The Impact Of Spillover And Spatial Interaction Of Growth Center Metropolitan "*MAMMINASATA*" In South Sulawesi, Indonesia

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Abstract—This paper aims to (1) Determine the existence of central growth areas and support regions in the *Mamminasata* metropolitan area using scalogram analysis and centrality index. (2) Detect the amount of the interaction value between the supporting regions and the central growth area using gravity analysis. (3) To Know the effect of growth overflow between the growth centers and support regions using the intersection of the sides and corners of the region through the local index Moran and Moran scatterplot in spatial autocorrelation. The results of this paper show that (1) Makassar City as a growth centers with a hierarchy of 991.60; Maros, Gowa and Takalar Regencies with hierarchy each levels of 558.30, 591.60, and 558.30. The three districts are support regions in the *Mamminasata* metropolitan area. (2) The sequence of interactions to the city of Makassar with the total index of each district. Gowa (636) pull power I. Maros Regency (89) with pull power II, Takalar Regency (15) with pull power III. The city of Makassar is in quadrant II, while the three districts are supporting regions in quadrant IV. Makassar City has a negative growth effect or absorptive effect on the three supported districts in the period 2002-2016.

Index Terms— Growth center, supporting regions, spatial Interactions, overflow effects, metropolitan city, spillover, region symptom.

1 INTRODUCTION

Symptoms of a region cannot avoid the occurrence of various densities such as population density, housing, economic, social, and political activities as well as urban transportation traffic due to concentrated operations. Some studies concentrated on all activities in an interacting region would widen the development gap in other regions [1], [2], [3], [4]. This raises interregional disparity. As a result, the structure of relations between regions that form of interaction can weaken one to another.

Myrdal's theory states that the symptoms of regional inequality can be explained based on the principle of cumulative circular causation. This principle explains that if an area is allowed to work on its strength, it will cause expansionary spread effects and backwash effects towards other regions so it is called spillover effect [2], [3], [5]. The cause of spillover effects because each region also has a pull and push power to other regions [6], [7], [8]. It depends on how strong the power of the area is. The emission of power can be in the form of human activities and various facilities available in the area.

Various theories explain that economic growth and development is influenced by physical capital, human capital, and technology. Therefore, regions are encouraged to collaborate between regions to increase economic activity. Also, the region needs to establish economic growth pole by observing the effects, influences, and interactions of the around the regions [5].

South Sulawesi can create added value that has resulted in a significant increase in the last five years, from 2012 to 2016. South Sulawesi GRDP data based on constant prices in 2012 amounted to 201.54 billion rupiahs. Whereas in 2013 it was recorded at 217.39 billion rupiahs. Then in the following year, namely in 2001, South Sulawesi's GRDP rose to reach 234.49 billion rupiahs. The year 2015 also experienced an increase of 251.68 billion rupiahs. Until the last year, 2016 was recorded at 270.62 billion rupiahs [9].

The *Mamminasata* area is one of the National Strategic Areas in Indonesia that have an important role as the gateway to the Eastern Region of Indonesia. The role of *Mamminasata* is very strategic in supporting Sulawesi Island as a center of economic activity. Based on the economic growth of the four districts/cities of *Mamminasata* in Sulawesi. From 2012 to 2016, they tended to fluctuations but grew equally.

The impact of spillover and the spatial interaction of the growth center in the *Mamminasata* metropolitan area should be important to study. Especially regarding the effects caused by the area that became a city. Considering every area in the *Mamminasata* metropolitan area has become part of the cooperation area. Makassar city as the capital city of South Sulawesi Province is actually as a pulling power, or the surrounding districts are push and support power of the city's growth. Based on this background, the problem analyzed in this study is how the impact of Spillover and Spatial Interaction of Growth Centers in the *Mamminasata* Metropolitan Area of South Sulawesi over the past 15 years (2002-2016).

2 THEORETICAL FRAMEWORK

2.1 Location Theory

In economics and geography, theory concerned with the geographic location of economic activity; it has become an integral part of economic geography, regional science, and spatial economics. Location theory addresses the questions of what economic activities are located where and why. The location of economic activities can be determined on a broad level such as a region or metropolitan area, or a narrow one such as a zone, neighborhood, city block, or an individual site.

