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Analysis Autocorrelation Spatial on Amount Fundraising at LAZISMU Semarang City Using Moran's Index

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Abstract

Institution Zakat and Infaq Collectors And Sed e kah Muhammadiyah (LAZISMU) , has role important in gather And distribute funds activity social use help communities in need . L AZISMU Semarang City in general special focus on management funds at the level city , with not quite enough answer gather And allocate funds from public to humanitarian programs like help education , health , and help social research This aim For increase effectiveness collection funds Institution Zakat, Infaq , and Charity Collectors Alms Muhammadiyah in Semarang City. With apply approach spatial , research This analyze pattern distribution geographical donors , potential donations , and characteristics economy as well as demographics in each sub-district . Methodology study involving spatial data collection and analysis statistics . Results study This expected can give contribution on understanding scientific related zakat- based management spatial And become guidelines for institution similar in optimize collection And allocation funds .

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INTRODUCTION

Spatial analysis is an analysis related to the influence of location, which is supported by the First Law of Geography formulated by W. Tobler. Tobler's law states that everything is interconnected with everything else, but something closer will have more influence than something further away. (Anselin, 1988). In the context of spatial data, observations at one location often depend on observations at nearby locations.

Spatial autocorrelation is a spatial analysis used to determine the pattern of relationships or correlations between locations (Triscowati & Bangun, 2019) . One test for spatial autocorrelation is the Moran Index test. The Moran Index is a technique in spatial analysis to measure spatial relationships that occur in unit space (Er et al., 2010) . This method is very important for obtaining information regarding the distribution patterns of characteristics of a region and the relationships between locations within it (Bekti, 2012) .

Several studies have used the test index moran . (Wuryandari et al., 2011) This study examined the spatial autocorrelation of unemployment in Central Java. This study concluded that there was positive spatial autocorrelation, but the correlation was weak because it approached zero, resulting in no spatial autocorrelation in the Moran index significance test. Kumboro et al. (2016) examined the spatial autocorrelation of the distribution of neglected children in Ketapang Regency. This study concluded that there was no spatial autocorrelation in the distribution of neglected children in Ketapang Regency, so the pattern that occurred was a random pattern. (Fat et al., 2020) study about autocorrelation spatial amount unemployment in Java East . Study This conclude that in unemployment in East Java there is no spatial autocorrelation and between district / city One with others No each other correlated . (Riznawati et al., 2023) study about autocorrelation spatial prevalence of stunting in West Java . The results of the study showed positive spatial autocorrelation and spatial correlation, meaning that the prevalence of stunting in one district/city area is related to the surrounding areas. (Maryanto Rompon et al., 2023) study about autocorrelation spatial inheritance culture not objects in Indonesia. Results study show that ICH is significant own autocorrelation spatial .

Spatial autocorrelation testing involves the use of a weight known as a spatial weighting matrix. The spatial weighting matrix (W) is a matrix that describes the relationship between regions and is obtained based on distance or neighborhood information (Hikmah, 2017) . In determining neighborhood relationships, several types of weighting matrices can be used, namely *Linear Contiguity, Rook Contiguity, Bishop Contiguity, Double Linear Contiguity, Double Rook Contiguity* , and *Queen Contiguity.* (Jay et al., 2000) .

By Because that , the writer want to do analysis autocorrelation spatial with index method Moran used fundraising data from the LAZISMU service office in Semarang City in 2021 and 2022. The determination of the observed weights was based on the neighborhood relationship between locations using *the Queen Contiguity* spatial weighting matrix type . The *Queen Contiguity type matrix* , namely neighboring areas, is determined based on the intersection of the border sides and the intersection of the border corners of other areas (Yunitasari, 2019) .

