangururan District, Nainggolan, Onanrunggu District, and Sitiotio District. From these results it can be said that overall the distribution of settlements in Samosir Regency tends to have a clustered pattern.

From the results of this study, The Samosir Regency Government may consider measures to reduce disparities between regions in Samosir Regency. One of them is by maximizing the main service centre as well as the capital, namely Pangururan District and shifting the focus of developing service facilities to areas that have the lowest urban hierarchy, the lowest interaction value, and dispersed settlement patterns, especially Ronggur Nihuta District and Onan Runggu District.

Development regions are designated areas for prioritised development based on their characteristics and potential. This policy aims to establish growth centres that can stimulate and catalyse growth not only within the region but also in its surrounding areas (Hariyanto, 2009).

The expedited advancement facilitated by the strategy of development regions (DR) is a deliberate move to implement regional development policies. This approach allows the development region to operate according to its designated functions and roles, leading to establishing a more equitable pattern of regional development (Hariyanto, 2009). The delineation of development regions is a thoughtful consideration for a more efficient and targeted development process in Samosir Regency.

REFERENCE LIST

Adisasmita, R. (1994). Teori-teori Lokasi dan Pengembangan Wilayah. Diktat Kuliah, Universitas Muslim Indonesia, Ujung Pandang.

Adisasmita, R. (2008). Pengembangan wilayah: Konsep dan teori. Yogyakarta: Graha Ilmu.

Adisasmita, R. (2011). Pembiayaan Pembangunan Daerah. Yogyakarta: Graha Ilmu.

Ariyanti, Rieke, M. Musiyam, and M. T. (2017). Analisis Perkembangan Permukiman Di Kecamatan Laweyan Tahun 2006 - 2015. Ariyanti, R., Musiyam, M., & TP, M. (2017). Analisis (Doctoral dissertation, Universitas Muhammadiyah Surakarta).

BAPPEDA Kabupaten Samosir. (2021). RPJMD Kabupaten Samosir Tahun 2021-2026. BAPPEDA Kabupaten Samosir.

BPS Kabupaten Samosir. (2022). Kabupaten Samosir Dalam Angka 2022. BPS Kabupaten Samosir.

Budihardjo, E. (1987). Percikan masalah arsitektur, perumahan, perkotaan. Gadjah Mada University Press.

Cornelin G. Kamagi, Jullie J. Sondakh, T. R. (2016). Analisis Kontribusi Pajak Daerah Terhadap Pendapatan Asli Daerah (PAD) Di Kabupaten Minahasa Utara Dan Kabupaten Minahasa Tenggara (Periode 2011-2015). Jurnal Berkala Ilmiah Efisiensi, 16(4), 1037–1049.

D.A., R. (1985). Applied Methods Of Regions Analysis: The Spatial Dimension Of Development Policy. Westwive Pres.

Deng, J. S., Wang, K., Hong, Y., & Qi, J. G.

(2009). Spatio-temporal dynamics and evolution of land use change and landscape pattern in response to rapid urbanization. Landscape and Urban Planning, 92(3–4), 187–198. https://doi.org/10.1016/j.landurbplan.2009.05.001

Getis, A. G. J. (2014). Christaller's Central Place Theory In A Geography of Urban Places. Routledge.

Haynes, K. E., & Fotheringham, A. S. (2020). Gravity and spatial interaction models.

Imam Buchori dan Kristiana Dwi Astuti. (2015). Studio Perencanaan Wilayah. Penerbit Universitas Terbuka.

Jayadinata, J. T. (1986). Tata guna tanah dalam perencanaan pedesaan, perkotaan dan wilayah. Penerbit Itb.

Kharisma, B., & Triwardani, W. A. (2018). Optimalisasi Aksesibilitas Sebagai Percepatan Pembangunan : Studi Kasus Penataan Jalan di Kabupaten Pangandaran. E-Jurnal Ekonomi Dan Bisnis Universitas Udayana, 5(2018), 1407. https://doi.org/10.24843/eeb.2018.v07.i05.p07

Lahagina, J. J. G. P., Ir. R. J. Poluan, M. S., & Windy Mononimbar, S. M. (2015). Kajian Struktur Ruang Kota Tomohon. Spasial, 1(1), 45–53.

