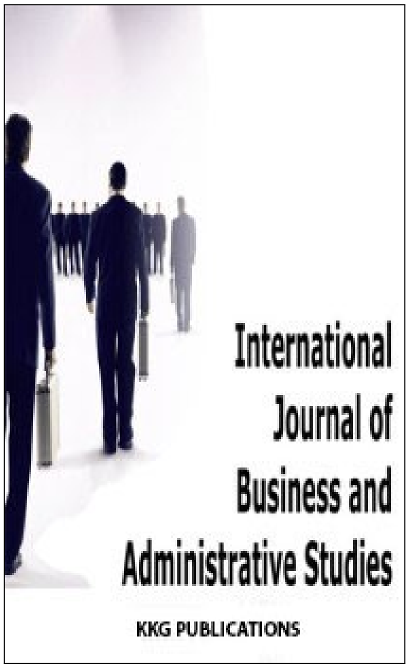

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Spatial Analysis of Newspaper Sales in East Surabaya Traffic Lights Using Moran Index

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SPATIAL ANALYSIS OF NEWSPAPER SALES IN EAST SURABAYA TRAFFIC LIGHTS USING MORAN INDEX

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Abstract. The purpose of this study is to examine whether there is a spatial relationship of newspaper sales in a traffic light area with another neighboring area. This research was conducted in traffict light area of East Surabaya. There are 7 sub-districts in East Surabaya namely Tambak Sari (5 traffict), Gubeng (12 traffict), Sukolilo (7 traffict), Mulyorejo (5 traffict), Tenggilis Mejoyo (8 traffict), Rungkut (5 traffict), and Gunung Anyar (1 traffict). Total trafficts in East Surabaya studied were 43 traffic lights. Moran Index method was used to examine the spatial relations of newspaper sales between neighboring regions. Its calculation result was 0.45. The calculation of *Z(I)* is 1.34 whereas is 1.34 whereas $Z_{0.95}$= 1.645 (Table), since $Z(I) < Z_{0.95}$. This can be concluded that there was no spatial autocorrelation of newspaper sales between neighboring areas in East Surabaya. Even though the vehicles were moving from one traffic to another in neighboring East Surabaya; however, buyers in certain traffic will not buy another newspaper on other traffic. So there was no spatial autocorrelation. Implication of the study: salesman of newspaper suggested to monitor fluctuation of vehicle density in traffic light. It means they should be making online network to analyze the real spatial correlation between traffic in East Surabaya.

INTRODUCTION

Trend of newspaper sales in traffic light in Indonesia is currently increased. New newspaper is called Super Ball that are sold in traffic light of Balik Papan plaza reaching 20 copies within 30 minutes (tribunnews.com). In Surabaya, selling newspapers in traffic lights that disturbs public convenience is still permitted under the Government Regulation No. 2 Year 2014. The regulation gives a permission to sell newspapers until 5 in the evening. In fact, the occurrence of newspaper sales transactions in traffic light is due to the daily demands as well as offers on newspaper needs. Consumers, like car drivers, are convenient to buy newspapers through car window glass. On the other side, newspaper sellers feel comfortable with selling newspapers in the traffict light since they do not need to spend rent fee for their newspaper boots. Therefore, in this study, car drivers are the demand factor; while newspaper distributors and sellers are the offers factor. The number of newspaper sales can be different between one region and another. It is considered by the sales in the surrounding area. This may be due to the movement of a vehicle from one traffic to another and from one area to another adjacent. Therefore, it is estimated that there is a regional linkage to the number of newspaper sales in East Surabaya traffic light. Spatial correlation between region used and Moran Index. Many spatial analyses use Moran Index (Chhetri, Butcher, & Corbitt, 2014; Devaux & Dube, 2016; Luekveerawattana, 2016; Mazzulla & Forciniti, 2012; Salvati, Venanzoni, Serra, & Carlucci, 2016; Song, Wang, Wu, & Yang, 2011; Wismadi, Zuidgeest, Brussel, & Maarseveen, 2014; Xiaoling & Ali, 2016).

Research Area

The research location of this study is in East Surabaya, as location map shown in Figure 1.