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Friedmann moved from a purely economic argument of regional development theory toward a linkage between regional interaction theory and the theory of social change. For the theory of social change, Friedmann relied on a modification of Ralf Dahrendorf's analysis of change through conflict in an authority dependency situation. As spatial systems are territorially organized systems of social relations, Dahrend1orf's conflict model constitutes a promising start for formulating a general theory of polarized socio-economic spatial development. The general theory of polarized development states [3], [10], [11].

2.2 Central Place theory

Central Place Theory is an attempt to explain the spatial arrangement, size, and the number of settlements. Central Place Theory is based on 2 fundamental concepts which are "Threshold" and "Range." The threshold is the minimum population needed to make a service viable at a particular place. If this size is not reached, then a specific activity will not start or it will be closed down. The range is the maximum distance a consumer is willing to travel to purchase good or avail a service, beyond this distance consumer will not move as the distance traveled for good/service will outweigh the benefit [12]. According to Christaller, Central place theory gives 3 principles, which are the marketing principle, transport principle and administrative principle for orderly arrangements and the formation of hierarchy [13]. Settlements are regularly spaced – equidistant spacing between same order centers, with larger centers farther apart as compared to smaller centers. The market area is hexagonal shaped as it is free from overlapping, most efficient in both number and function. The different layouts predicted by Christaller have K-values, which show how much the Sphere of Influence of the central places takes in the central place itself counts as 1 and each portion of a satellite counts as its portion. The portions are Marketing Principle (K=3); Transport Principle/ Traffic Principle (K=4); Administrative Principle (K=7).

2.3 Regional Economic Growth Theory

Krugman has opened a black box mystery about economic externalities that explicitly include spatial dimensions in urban and regional development. Krugman explained why spatial concentrations occur in major cities in developing countries and the tendency of people to be concentrated in areas that are the center of activity [14]. Agglomeration is caused by economies of scale and economies of localization. Economies of scale is an advantage because it can produce especially so that production is greater and the cost per unit is more efficient while economies of localization is an advantage because in that place various needs and facilities can be used by the community [12].Copyright Form

3 METHOD

3.1 Research Samples

The sample of this study is GRDP data, per capita income, and population in each region in the *Mamminasata* metropolitan area during the period 2002-2016 in four regencies/cities in the Mamminasata metropolitan area. The names of these districts/cities are Makassar City, Maros Regency, Gowa Regency, Takalar Regency. While spatial samples between regions of the Mamminasata metropolitan area and calculated by the main route the shortest highway (in meters).

3.2 Data Analysis Design

Data analysis in the study used three analysis methods and used 2 applications analysis tool, which is ArcView GIS [15] and Geoda application [16]. Scalogram analysis and centrality index are used to find out which categories of regions are the growth centers and support region of the Mamminasata metropolitan area. Gravity analysis is used to see the magnitude of the interaction strength of the buffer zone towards the central growth area in the Mamminasata metropolitan area. The local Morran's index and the Morran scatterplot are used to find out how much of the overflow effect the central growth area has given to its support regions in the Mamminasata metropolitan area.

Scalogram Analysis is an analytical tool used to determine the ability of an area to provide services to the community. The higher the development of a region means, the abler to provide services to the community. The service referred to in this case is the availability of facilities in the area, such as facilities related to economic activities, social activities, and government activities. Using scalogram analysis can be determined which regions can be used as centers of growth. Regions that have the highest complete facilities can be used as the center of growth [17].

The gravitational analysis is the most widely used analytical tool to see the magnitude of the attraction of an area against other regions. The main objective of this analytical tool is to quantitatively estimate economic relations between regions, both in the form of passenger and goods interactions between regions [18], [19]. The formula for calculating interactions in relations between regions is to use gravity.

$$I_{1,2} = (W_1 P_1)(W_2 P_2) / J_{1,2} \quad (1)$$

Where :

I1,2 : Gravity figures among region 1 (growth centre) and 2 (support)

W1 : Income Per capita Region 1 (growth centre)

W2 : Income Per capita Region 2 (support)

P1 : Number of Population Region 1 (centre)

P2 : Number of Population Region 2 (support)

J1,2 : Distance between Region 1 (centre) and Region 2 (support)