Latifah. (2018). Penentuan Pusat-Pusat Pertumbuhan Wilayah Pembangunan (WP) Lebak Selatan di Kabupaten Lebak Provinsi Banten. Jurnal Online Mahasiswa (JOM) Bidang Perencanaan Wilayah & Kota, 1(1).

Latuconsina, Z. M. Y., Rustiadi, E., & Sahara. (2018). An analysis of the level of development in Malang Regency based on a typology of development regions. Journal of Regional and City Planning, 29(1), 1–17. https://doi.org/10.5614/jrcp.2018.29.1.1

Mahi, A. K. (2016). Pengembangan Wilayah: Teori & Aplikasi. Kencana.

Marpaung, & D., T. (2019). Tinjauan Regulasi Pembangunan Permukiman Daerah Tepi Air di Pangururan Kabupaten Samosir. December 2019, A001–A008. https://doi.org/10.32315/ti.8.a001

Mita Apriana, I. R. (2020). Penentuan Pusat Pelayanan Perkotaan di Kota Tanjung Pinang. Jurnal Tunas Geografi, 09(01), 1–12.

Muliana, R., Astuti, P., & Fadli, A. (2018). Kajian Pusat-Pusat Pelayanan Di Kabupaten Kampar. Jurnal Saintis, 18(1), 59–72. https://doi.org/10.25299/saintis.2018.vol18(1).2846

Muta'Ali, L. (2015). Teknik analisis regional untuk perencanaan wilayah, tata ruang dan lingkungan. Yogyakarta: Badan Penerbit Fakultas Geografi (BPFG).

OECD. (2016). OECD regional outlook 2016: Productive regions for inclusive societies. OECD Publishing Paris.

Padangarang. (2008). Teknik Analisis Kuantitatif Wilayah. Program Pasca Sarjana Universitas Halu Oleo Kendari.

Rapoport, A. (2016). Human aspects of urban form: towards a man—environment approach to urban form and design. Elsevier.

Respati. (2015). Konsep Wilyah Teori Interaksi.

Restiatun. (2009). Identifikasi sektor unggulan dan ketimpangan antarkabupaten/kota di Provinsi Daerah Istimewa Yogyakarta. Jurnal Ekonomi Dan Studi Pembangunan, 10(1), 77–98. http://eprints.undip.ac.id/75918/

Rifda, E., Sriyono, R. , & Liesnoor Setyowati. (2014). Analisis Pola Sebaran Permukiman Berdasarkan Topografi Di Kecamatan Brangsong Kabupaten Kendal. Geo Image, 3(2), 2252–6285. http://journal.unnes.ac.id/sju/index.php/geoimage

Riyadi, D. S. (2002). Pengembangan Wilayah Teori Dan Konsep Dasar Dalam Pengembangan Wilayah Dan Otonomi Daerah Kajian Konsep Dan Pengembangan. P2KTPW-BPPT: Jakarta.

Rustiadi, E., Saefulhakim, S., & Panuju, D. R. (2009). Perencanaan pengembangan wilayah. Bogor: Crespent Press & Yayasan Obor Indonesia.

Safitri, I., & Mayzonny, H. (2014). Penentuan Struktur Ruang PKW Kadipaten Melalui Pendekatan Analisis Cluster ,. Statistika, 14(2), 77–86.

Sirojuzilam. (2005). Beberapa Aspek Pembangunan Regional. Ikatan Sarjana Ekonomi Indonesia.

Tower, G. (2005). An Introduction To Urban Housing Design: At Home In The City. Architectural Press of Elsevier.

Utoyo, B. (2007). Geografi: Membuka Cakrawala Dunia, untuk Kelas X Sekolah Menengah Atas. Bandung: Setia Purna Inves.

UU Pengertian Dasar Permukiman, Pub. L. No. 1 (2011).

Wulandari, N. D., & Setyo, D. L. (2020). Analisis Pola Persebaran Permukiman Tahun 1998, 2006, dan 2019 di Kecamatan Gunung Pati Kota Semarang. Geo Image, 9(1), 65–72. http://journal.unnes.ac.id/sju/index.php/geoimage

Yin, J., Yin, Z., Zhong, H., Xu, S., Hu, X., Wang, J., & Wu, J. (2011). Monitoring urban expansion and land use/land cover changes of Shanghai metropolitan area during the transitional economy (1979-2009) in China. Environmental Monitoring and Assessment, 177(1–4), 609–621. https://doi.org/10.1007/s10661-010-1660-8