METHOD

2.1 Spatial Data Analysis

Spatial data is data that contains information covering the location or geography of an area. (D. Agustina, 2017) states that spatial analysis leads to many kinds of operations and concepts including simple calculations, classification, arrangement, overlapping geometric arrangement, and cartographic modeling. In general, spatial analysis requires data that is location-based and contains the characteristics of that location. Spatial analysis consists of three groups: visualization, exploration, and modeling. (Wuryandari et al., 2011) . Visualization is the presentation of spatial analysis results. Exploration is the processing of spatial data using statistical methods. Modeling, on the other hand, demonstrates the concept of causal relationships using methods from spatial and

non-spatial data sources to predict spatial patterns. Locations in spatial data must be measured to determine the spatial effects that occur. Location information can be obtained from two sources : connection neighborhood And distance (Wuryandari et al., 2011) .

2.2 Spatial Autocorrelation

Spatial autocorrelation is a indicator similarity object in something space , which can covers distance , time , and region Existence pattern systematic indicates existence autocorrelation spatial . On level point or object , autocorrelation spatial measure as far as where relatedness between point or object or describe phenomena that occur on location the . Autocorrelation spatial positive show that point or object the own characteristics the same one And tend close together One each other. On the other hand , autocorrelation spatial negative show that point the own different characteristics . If point distributed random , then No There is autocorrelation spatial . On testing autocorrelation spatial , matrix weighting agent spatial used to determine connection proximity between location .

2.3 Spatial Weighting Matrix

A spatial weighting matrix is a matrix that describes the proximity of a location to another location (M. Agustina et al., 2022) . A spatial weighting matrix is a matrix that describes the relationship between neighbors between locations by determining the weights between observed locations. The spatial weighting matrix is denoted by C, and c_{ij} is the value in the matrix of the i-th row and j-th column (Jay et al., 2000) .

$$c_i = \sum_{j=1}^{n} c_{ij} \quad (1)$$

In calculating the standardized spatial weighting matrix, a standardization process is required for the spatial weighting matrix to obtain the number of rows *of unity* , namely the number of rows is equal to one (Yuriantari et al., 2017) .

$$W_{ij} = \frac{c_i}{c_{ij}} \quad (2)$$

2.4 Moran's Index

The Moran index measures whether the variables x and y are correlated in one variable, for example x (x_i and x_j) where $i \neq j$, i=1,2,...,n j=1,2,...,n with the amount of data n, then the formula for the Moran Index a is in equation 3.

$$I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n}(x_i - \bar{x})^2} \quad (3)$$

With $\bar{x}$is the average of the variable x, andw_{ij} is an element of the weighting matrix. The value of this index ranges from -1 to 1. A value of $-1 \leq I < 0$ indicates negative spatial autocorrelation, while a value of $0 < I \leq 1$ indicates positive spatial autocorrelation.

Identification of patterns using Moran's I index value criteria, if the value of I > E(I) then it has a clustered pattern, if I < E(I) then it has a spread pattern, if I = E(I) then it has an uneven spread pattern. E(I) is the expected value of I which is formulated as follows (Jay et al., 2000) .

$$E(I) = \frac{-1}{(n-1)} \quad (4)$$

Hypothesis testing of parameter I can be done as follows.

H0 : I= 0 (no spatial autocorrelation)

H1 : I≠ 0 (there is spatial autocorrelation)

According to (Jay et al., 2000) the test statistic of Moran's I index is derived in the form of a standard normal random variable statistic . This is based on the Central Limit Theorem theory where for known large and varied n, Z(I) will have a standard normal distribution as follows:

$$Z_{hitung} = \frac{I - E(I)}{\sqrt{Var(I)}} \quad (5)$$

with I being Moran's Z_{hitung}index I, is the n value of the Moran's index I test statistic , E (I) is the n value of the Moran's index I test expectation , and Var (I) is the n value of the variance of the Moran's I index

$$Var(I) = \frac{n^2 S_1 - nS_2 + 3{S_0}^2}{(n^2 - 1){S_0}^2} \quad (6)$$

where $S_0 = \sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}$, $S_1 = \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n}(W_{ij} + W_{ji})^2$, $S_2 = \sum_{j=1}^{n}(W_{i.} + W_{i.})^2$, $W_{i.} = \sum_{j=1}^{n} W_{ij}$, $W_{.i} = \sum_{j=1}^{n} W_{ji}$. With the decision-making criteria reject H $_0$ if the value of $|Z_{count}| > Z_{(\alpha)}$. So it can be concluded that there is a relationship between regions. The value of the Moran's I index is between -1 and 1, if I > E(I) then it has positive autocorrelation, if I < E(I) then the data has negative autocorrelation.