Value I1,2 is the gravity number for the two regions show the close relationship (interaction) between the area that is the centre of growth and the support region, the greater the value I1,2. Therefore, the relationship between the two regions is increasingly tight. Thus the more economical trips that occur because of inter-regional interaction in regional coverage. The next step is to calculate the growth rate of the gravity numbers of each district/city from the year of the study. In this case, the rate of growth of the gravity number every year for the district becomes the support area of Makassar as the centre of growth, period 2002 to 2016. The final step of analysis is to find the total index of each gravity number from the research year of each district/city, then divide the highest gravity number with the lowest gravity number in the same year in the area that is the support region. For more details, see the formula below:

$$\text{Total Index} = \frac{\text{maximum value support region year} - t}{\text{minimum value support region} - t} \quad (2)$$

Then, to sum of the gravity index value from the first to end year of the study. Three support area in the *Mamminasata* metropolitan area to get pull power ratings. Pull power I am the area that has the largest total index, rating II is the area that has the total index below the largest total index, and so on to the smallest.

4 Results and Discussion

4.1 Scalogram Analysis and Centrality Index

Scalogram analysis is used to determine the existence and condition of facilities and potential resources in the *Mamminasata* metropolitan area which consists of 4 districts/cities, namely, Makassar city, Maros district, Gowa district and Takalar district, then analyze how much needs to be developed. Also, this analysis can determine which regions or regions become centers of growth by the hierarchy and potential of resources in the *Mamminasata* metropolitan area. With the establishment of a growth center in the area, it will be seen which areas are influential as centers of growth (see Table 1).

Based on the results of the scalogram analysis and index of centrality in the *Mamminasata* metropolitan area, district/city hierarchies can be grouped sequentially. Regions that have a higher hierarchy will function to serve lower areas. From the results of this calculation, which is included as a hierarchy area, I is the city of Makassar and hierarchy III is the area around it, namely Maros district, Gowa district, and Takalar district. The results of this study are seen from a large number of research areas and regional orders, in the *Mamminasata* metropolitan area divided into 3 hierarchies, namely hierarchy I, hierarchy II, and hierarchy III. However, none of the four districts/cities in *Mamminasata* belongs to hierarchy II. This is due to the accumulation of the value of the centrality and number of hierarchies so that the length of the class (range) is only equal to 144.43. For more details, see the formula below:

TABLE 1
HIERARCHY AND CENTRALITY INDEX CATEGORIES BASED ON NUMBER OF FACILITY TYPES IN THE MAMMINASATA METROPOLITAN AREA

No	Regency/ city	Number of Facility Types observed	Centrality Index	Hierarch y
1	Makassar	27	991,60	I
2	Maros	22	558,30	III
3	Gowa	23	591,60	III
4	Takalar	22	558,30	III

$$\text{Number of classes} = 1 + 3{,}3 \log n \quad (3)$$

where: n is the number of districts/cities studied, so the number of classes is equal to 1+3, $\log n = 2.986 \sim 3$. From the above formula, it can be concluded that in the *Mamminasata* metropolitan area there are many classes or also called hierarchies as many as 3, namely hierarchy I, hierarchy II, hierarchy III. After the number of classes or hierarchies has been generated, the next is calculating the range with the following formula:

$$\text{Range} = \frac{\text{highest central index} - \text{lower central index}}{\text{number of classes}} \quad (4)$$

so:

$$\text{Range} = \frac{(991.60 - 558.30)}{3} \quad (5)$$

$$\text{Range} = \frac{(433.3)}{3} = 144.43 \quad (6)$$

Based on the results of the above calculations, it can be obtained the length of the class (range) for each hierarchy:

1. Hierarchy I = 847.18 – 991.61
2. Hierarchy II = 702.74 – 847.17
3. Hierarchy III = 558.30 – 702.73

It can be concluded that the four regencies/cities that have several service facilities in the *Mamminasata* metropolitan area can be divided into 3 categories as follows:

1. The regional category that has high service facilitie is hierarchy I is the city of Makassar.
2. Regional categories that have medium service facilities are hierarchies II; apparently, none of the regions in the *Mamminasata* metropolitan area belongs to this category.
3. Regional categories that have low service facilities are hierarchies III are Maros district, Gowa district, and Takalar district.