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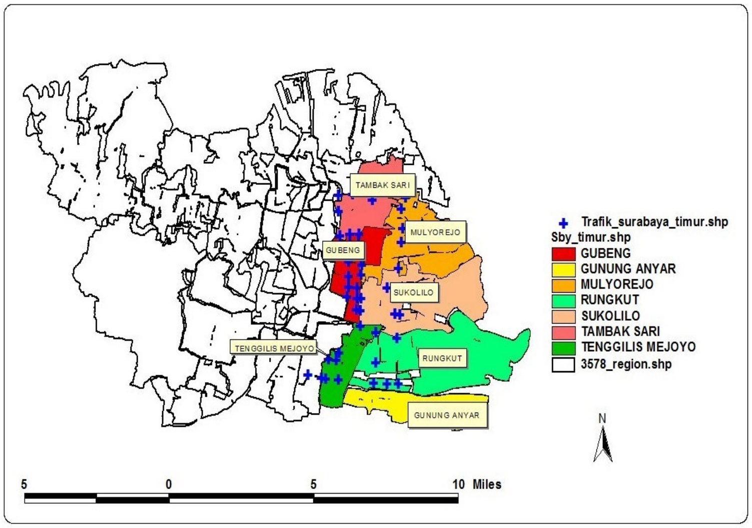
FIGURE 1
Research Location Map in East Surabaya



The number of traffic for each sub-district is shown in Table 1.

TABLE 1
Number of Traffic in Each Sub-District

No	District Names	Numbers of Traffic
1	Tambak Sari	5
2	Gubeng	12
3	Sukolilo	7
4	Mulyorejo	5
5	Tenggilis Mejoyo	8
6	Rungkut	5
7	Gunung Anyar	1
		43

LITERATURE REVIEW

Spatial data are data that contain "location" information. It is not only "what" is measured but indicates the location where the data reside (Anselin, 1993). Spatial data can be information about geographic location such as the location of latitude and longitude of each region and border between regions. Simply, the spatial data are recounted as address information. In other forms, spatial data are in the form of coordinate grid as in map presentation or in pixel form as in the form of satellite imagery Banerjee (2004). Thus, the general spatial statistical analysis approach can be presented in the form of thematic maps.

The first law on geography was put forward by Tobler (1979). As cited in Anselin (1993), he argues that all things are related to each other, but something closer will be more related than others far apart. This theory is the pillar of regional science study. It can be concluded that spatial effect is a natural thing between one region and another. The study about effect the spatial factor has on economy has been done by Abdul, Hasmi, Peck, Masria, and Rohana (2015); Agovino, Parodi, and Barajas (2014); Rochana, Kombaitan, and Purwanda (2015); Rusanovskiy and Markov (2016); Pabian (2017); Sofi and Durai (2015).

Spatial data are data that contain the location or geographical information of a region. According to DeMers (1997) in Budiyanto (2009), spatial analysis leads to many kinds of operations and concepts including simple calculations, classifications, structuring, geometric overlap, and cartographic modeling. In general, spatial analysis requires the location-based data and contains the characteristics of the location. Spatial analysis consists of three groups: visualization, exploration, and modeling. Visualization is to inform the results of spatial analysis. Exploration is to process spatial data with statistical methods. The study of visualization to explore Geographic Patterns has been done by Wilson (2011). While modeling is to show the existence of causality concept by using methods of spatial data source and non-spatial data to predict spatial patterns. Location in the spatial data must be measured in order to know the existence of spatial effects that occur. According to Kosfeld (2006), location information can be known from two sources i.e., neighborhood relationship and distance.

Neighborhood Relationship

The neighboring relationship reflects the relative location of a spatial unit or the specific location to another location within a certain space. The neighborhood relationships of the spatial units are usually formed on the map. The neighborhood of these spatial units is expected to reflect a high degree of spatial dependence if they are compared to spatial units located far apart.

Distance

Location within a certain space with the latitude and the line-longitude becomes a source of information. This information is used to calculate the distance between points in space. It is expected that the strength of spatial dependence will decrease according to the distance.