2.5 *Moran's Scatterplot*

The steps to interpret the Moran Index are through a Moran *Scatterplot* . Moran's *Scatterplot* is a diagram that shows the relationship between the observed value at a standardized location and the average observed value of its neighbors (Habinuddin, 2021) . The grouping and distribution patterns of fundraising in the sub-district are presented using a Moran *Scatterplot,* as shown in Figure 1.

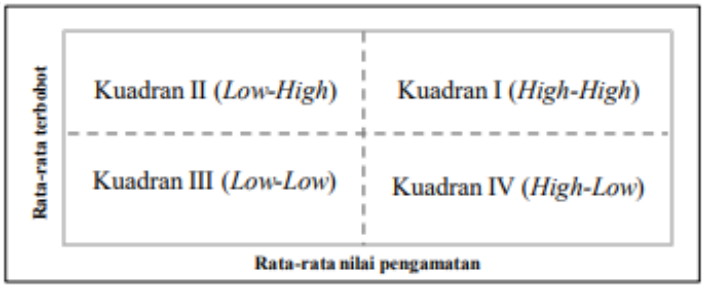


Figure 1. *Moran's Scatterplot*

Moran's Scatterplot is divided into 4 quadrants. Quadrant I (located in the upper right) is called *High-High* (HH), showing areas with high observation values surrounded by areas with high observation values. Quadrant II (located in the upper left) is called *Low-High* (LH), showing areas with low observation values but surrounded by areas with high observation values. Quadrant III (located in the lower left) is called *Low-Low* (LL), showing areas with low observation values and surrounded by areas with low observation values. Quadrant IV (located in the lower right) is called *High-Low* (HL), showing areas with high observation values surrounded by areas with low observation values (Riznawati et al., 2023) .

2.6 Data Types

The type of data used in this study is secondary data originating from LAZISMU Semarang City. The data taken is data collected from LAZISMU service offices in Semarang City. The locations used in this data include all administrative areas in LAZISMU Semarang City which consist of 16 sub-districts, namely Banyumanik District, Candisari District, Gajahmungkur District, Gayamsari District, Genuk District, Gunungpati District, Mijen District, Ngaliyan District, Pedurungan District, Semarang Barang District, South Semarang District, Central Semarang District, East Semarang District, North Semarang District, Tembalang District, and Tugu District .

2.7 Data source

The data source was obtained from the monthly reports of the Finance and General Administration Division of LAZISMU Semarang City for December 2021 and 2022. The data used in this analysis is the total fundraising data collected from each LAZISMU service office spread across 16 districts in Semarang City. Data on the total fundraising from LAZISMU Semarang City Service Offices in 2021 and 2022, covering 16 (sixteen) districts, is presented in Table 1.

Table 1. Data on the Total Collection from the Semarang City Lazismu Service Office per District in 2021 and 2022

Subdistrict	Year	
	2021	2022
Banyumanik	276257009	85796000
Candisari	41339577	43035423
Gajahmungkur	316666500	392468913
Gayamsari	134507700	122403800
Genuk	117036000	145230290
Mount Pati	866376711	1.259287156
Mijen	82986600	957425700
Ngaliyan	252819401	365855670
The barracks	635796010	737001200
West Semarang	281854415	882080181
South Semarang	19200000	4100010
Central Semarang	55800000	36014200
East Semarang	26216900	23529705
North Semarang	4815000	14100300
Tembalang	203253705	28639900
Monument	410000	200000

2.8 Data Analysis Stages

The analysis begins with describing the 2021 and 2022 fundraising data. The next step is to determine the spatial weighting matrix. In this study, the established weighting matrix is *queen contiguity.* The final step is to detect spatial autocorrelation using Moran's I from the 2021 and 2022 fundraising data at LAZISMU Semarang City.

