Sumatra Island Economic Cluster

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Abstract. The growth of a region cannot be released from its position in a larger urban system. Interactions in urban systems manifest in various forms such as population migration, trade, and information exchange. These interactions then have an influence on other regions. One of the expected outcomes of urban interaction is economic growth. However, not all regions can have a positive influence in their interactions in urban systems. This influence can be seen through spatial spreads that occur in existing economic indicators. This research seeks to look at clusters of economic activity on Sumatra Island because of the urban interactions that occur. This research uses the LISA method on economic data of 172 districts under the administrative area of the island of Sumatra. It is seen that the spatial distribution of economic activity is not random. There are several clusters of economic activity following the concentration of the population on the island of Sumatra namely in the area around Medan and Lampung. This spatial arrangement has no significant change between the two years of observation. While population and quality of transportation have a strong relationship, but these two variables do not appear to have a relationship with the GDRP of transportation.

Keywords: urban system, urban interaction, LISA, spatial cluster.

1. Introduction

Given transportation as a derivative need, the interaction between transportation and economic development is a relationship to transportation capabilities in magnifying the impact of urban agglomeration. In other words, transportation can only have an economic impact if transportation can directly improve urbanization [1]. Similarly, said that accessibility without increased employment or income in a region, then the development of access on economic grounds cannot be justified. This makes the relationship between economy and transportation need to be discussed in economic development efforts [2].

Central Bureau of Statistic states, in 2000, Sumatra Island's GDRP was known to be about 21.3% of Indonesia's GDP. In 2017, the GDRP of Sumatra island increased against Indonesia's GDP to about 21.7%. This indicates that the amount of economic activity that is currently located on the island of Sumatra. However, with high economic activity in Sumatra Island, there are still disadvantaged areas and disparities between high regions where the gap at the city/district level is higher than the provincial level, judging by Williamson Index GDRP per capita and HDI in 2010-2017 [3].

In the context of Sumatra Island, this is seen from the plan of development of transportation infrastructure as one of the efforts in addressing the problem of inequality in Sumatra Island. This is explained in the purpose of
spatial arrangement of Sumatra Island namely "Intermodal transportation network that can increase inter-regional relations, economic efficiency, and open regional isolation". So, it is planned to improve the accessibility of the road network from Lampung Province to Aceh Province.

In explaining this urban development, it cannot be explained on its own but rather should look at its relationship with other regions. It is important to know the magnitude of the implications of the model to be made with the provincial economy in Sumatra Island because there is no size and percentage of the state budget, thus being an evaluation of the scale of accessibility development in Sumatra Island.

Practically, in order to provide transportation infrastructure, the need for knowledge about urban interactions that occur on the island of Sumatra is important to know. The priority of this research is to improve the accessibility of the region into a tool to assess the effectiveness of transportation infrastructure development plan in Sumatra Island. Through effective infrastructure can have a positive impact on the development of regions and cities. The main objective of this study is to analyze the Local Indicators of Spatial Association (LISA) of population, economic activity, transportation infrastructure in Sumatera Island.

2. Method

This research is based on the concept of spatial autocorrelation which gives an indication of the grouping of data on spatial distribution using Local spatial statistics are often referred to as Local Indicators of Spatial Association (LISA) or Local Moran I statistics. This method is a development of global spatial autocorrelation is a measure of the overall clustering of the data. One of the statistics used to evaluate global spatial autocorrelation is Moran's I. It was initially suggested by Moran [4] and popularized through the classic work on spatial autocorrelation by Cliff and Ord [5].

Moran's I is defined as

$$ I = \frac{N}{W} \sum_i \sum_j w_{ij} (x_i - \bar{x})(x_j - \bar{x}) \sum_i (x_i - \bar{x})^2 $$

(1)

Where $N$ is the number of spatial units indexed by $i$ and $j$; $x$ is the variable of interest; $\bar{x}$ is the mean of $x$; $w_{ij}$ is a matrix of spatial weights with zeroes on the diagonal (i.e., $w_{ij} = 0$); and $W$ is the sum of all $w_{ij}$. Values of $I$ usually range from −1 to +1. Values significantly below $−1/(N − 1)$ indicate negative spatial autocorrelation and values significantly above $−1/(N − 1)$ indicate positive spatial autocorrelation [5].