4.2 Gravity Analysis

Based on the results of the analysis of the gravity model using a variable number of population, per capita income, and distance between regions for economic growth and public welfare. Data from the table shows the gravity numbers of the three districts in the *Mamminasata* metropolitan area as a supporting area for the city of Makassar during the period 2002 to 2016 showing a varied value and increasing year to year. Gowa Regency is the supporting region that has the greatest gravity with the city of Makassar, followed by Maros district and then the region with the smallest gravity is Takalar district. This is supported because the distance of Gowa district to Makassar city is the closest when compared to other supporting areas such as Maros and Takalar districts. Gowa Regency is an area that has I (first) pull power rating and a total index of 636. That is, Gowa district has the largest interaction with Makassar compared to the other two districts. This research is still in line with the theory proposed by Carrothers. The strength of economic relations between regions is directly proportional to the size of the population and inversely proportional to the distance among them [20]. That is, the more residents of the two regions, the greater the economic interaction, but the farther the distance between them, the less the interaction value will be.

In 2002 to 2003, Takalar district had a very significant interaction value growth, which grew to 165.51 percent. This has become a good initial reference in the interaction relationship with the central growth region, namely the city of Makassar. Although the interaction value of Takalar district is the smaller of the two other districts, the average growth from 2002 to 2016 reached 71.25 percent or around 0.58 percent above the average growth of interaction between Gowa

districts as the most supporting region. Close to the growth center. Takalar Regency is an area that has the smallest index and the weakest pull power between the other two districts. This is suspected because the Takalar district is located farthest from the city of Makassar compared to the other two districts in the metropolitan area of *Mamminasata*.

In the northern part of the city of Makassar, Maros district is also able to create a significant value of interaction with the central growing region. Even in 2009, the Maros district was able to create a very large interaction value, which almost rose seven times the value of the interaction in the previous year or increased by 599.95 percent. In 2012, the interaction rate of Maros district also rose to 341.91 percent from the previous year. On the other hand, Maros district also has an average growth rate of interaction from 2002 to 2016 of 80.62 percent or the largest among the three districts, which are the buffer zones of the growth center. Maros Regency has a second attraction rating after Gowa district, and a total index of 86. Maros Regency is a district that has a large interaction after Gowa district.

As the closest supporting area of the central growth area, Gowa district must have the greatest interaction value among other supporting areas in the *Mamminasata* metropolitan area. In 2003, 2010 and 2012, the value of district interactions rose significantly. However, the average growth rate of interaction between Gowa districts is the smallest compared to the other two districts, namely Maros and Takalar districts.

4.3 Spatial Autocorrelation

In determining or detection of spatial autocorrelation, we can see and determine the weighting in the form of a matrix that describes the closeness or relationship between observations or better known as a spatial weight matrix. In this study, the decision to use the spatial weighting criteria used was queen contiguity. This can be seen through Table 2 below:

Table 2 above shows that a spatial weighting matrix 4x4. The matrix weighting method uses queen contiguity. Makassar City as a growth center has a weighting numbering 3. This means that the city of Makassar is directly adjacent to the 3 regencies which are supporting areas such as Maros, Gowa and Takalar districts. Similarly, Gowa district is a supporting area that has a weighting of 3. Gowa Regency is also directly adjacent to the city of Makassar as the center of growth, and directly borders with 2 other supporting areas such as Maros and Takalar districts. It is different from Maros and Takalar regencies which have 2 spatial weights, respectively, because both of them do not intersect and only intersect with Makassar city as a growth center and Gowa district as other supporting centers.

From the analysis of the Local Index of Moran and Moran Scatterplot, the sample is in the form of GDP per capita per city growth rate in the *Mamminasata* metropolitan area during the period 2003-2016, where Makassar as the growth center is dependent variable independent variable (X). In this case, the supporting area is divided into 3 regencies namely, Maros Regency (X1), Gowa Regency (X2), and Takalar Regency (X3). LISA Significant Map below in Figure 1 shows that, geographically, there is a spatial relationship/interaction in the area of the central growth region, in this case, the city of Makassar towards supporting areas such as Maros district, Gowa district, and Takalar district in the *Mamminasata* metropolitan area. This spatial relationship occurs at a significance level of 0.001. Then the results are as follows:

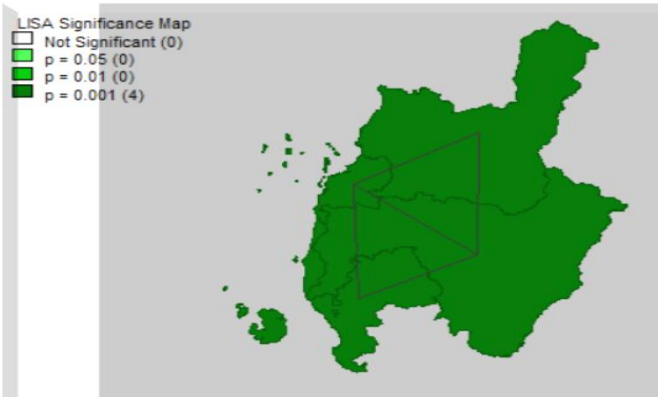

Fig. 1. Significance Map of the *Mamminasata* Metropolitan Area

That is, the relationship between the central area of growth towards the supporting area is very strong because of the value of p = 0.001 <alpha value (α) = 0.05. The assumption of the p value is the smaller the p-value, the stronger the evidence for rejecting the null hypothesis (H0). From the p-value, it can refute the null hypothesis (H0: I = 0), which means there is no autocorrelation.

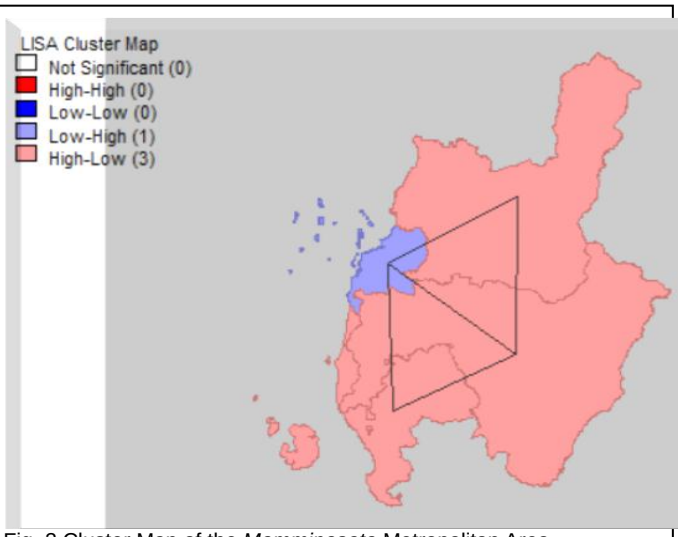

Fig. 2 Cluster Map of the *Mamminasata* Metropolitan Area

In figure 2 above, it can be concluded that the four regions in the *Mamminasata* metropolitan area have different awareness, in this case, the central areas of growth and supporting regions. This quadrant division can be seen in the following explanation:

1. There is no single area in the *Mamminasata* metropolitan area, neither the growth center area nor the supporting area in quadrant I, HH (High-High).
2. Quadrant II HL (High-Low), the central area of growth, in this case, is the city of Makassar. This indicates that in quadrant II HL, the city of Makassar, which has a high observation value (High) is surrounded by areas that have a low observation value (Low).

3. Quadrant III LL (Low-Low), none of the areas in the *Mamminasata* metropolitan area are either growth centers or supporting areas in this quadrant.

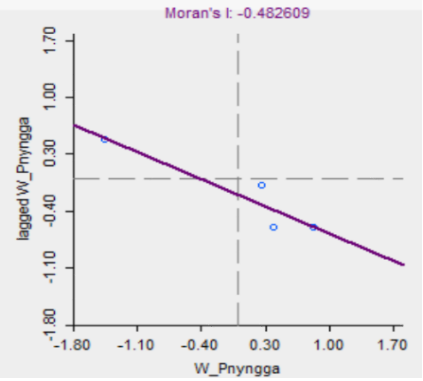

Fig. 3 Moran Scatterplot of growth rate for the Product Domestic Regional Bruto (PDRB) percapita 2003 to 2016 in the area of Metropolitan Mamminasata