The most important thing in spatial analysis is the weighting called as the spatial weighted matrix. Spatial weighted matrices are used to determine the weights between locations observed based on the neighboring relationships between locations. According to Kosfeld (2006), the common grid neighbors can be defined in several ways, namely:

a. *Rook Contiguity*

The area of observation is determined based on the sides that touch each other and the angle is not taken into account. The illustration of rook contiguity is seen in Figure 2, where units *B1*, *B2*, *B3*, and *B4* are neighbors of unit A.

FIGURE 2
Rook Contiguity

		UnitB2		
	UnitB1	UnitA	UnitB3	
		UnitB4		

b. *Bishop Contiguity*

The area of observation is determined by the angles that are tangent to each other and the sides are not taken into account. Illustration for bishop contiguity is seen in Figure 3, where units *C1*, *C2*, *C3*, and *C4*are neighbors of unit A.

FIGURE 3
Bishop Contiguity

	UnitC1		UnitC2	
		UnitA		
	UnitC4		UnitC3	

c. *Queen Contiguity*

The area of observation is determined based on the sides that touch each other and the angle is also taken into account. The illustration for queen contiguity can be seen in Figure 4, where units *B1*, *B2*, *B3*, and *B4* and *C1*, *C2*, *C3*, and *C4* are neighbors of unit A.

FIGURE 4
Queen Contiguity

	UnitC1	UnitB2	UnitC2	
	UnitB1	UnitA	UnitB3	
	UnitC4	UnitB4	UnitC3	

In general, the neighborhood between locations is based on the main sides rather than the angles. According to Kosfeld (2006), the spatial weighted matrix W can be derived from two ways: standardized contiguity matrix W and unstandardized contiguity matrix. Standardized contiguity matrix *W* is a weighting matrix obtained by giving equal weight to neighboring and other neighboring locations; while unstandardized weighting matrix is a weighted matrix obtained by giving one weight to the nearest neighbor and the other zero. The study about neighbourhoods using Moran Index has been done by Mare, Pinkerton, Poot, and Coleman (2012).

PREVIOUS RESEARCH

Erdogan (2009) findings are regions with high concentration of fatal accidents and deaths were located in the provinces that contain the roads connecting the Istanbul, Ankara, and Antalya provinces. Accident and death rates were also modeled with some independent variables such as number of motor vehicles, length of roads, and so forth using geographically weighted regression analysis with forward step-wise elimination. The level of statistical signicance was taken as $p < 0.05$. Large differences were found between the rates of deaths and accidents according to denominators in the provinces. The geographically weighted regression analyses did significantly better predictions for both accident rates and death rates than did ordinary least regressions, as indicated by adjusted R^2 values. Geographically, weighted regression provided values of 0.89-0.99 adjusted R^2 for death and accident rates, compared with 0.88-0.95, respectively, by ordinary least regressions.

Nunes and Nascimento (2012) identified spatial patterns of mortality in the state of Sao Paulo. They say that despite the the restrictive law on alcohol being in force, many micro-regions presented deterioration of their rates, indicating locations where surveillance actions should be reviewed in order to become more effective for the prevention of traffic accidents and for road safety.

Blazquez and Celis (2013) identified seven critical areas with high child pedestrian crash risk employing kernel density estimation, and subsequently, statistically significant clusters of the main attributes associated with these crashes in each critical area were determined in a geographic information systems environment. Moran's I index test identified a positive spatial autocorrelation between crash contributing factors, time of day, straight road sections and intersections, and roads without traffic signs within the critical areas during the studied period, whereas a random spatial pattern was identified for crashes related to the age attribute. No statistical significance in the spatial relationship was obtained in child pedestrian crashes with respect to gender, weekday, and month of the year. The results from this research aid in determining the areas in which enhanced school-age child pedestrian safety is required by developing and implementing effective enforcement, educational, and engineering preventive measures. Rukewe, Taiwo, Fatiregun, Afuwape, and Alonge (2014), their findings are all the traffic accidents were categorized into motor vehicular, motorbike, and pedestrian crashes. Geo referencing of accident locations mentioned by patients was done using a combination of Google Earth and Arc GIS software. Nearest neighbor statistic, Moran's-*I*, Getis-Ord statistics, Student *t*-test, and ANOVA were used in investigating the spatial dynamics in crashes. This study showed that the use of geographic information system can help in understanding variations in road traffic accident occurrence, while, at the same time, identifying locations and neighborhoods with unusually higher accidents frequency.