However, Moran’s index cannot determine the spatial aspect of agglomeration effect [9,10]. Instead, Moran’s I is limited to signaling the existence of spatial autocorrelation in the global scale. This is related to Tobler’s first law of geography, which states that Everything depends on everything else, but closer things more so This spatial grouping is then visualized in the form of graphics called Moran’s Scatterplot, provides correlation value and value relative to its neighbors [6]. Moran’s Scatterplot divides spatial correlations into 4 clusters: high-high (H-H), low-low (L-L), high-low (H-L), low-high (L-H). These clusters are organized based on the relative value of their regions and neighbors against the global average. However, we will only pay attention to H-H and L-L clusters for clear interpretation.

We use Geoda software with recommended procedures in workbooks in performing and interpreting Univariate Moran’s I. This gives us knowledge of the existence of spatial autocorrelation, spatial clustering, and relationships between multivariate variables that are then known through parallel coordinate plots [7]. Since cannot tell about the process whether the existence of spatial clusters is caused by true contagion or not. Here we assume that spatial clusters that are formed are apparent contagion, where spatial heterogeneity different spatial structures create local similarity [8].

This research conducted by showing the relation of region gross domestic product in transportation and the amount of road that in good condition population of the study area. This research was conducted on the assumption that the population increases spending and revenue from the transportation sector so that it can directly improve the quality of roads in the region [11]. This assumption makes there is a research focus on the relationship between variables that occur in transportation and population. The data used to assess the quality of transportation infrastructure is the length of the road that is feasible to use. Spatially, we collect data from 172 rural and urban...
district under the administrative area of the island of Sumatra Island. The data used in this study was collected from the official statistic report published by BPS (Kabupaten/Kota Dalam Angka).

**Figure 1.** Assumptions of the relationship of influence that occurs on the Population, GDRP and quality of transportation

### 3. Result and Discussion

Using the methodology that has been ed before, it can be seen the value of the global spatial autocorelation, Moran’s I. For an overview of the value between Moran’s I and the cluster that forms by each variable we observe, see Table 1.

It appears in Table 1 that there was no major change in Moran’s I value in every aspect between 2011 and 2016. In the table it appears that all variables tend to have spatial clusters indicated with positive values of Moran’s I (with at least 0.077 and as high as 0.412) indicate the occurrence of spatial autocorelation in Sumatera Island for both years. This is an indicator, spatial cluster and occurs on the island of Sumatra on every variable juxtaposed. While the spatial relationship of the population becomes an argument that can be understood in public, this gives confidence in the possibility of relationships on a space related manner in the value of economic variables (GDP on transport) and value of transport quality variable. In general, in spatial clusters that form. Medan Area is in the H-H cluster in each variable used. However, Moran’s I is notorious to not be compared by value but can only give an indication of the existence of spatial clustering. Spatial clusters formed on each variable will be discussed next.

| No | Variable                | Moran's I 2011 | Moran's I 2016 | H-H Cluster                                             | L-L Cluster                                             |
|----|------------------------|----------------|----------------|---------------------------------------------------------|---------------------------------------------------------|
| 1  | Population             | 0.402          | 0.412          | Medan Area, Lampung Province                            | Aceh Province, North Sumatera Province                  |
| 2  | GDRP on Transportation | 0.127          | 0.077          | Medan Area, Padang                                      | Riau Province, North Sumatera Province                  |
| 3  | Transportation Quality | 0.336          | 0.264          | Riau Province, Medan Area                               | Mentawai Islands                                       |