RESULTS AND DISCUSSION

3.1 Descriptive Analysis

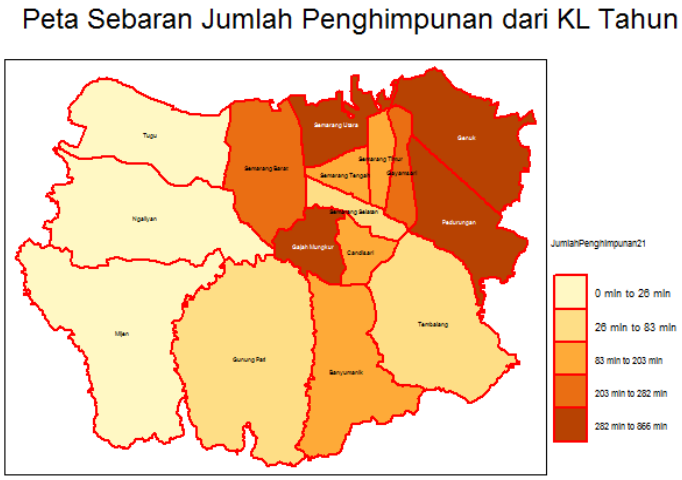
Descriptive analysis is used to provide an overview or describe data seen from the average value (*mean)* , minimum value, and maximum value.

Table 2 . Descriptive Analysis

Year	Mean	Min	Max
2021	207208470	410000	866376711
2022	318573028	200000	1259287156

Table 2 shows that in 2021, the average fundraising from the LAZISMU Semarang City service office by sub-district was 207208470 with a minimum value of 410000 in Tugu District and a maximum value of 866376711 in Gunungpati District. In 2022, the average fundraising from the LAZISMU Semarang City service office by sub-district increased to 318573028 with a minimum amount of 200000 in Tugu District and a maximum amount of 1259287156 in Gunungpati District.

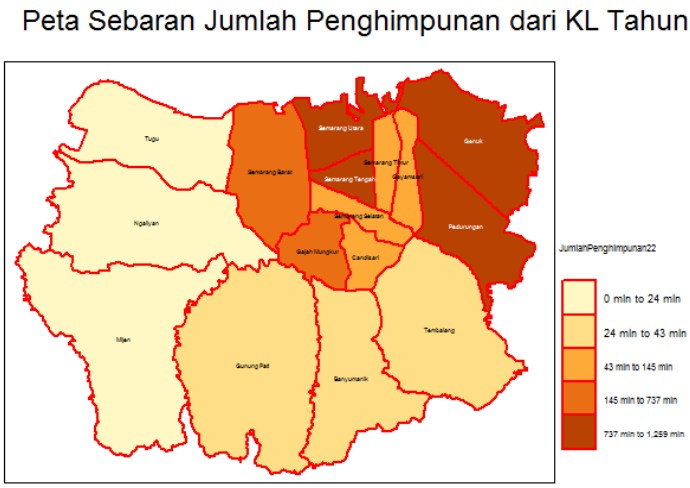
3.2 Quantile Distribution of Fundraising Amounts from LAZISMU Service Offices in Semarang City in 2021



Picture 2 . Distribution of Fundraising Amount from LAZISMU Service Office in Semarang City in 2021

Figure 2 is a map of the distribution of data on the amount of fundraising in each sub-district in Semarang City. Figure 2 explains that the category of the amount of fundraising is divided into five parts, where the five parts are indicated from light red to dark red. Figure 2 shows that there are areas with the largest amount of fundraising in the category where this is indicated by the darkest red area among the other red areas with the amount of fundraising between 282 to 866 fundraising with 4 areas classified as the largest amount of fundraising, namely Gajahmungkur District, North Semarang District, Pedurungan District, and Genuk District. Judging from the geographical location of each area indicated by the largest amount of fundraising, the location of the areas included in the highest collection category tends to be close to each other, such as in Genuk District which is adjacent to Pedurungan District. From Figure 2, the lower the level of fundraising in each area is indicated by the increasingly bright red color in each area. The bright red color is the color to mark the area with the smallest amount of fundraising, namely between 0 and 26 fundraisings, where the areas covered by the amount of fundraising are 3 areas, namely Tugu District, Ngaliyan District, and Mijen District.