Wuryandari, Hoyyi, Kusumawardani, and Rahmawati (2014): They identified unemployment is caused by the workforce or job seekers are not proportional to the number of existing jobs. Unemployment is often a problem in the interconnected economy as the unemployment, productivity, and income will be reduced. The number of unemployed in an area is expected to be affected by unemployment in the surrounding area. This is made possible because of the proximity factor or adjacency between regions. It is estimated that there are linkages to the regional unemployment rate. To determine the relationship between regional linkages, authors used Moran's Index method. They found that the similarity between the district does not exist in Central Java.

RESEARCH METHODS

Spatial autocorrelation is an estimate of the correlation between observed values associated with the spatial location of the same variable. Positive spatial autocorrelation showsthe similarity of values from adjacent locations. It also tends to work in groups. Whereas negative spatial autocorrelation indicates that the adjacent locations have different values and tend to spread. Characteristics of spatial autocorrelation stated by Kosfeld (2006) are as follow:

- If there is a systematic pattern on the spatial distribution of the observed variables, sospatial autocorrelation exists.
- If proximity or neighborhood between regions is closer, so there can be a positive spatial autocorrelation.
- Negative spatial autocorrelation illustrates an unsystematic neighboring pattern.
- A random pattern of spatial data indicates no spatial autocorrelation.

Spatial autocorrelation measurements for spatial data can be calculated using the Moran's Index method. According to Kosfeld (2006), the calculation of spatial autocorrelation by Moran Index method can be conducted in two ways, such as:

Moran Index with unbranded spatial weighted matrix

$$W^{*}.\ I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(X_j-\bar{X})(X_j-\bar{X})}{S_0\sum_{i=1}^{n}(X_i-\bar{X})}$$

where

$S_0 = \sum_{i=1}^{n}\sum_{j=1}^{n} w*_{ij}$

Moran Index with standardized spatial weighted matrix W.

$$I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(X_j-\bar{X})(X_j-\bar{X})}{\sum_{i=1}^{n}(X_i-\bar{X})^2}$$

Where :

I: Moran Index

n: number of incident locations

x_i: value at location i

x_j: value at location j $\bar{X}$:average of the variable numbers or values $W*_{ij}$: element in non-standardized weighting between region i and j W_{ij}: standardized weighing elements between regions i and j.

The range of values of the Moran Index in the case of standardized spatial weighted matrix is $-1 \leq I \leq 1$. The value $-1 \leq I < 0$ indicates a negative spatial autocorrelation, whereas the value $0 < I \leq 1$ indicates a positive spatial autocorrelation.. The value of the Moran Index is zero indicating non-clustering. The Moran Index score does not guarantee the accuracy of the measurement if the weighting matrix used is non-standardized weighting. For identifying the presence of spatial autocorrelation, a Moran Index of significance is tested. The hypothesis test for Moran Index is as follows:

i. Hypothesis

H0: There is no spatial autocorrelation.

H1: There is spatial autocorrelation.

ii. Level of significance: α

iii. Test statistics

$$Z(I) = \frac{(I-E(I))}{\sqrt{Var(I)}} \approx N(0,1)$$

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

$$Var(I) = \frac{n^2.s_1 - nS_2 + 3.S_0^2}{(n^2-1)S_0^2} - [E(I)]^2$$

$S_0 = \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}$

$S_1 = \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n}(w_{ij}+w_{ij})^2$

$S_2 = \sum_{i=1}^{n}\left(\sum_{j=1}^{n} w_{ij} + \sum_{j=1}^{n} w_{ij}\right)^2$

Test criteria: Reject H0 at the significance level if $Z(I) < Z_{1-\alpha}$

RESEARCH RESULT AND DISCUSSION

Result

The data used in this research are newspaper sales data in East Surabaya traffic lights in June 2016 shown in Table 2.