Figure 3 above shows that the value of Moran Scatterplot from the growth rate of Per capita GRDP from 2003-2016 is negative, which is equal to -0.4482609. When viewed from a slope that forms a straight line from top left to bottom right, the 4 regions in the *Mamminasata* metropolitan area form a linear relation or indicate a close relation between the city of Makassar as a growth center area towards Maros district, Gowa district, and Takalar district. based on the slope from the upper left to the lower right the liner and the value of Moran l 'which is negative indicates that between the central growth area (located in the upper left point) with Maros district, Gowa district and Takalar district which are predicated as supporting regions (at point lower right) in the Mamminasata metropolitan area spillover impacts occur, but what happens between the central growth area and the supporting area in the *Mamminasata* metropolitan area is a backwash effect. This means that the city of Makassar tends to absorb the surrounding areas that are supporting areas and there is no feedback effect.

In the results of the Local Moran Index and Moran Scatterplot in the three figures above, It appears that there are 3 regencies in the *Mamminasata* metropolitan area that are in this quadrant and form clusters, namely Maros regency, Gowa regency and Takalar district which in fact these 3 regions have a predicate as buffer zones. This indicates that these 3 districts have low observation values which are surrounded by areas with high observation values, in this case, Makassar is the central area of growth in the *Mamminasata* metropolitan area. For illustrated can be seen to figure 4 below:

Quadrant II HL (High-Low) Makassar City	Quadrant I HH (High-High)
Quadrant III LL (Low-Low)	Quadrant IV LH (Low-High) Maros Regency Gowa Regency Takalar Regency

Fig.4 Moran I' Quadrant in *Mamminasata* Metropolitan area

On the other hand, Gowa district, Maros regency and Takalar district, which are categorized as supporting regions, form a cluster in quadrant IV that means the three districts show spatial dependence on the city of Makassar. However, in reality, the city of Makassar only has a backwash effect on the surrounding areas. Based on the Regional GDP (PDRB) per capita from 2002 to 2016 between the city of Makassar as a growth center area and Maros, Gowa, and Takalar district as a supporting area in the *Mamminasata* metropolitan area, it tends to increase significantly. But at the same time, this will also increase/increase the backwash effect received by Maros, Gow, and Takalar towards Makassar city. This condition happened because the city of Makassar in the development process tended to only absorb resources from Gowa, Maros, and Takalar districts. The other hand, the thing that suggests the occurrence of backwash effect is the growth center with its supporting area due to the influence of economic globalization. Urban areas often share connectivity with areas outside the boundaries of their coverage area or even outside the boundaries among provinces, while for the surrounding region; they are only able to absorb their resources. The geographic and economic spatial or neighboring relations occur, but it does not show identical characteristics. In the other hand, between the central growth areas and the supporting regions in the *Mamminasata* metropolitan area, they do not have a symbiotic mutualism growth relation.

5 Conclusion

Based on the scalogram and centrality index analysis of various social and economic facilities in the *Mamminasata* metropolitan area, one area was identified that could be categorized as a growth center area, namely Makassar city and the category of predicated areas, that is Maros, Gowa and Takalar districts. Based on the regional hierarchical character, the *Mamminasata* metropolitan area is divided into three hierarchical characters. Makassar City as hierarchy I serve as the main center of the entire region which can stimulate all other regions which have lower hierarchical levels. Meanwhile, Maros, Gowa, and Takalar districts are included in the hierarchy III category are supporting regions. Based on gravity analysis, it can be seen that the interaction between the supporting regions and the growth centers in the *Mamminasata* metropolitan area shows a level of interrelation or spatial attraction. Based on pull power ratings to Makassar City, respectively according to rank I, II, III, namely Gowa, Maros and Takalar district. Based on the analysis of spatial autocorrelation using the local Moran index method, which was visualized into LISA cluster maps, LISA significance maps, and scatterplot Moran. In the *Mamminasata* Metropolitan area, there is a linear relationship, and the value of Moran l 'growth rate of Regional GDP per capita from 2002-2016 is at -0.482609. That is, between central growth areas and buffer zones in the *Mamminasata* metropolitan area, there is a close relationship geographically but negatively related economically. In other hands, there is a backwash effect between the city of Makassar and the supporting areas in the metropolitan area of *Mamminasata.*

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