3.3 Quantile Distribution of Fundraising Amounts from LAZISMU Service Offices in Semarang City in 2022



Picture 3 . Distribution of Fundraising Amount from LAZISMU Service Office in Semarang City in 2022

Figure 3 is a map of the distribution of data on the amount of fundraising in each sub-district in Semarang City. Figure 3 explains that the category of the amount of fundraising is divided into five parts, where the five parts are shown from light red to dark red. Figure 3 shows that there are areas with the largest amount of fundraising in the category where this is indicated by the darkest red area among the other red areas with the amount of fundraising between 737 to 1259 fundraising with 4 areas classified as the largest amount of fundraising, namely North Semarang Sub-district, Central Semarang Sub-district, Genuk Sub-district, and Pedurungan Sub-district. Judging from the geographical location of each area indicated by the largest amount of fundraising, the location of the areas included in the highest collection category tends to be close to each other such as North Semarang Sub-district which is adjacent to Central Semarang Sub-district and Genuk Sub-district which is adjacent to Pedurungan Sub-district. From Figure 3, the lower the level of fundraising in each area is indicated by the increasingly brighter red color in each area. The bright red color is the color to mark the area with the smallest amount of fundraising, namely between 0 and 24 fundraisings, where the areas covered by the amount of fundraising are 3 areas, namely Tugu District, Ngaliyan District, and Mijen District.

3.4 Spatial Weighting Matrix

In spatial analysis to determine the presence of spatial autocorrelation, the main component required is a location map. The map is used to determine the proximity relationship between sub-districts in Semarang City. Thus, it will be easier to assign weights to each location or sub-district. From the map of Semarang City, it is known that there are 16 sub-districts so that the spatial weighting matrix will be 16x16 in size. The matrix weighting method used is *queen contiguity* and the way to obtain the spatial weighting matrix is based on *the standardize contiguity matrix* W (standardized weighting matrix). *Standardize contiguity matrix* W (standardized weighting matrix) is obtained by giving equal values or weights to the nearest location neighbors and other locations are given zero weight (Kosfeld & Dreger, 2006) . Based on the spatial weighting matrix, the number of neighbors of each location can be determined. The graph of the number of neighbors for each sub-district is as follows:

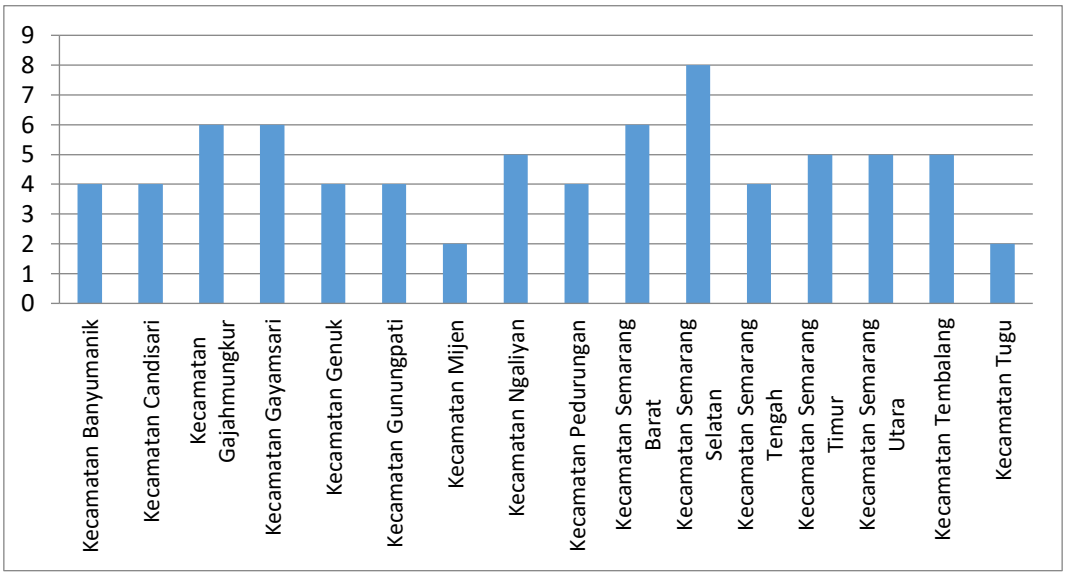


Figure 4. Number of Neighbors in Each District

The neighbor count graph is a graph that explains the number of sub-district locations that directly border according to the *queen contiguity provisions* with the observed sub-district. Based on Figure 4, it can be seen that the sub-district with the most location boundaries (neighbors) is South Semarang Sub-district, with 8 neighbors. Furthermore, the district with the fewest location boundaries (neighbors) is Tugu Sub-district and Mijen Sub-district has 2 neighbors.

3.5 Testing Moran's Index

The results obtained from study This is in the form of information about sub - districts in Semarang City that have data on the amount of funds collected each other correlated between one sub -district with other sub-districts . Autocorrelation process spatial used For know pattern fundraising that happens all over sub-districts in Semarang City . From the data on the number of collection funds form patterns grouped on location The results of the spatial autocorrelation calculations on the amount of funds raised can be seen in Table 3.

Table 3. Results of the Spatial Autocorrelation Process for the Amount of Fundraising in 2021 and 2022

Year	Moran's Index	Expected Value	Variance	Z-score	p-value
2021	0.20885	-0.06667	0.02001	1.94773	0.02572
2022	0.20251	-0.06667	0.02001	1.90291	0.02852

Based on Table 3, it can be seen that the Moran index (I) value for the amount of fundraising in 2021 was 0.20885 and in 2022 it was 0.20251, which is greater than the expected value E(I) -0.06667 or I > E(I), which indicates the presence of positive spatial autocorrelation or the formation of a clustered pattern . statistics test p- value on in 2021 amounting to 0.02572 and p-value on 2022 amounted to 0.02852 with level significance 5% p- value more small from α (0.05), then H_0 rejected And can concluded that There is a spatial correlation between sub-districts based on the amount of funds collected in Semarang City.

3.6 Moran Plot

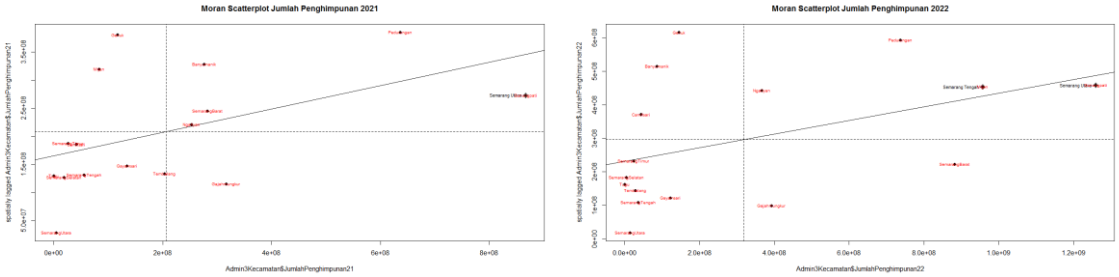
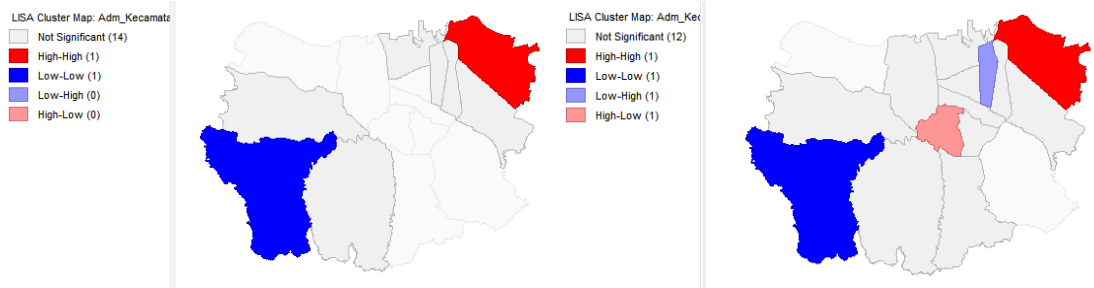