TABLE 2
Average Sales Turnover Per Day in East Surabaya

No	District	(Traffict Light Coordinate)		Omzet/Day	Omzet Average
		SOUTH	EAST		
1	Tambak Sari	07°15′21.6″	112°45′02.8″	15	8
2		07°14′56.2″	112°45′01.7”	6	
3		07°14′55.3″	112°45′28.4″	6	
4		07°15′57.7″	112°45′23.1″	9	
5		07°15′04.0″	112°46′03.8″	6	
6	Gubeng	07°16′41.0″	112°45′20.9″	24	9
7		07°17′04.5″	112°45′20.7″	9	
8		07°17′21.5″	112°45′21.4″	9	
9		07°17′58.1″	112°45′42.9”	12	
10		07°17′38.1″	112°45′36.0″	9	
11		07°16′00.3″	112°45′04.8″	15	
12		07°17′56.3″	112°45′35.3″	3	
13		07°17′22.3″	112°45′35.8″	4	
14		07°17′36.0″	112°45′18.7”	6	
15		07°16′13.6″	112°45′23.0″	6	
16		07°15′58.0″	112°45′39.4″	4	
17		07°16′14.2″	112°45′39.0″	3	
18	Sukolilo	07°17′22.1″	112°46′31.2″	20	10
19		07°17′21.3″	112°46′50.0″	12	
20		07°16′46.3″	112°45′44.2″	18	
21		07°18′04.1″	112°46′54.3″	6	
22		07°17′28.3″	112°45′44.0″	12	
23		07°17′01.6″	112°45′44.0″	2	
24		07°18′03.0″	112°46′45.2″	3	
25	Mulyorejo	07°16′51.0″	112°46′51.7″	20	11
26		07°16′10.5″	112°46′55.8″	12	
27		07°15′48.1″	112°46′58.6″	9	
28		07°15′00.1″	112°47′03.6″	9	
29		07°15′17.7″	112°46′56.4″	4	
30	Tenggilis	07°19′15.7″	112°45′00.0″	6	9
31		07°19′45.6″	112°44′40.4″	9	
32		07°19′14.5″	112°44′45.4″	4	
33		07°19′38.6″	112°44′07.7″	12	
34		07°18′22.6″	112°45′42.4″	20	
35		07°19′46.8″	112°45′03.9″	4	
36		07°19′44.7″	112°44′32.4″	2	
37		07°19′04.6″	112°45′04.5″	9	
38	Rungkut	07°19′19.8″	112°46’11.4”	9	9
39		07°19′52.6″	112°46′31.1″	6	
40		07°19′51.1″	112°46′07.7″	4	
41		07°18′31.6″	112°46′11.5″	15	
42		07°18′41.5″	112°46′49.3″	12	
43	Gunung Anyar	07°19′52.7″	112°46′52.6″	12	12

Spatial Weighted Matrix

The main component needed to determine the existence of spatial autocorrelation is the location map. The map is used to determine the proximity relationship between districts in East Surabaya. Thus, it would be easier to give weight to each location or district. From the location map in East Surabaya, it was known that there were 7 districts, so the spatial weighted matrix will be 7x7. Matrix weighting method used was rook contiguity and based on standardized contiguity matrix W (standardized weighing matrix) to obtain spatial weighted matrix. Then, standardized contiguity matrix W (standardized weighing matrix) was obtained by assigning an equal value or weight to the nearest neighboring location and the other location being assigned a zero weight. Based on the spatial weighted matrix, it could be known for the numbers of neighboring locations owned by each sub-district. The number of neighborhoods for each sub-district is shown in Table 3 below

TABLE 3
Number of Neighborhoods Each District

No	District	Number of Neighbors
1	Tambak Sari	2
2	Gubeng	4
3	Sukolilo	4
4	Mulyorejo	3
5	Tenggilis Mejoyo	4
6	Rungkut	3
7	Gunung Anyar	2

The Table of number of neighbors above shows a graph explaining the number of sub-district locations that are directly adjacent to the rook contiguity with the observed districts. Based on Figure 1, it can be seen that sub-districts with four borders of location (neighbors) are Gubeng, Sukolilo, and Tenggilis Mejoyo. Furthermore, the sub-districts with only 2 neighbors are Tambak Sari and Gunung Anyar. The standardized weighing elements between regions i and j (W_{ij}) showed in Figure 5.