To provide an overview of spatial clustering that occurs on Sumatra Island, LISA analysis is carried out to provide spatial and not merely an indication given by Moran's I. On population variables, can be seen in Figure 1, seen both in 2011 and 2016, clusters are high-high in Medan, Lampung, and Palembang Area. This is consistent with population concentration data indeed occurring in areas with high-high clusters in LISA analysis. The area that looks to change is in Siak district where in 2016 was in a high-high cluster, which was previously insignificant. On the other hand, South Lampung regency looks to be increasingly insignificant in 2016 than it was in 2011 at H-H clusters.
Next, we can pay attention to the spatial patterns that occur in GDRP on transportation on Sumatra Island. Previously, Moran's I value on this variable did show a very small and almost insignificant number. Clusters formed are only H-H and L-L clusters. Moran's I decline in 2016 to 0.077 from 0.127 in 2011, can be seen in Figure 2 on the right that many areas are becoming insignificant to spatial clusters. When compared to population variables, in this variable GDRP in transportation, Medan area is still at a H-H cluster in both years of analysis, while Palembang and Lampung areas become insignificant. In 2011, Padang is in H-H cluster but become insignificant in 2016.

At a good road length variable, it is surprisingly not at all comparable to the clusters formed in the LISA analysis conducted on variable GDRP on Transportation or population variables. Can be seen in Figure 4, in addition to medan area, on this variable length of road, which is in a high-high cluster is in Riau Province; Pekanbaru and the surrounding area. Changes in clusters formed in 2011 became more random in 2016 with many regions becoming insignificant to include in clusters.

Figure 2. LISA Cluster Map of Population in Sumatra Island

Figure 3. LISA Cluster Map of GDRP on Transportation in Sumatra Island
Of all the spatial clustering analysis carried out, Medan Area remains a cluster with high value. This raises questions about the relationship between variables that occur. To see the relationship between variables this does not explain the relationship between variables that occur in the relationship between variables. Seen in Figure 5, the relationship between variables does not give a clear picture of how the concentration of the population provides an improvement in road quality. The correlation between population and transport GDRP and transport GDRP on road quality does not show a strong relationship.

Figure 5. Scatterplot for Variables

Seen in the scatter plot done in Figure 5, each variable has a positive relationship with each other. But of all the relationships analyzed, the relationship transport quality is best explained by population variables. However, our assumption that the population is affecting the quality of transport through increased GDRP looks unprovable. Nevertheless, the quality of transportation infrastructure can still be explained well through the population in the
region; increase in population in line with the improvement of the quality of transportation infrastructure. This is consistent with the parallel analysis of the plot coordinates seen in Figure 6.

Visual comparison using standard deviation of each variable in Figure 6 provides an overview of relationship between the variables analyzed in each district region in Sumatera Island. The relation between variable can be seen by the cluster of the line that appear in the graph convey the standard deviation of each variable in the district region. The population number are closely related with quality of transportation but there is no strong relationship with GDRP for transport. This applies to any standard deviation. However, it becomes interesting to see a strong relationship between the population and quality of transportation only shows on the high standard deviation, which is represented by the red line in the chart, that is clustered towards the very end of the graph. This pattern does not show at the low standard deviation, that represented with blue line, that is more scattered.

Figure 6. The result plot coordinates of the variables

4. Conclusion

There is a concentration of people in the Medan Area, but this does not reflect GDRP. As for the closer described by the population of the population is the length of the road. No significant changes to urban clusters on the island of Sumatra in the two years observed; 2011 and 2016. However, our assumption that the population is affecting the quality of transport through increased GDRP looks unprovable. The quality of transportation infrastructure can still be explained well through the population in the region; increase in population in line with the improvement of the quality of transportation infrastructure. This implies that GDRP concentration cannot explain investment in transport.

This research has several disadvantages, namely, transportation infrastructure may not have a direct impact on the population but rather in the form of more mobility improvement. Mobility was not included in the study. In terms of variable selection, we only consider road transportation on the quality of transportation. Whereas some areas in the study area have waters and islands that make roads no longer the only need for transportation. It also eliminates the need to make movements using air transportation. In terms of methods, the Local Indicators of Spatial Association uses the concept of neighboring in representing the distance. However, because neighborly relations between rook and queen cannot accommodate the existence of the island contained in this research area. The spatial relationships in this study should have been based on the euclidean distance of the region centroid that is limited with the K Means method to mimic neighborly relationship of rook and queen type.

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