Figure 5. Moran's Plot of Total Collection in 2021 and 2022

Figure 5 is a Moran plot showing the relationship between the amount of fundraising in 2021 and 2022 from the LAZISMU Semarang City service office in one sub-district and another sub-district . connection This show that amount collection funds in a subdistrict tend influenced by amount collection funds in the sub-district surrounding areas . Sub-districts that consistently fall into quadrant I are Ngaliyan and Pedurungan Sub-districts, indicating that these sub-districts have the highest fundraising numbers and are adjacent to other sub-districts that also have the highest fundraising numbers. Sub-districts that consistently fall into quadrant II are Genuk Sub-district, indicating that Genuk Sub-district has the smallest fundraising numbers and is surrounded by other sub-districts that have the highest fundraising numbers. Sub-districts that consistently fall into quadrant III are East Semarang Sub-district, South Semarang Sub-district, Tugu Sub-district, Tembalang Sub-district, Central Semarang Sub-district, Gayamsari Sub-district, and North Semarang Sub-district, indicating that these sub-districts have the smallest fundraising numbers and are surrounded by other sub-districts that also have the smallest fundraising numbers. Sub-districts that consistently fall into quadrant IV are Gajahmungkur Sub-district, indicating that Gajahmungkur Sub-district has the largest fundraising numbers and is surrounded by other sub-districts that have the smallest fundraising numbers. Sign like *diamond* on the Moran plot 2021 and 2022 have great influence to autocorrelation spatial . On the Moran plot in 2021 there was One sub - districts included to in quadrant I, namely North Semarang District with *hotspot – high high* which means North Semarang District includes to in areas that have amount collection funds the most , while the Moran plot 2022 increases One subdistrict that is Central Semarang District. The kitchen cluster's total fundraising in Semarang City in 2021 and 2022 is shown in Figure 6.



Picture 6 . Visualization Autocorrelation Spatial Fundraising in 2021 and 2022

Based on Figure 6, the spatial pattern of fundraising in 2021, which includes the *Cluster pattern,* is in quadrant I (*High-High*), quadrant III (*Low-Low*). The sub-districts included in the *Cluster pattern* in quadrant I (High-High) are Genuk Sub-district. Meanwhile, the sub-districts included in the *Cluster pattern* in quadrant III (*Low-Low*) are Mijen Sub-district. Furthermore, in 2022, *the Cluster pattern* is included in quadrant I (*High-High*), quadrant II (*Low-High*), quadrant III (*Low-Low*), and quadrant IV (*High-Low*). The sub-districts included in the *Cluster pattern* quadrant I (*High-High*) are Genuk Sub-district, the sub-districts included in the *Cluster pattern* quadrant II (*Low-High*) are East

Semarang Sub-district, the sub-districts included in the *Cluster pattern* quadrant III (*Low-Low*) are Mijen Sub-district and the sub-districts included in the *Cluster pattern* quadrant IV (*High-Low*) are Gajah Mungkur Sub-district.

CONCLUSION

Based on results analysis autocorrelation spatial collection funds in Semarang City, can concluded that there is positive spatial autocorrelation . This is means that mark collection funds in a subdistrict tend The same with mark collection funds in the sub-district surrounding area . Results test significance method Moran's index shows that pattern distribution spatial collection funds in Semarang City have pattern cluster . On map pattern distribution spatial collection funds In 2021, the sub-districts that were included in the *cluster pattern* (quadrant I (*High-High*) and quadrant III (*Low-Low*)) were Genuk Sub-district (*High-High*) and Mijen Sub-district (*Low-Low*). Meanwhile, in map spatial distribution pattern of fundraising in 2022, the sub-districts included in the *Cluster pattern* (quadrant I (*High-High*), quadrant II (*Low-High*), quadrant III (*Low-Low*) and quadrant IV (*High-Low*)) are Genuk Sub-district (*High-High*), East Semarang Sub-district (*Low-High*), Mijen Sub-district *(Low-Low)* , and Gajah Mungkur Sub-district (*High-Low*).

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