FIGURE 5
Standardized Weighing Elements Between Regions i and j (W_{ij})

j \ i	1	2	3	4	5	6	7
1	1/2	0	0	0	0	0	0
2	0	1/4	0	0	0	0	0
3	0	0	1/4	0	0	0	0
4	0	0	0	1/3	0	0	0
5	0	0	0	0	1/4	0	0
6	0	0	0	0	0	1/3	0
7	0	0	0	0	0	0	1/2

The Moran Index is one of the spatial analysis techniques that can be used to determine the existence of spatial autocorrelation between observation sites. Moran Index Calculation is as follows:

$$I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(X_j-\bar{X})(X_j-\bar{X})}{S_0\sum_{i=1}^{n}(X_i-\bar{X})} = \frac{5.0799}{11.4284} = 0.4445.$$

In this study, the significance test used a normal approach to determine whether there was spatial autocorrelation. The hypothesis test was considered as follow:

i. Hypothesis

H0: There is no spatial autocorrelation.

H1: There is spatial autocorrelation.

ii. Level of significance $\alpha = 5\%$

iii. Test statistics

$E(I) = \frac{-(1)}{(n-1)} = -1.1667.$

$S_0 = \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij} = ((1/2)+(1/4)+(1/4)+(1/3)+(1/4)+(1/3)+(1/2)) = 2.42.$

$S_1 = \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n}(w_{ij}+w_{ij})^2 = 1/2(((1/2)+(1/2))^2 + ((1/4)+(1/4))^2 + ... + ((1/2)+(1/2))^2) = 1.82.$
$S_2 = \sum_{i=1}^{n}\left(\sum_{j=1}^{n} w_{ij} + \sum_{j=1}^{n} w_{ij}\right)^2 = (((1/2) + (1/2))^2 + ((1/4)+(1/4))^2 + ... + ((1/2)+(1/2))^2) = 3.64.$
$Var(I) = \frac{n^2.s_1 - nS_2 + 3.S_0^2}{(n^2-1)S_0^2} - [E(I)]^2 = 0.01354.$
$Z(I) = \frac{(I - E(I))}{\sqrt{Var(I)}} \approx N(0,1) = 0.78059.$
iv. Test criteria: Reject H0 at the significance level α if $Z(I) > Z_{1-\alpha}$ and $Z_{1-\alpha} = Z_{0.95} = 1.645$
v. Conclusion
From the calculation results, it could be seen that the value of *Z(I)* = $0.78059 < Z_{0.95} = 1.645$. Thus, H_0 was accepted or the conclusion that there was no spatial autocorrelation.
From Moran Index testing, it could be concluded that at 5% significance level, there was no spatial autocorrelation to the sales of newspapers between neighboring areas in East Surabaya. The Moran Index value of 0.4445 was in the range $0 < I \leq 1$ and indicated a positive spatial autocorrelation but the correlation was weak because it was close to zero. This study concluded that one district with other districts has no similarity in value. In other words, this study indicated that data were not in groups.

DISCUSSION

The similarity of this study with previous researches of Erdogan (2009); Blazquez and Celis (2013); Nunes and Nascimento (2012); Rukewe et al. (2014); Wuryandari et al. (2014) is the use of the Moran Index for Spatial Autocorrelation measurements. However, the difference is in the cases being investigated and location. For example, Erdogan (2009) studied spatial patterns of child pedestrian safety the Istanbul, Ankara, and Antalya provinces, Nunes and Nascimento (2012) studied spatial patterns of mortality in the state of Sao Paulo, Blazquez, and Celis (2013) studied spatial pattern of child pedestrian safety in Santiago, Chile. Rukewe et al. (2014) examined spatial patterns of child traffic accidents in Ibadan, Nigeria, Wuryandari et al. (2014) examined regional linkages of unemployment in Central Java, and this study studied about newspaper sales in East Surabaya.

CONCLUSION

Based on the results of the analysis and discussion, the conclusions of this study is depicted below:

- Based on the calculation, the value of Moran Index I = 0.4445. The Moran Index value was in the range of $0 < I \leq 1$ to indicate a positive spatial autocorrelation but its correlation wasweak because it was close to zero, thus causing no spatial autocorrelation in testing the significance of the Moran index.
- Based on the significance test of Moran Index with significance level of 5% , this study concluded that the inter-districts with each other did not have similar values. This indicated that the number of sales of newspapers was not correlated between sub-districts in East Surabaya.

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— This article does not have any appendix. —