

Sustainable Development Clustering in East Java Using the K-means Method

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ABSTRACT

East Java Province has an important role in the national economy, given its significant contribution to economic development. Of course, economic development must be oriented towards its usefulness and sustainability. Therefore, this study aims to identify sustainable development clustering in East Java Province and what factors influence sustainable development. The analytical tool used is K-means. The reasons for using the K-Means algorithm are among others because this algorithm has a high enough accuracy to the object size. Based on the results of the analysis, it can be seen that economic performance does not significantly affect the occurrence of sustainable development in East Java. Welfare is able to significantly influence the occurrence of agglomeration of sustainable development in East Java.

Keywords: *Economic development, Sustainable development, and East Java.*

1. INTRODUCTION

Sustainable development is development that is oriented towards meeting human needs through the use of natural resources wisely, efficiently, and paying attention to their sustainable use for present and future generations [1, 2].

Sustainable regional development has three dimensions or aspects of life, namely economic, social and environmental aspects [1]. These three aspects become weighting criteria in decision making. Economic aspects are viewed from the criteria of economic aggregate, average economy, economic quality, and economic growth in each region. The social aspect is viewed from the criteria for the population population, regional infrastructure development, the quality of life of the population, and the progress of social civilization. Environmental aspects are viewed from the criteria for natural resources, ecosystems, and environmental quality in each region. The principle of balance in inter-dimensional aspects, namely economic, social and environmental aspects, makes an area sustainable [3]. On the other hand, on a local, national, and global scale, the realization of sustainable development is closely related to quantitative or qualitative measurements. Through measurement in

sustainable development, there are efforts to take a role in decision making, which is functioned to help formulate policies in the future [4]. Therefore, measurement in sustainable development is a very important assessment in an area.

In its development, it is shown that greater development leads to economic and social aspects, and gives an impact on environmental aspects. This shows that sustainable development is expected to prioritize environmental aspects, to optimize the interdimensional balance so that the pressure from environmental aspects becomes a "correction" in the progress of other aspects, namely economic and social [5]. The sustainable development process is linked to the establishment commission, which conceptually provides assistance to developing countries. Especially developing countries have a greater abundance of natural resources, with less optimal utilization because the environment and natural resources are not directed to aspects of sustainability [6].

There are three main factors why development from various aspects must be sustainable. The first factor, in terms of economic development, is defined as development that is able to produce goods and services continuously to maintain the sustainability of the government and avoid sectoral imbalances that can

damage agricultural and industrial production. The second factor, in terms of ecological or environmental development, is that the concept of environmental sustainability must be able to maintain stable resources, avoid exploitation of natural resources and the function of environmental absorption. This concept also concerns the maintenance of biodiversity, stability of air space, and other ecosystem functions that do not include economic resources. The third factor, in terms of social development [5].

The aspects or criteria that exist in the evaluation of regional sustainable development have various relationships. It is important to carry out performance assessments and evaluations in relation to sustainable development which show the trend of progress or decline in aspects of sustainable development such as economic, social and environmental, also can provide information for policy makers to determine strategies and communicate the results to stakeholders [7, 8, 9, 10].

Research on the implementation of sustainable development is needed to determine the success rate of development. Much quantitative research has been carried out and includes all dimensions / aspects of sustainable development simultaneously so that it can be used as an evaluation of policy implementation and development success [11].

For example, the growth of a city accompanied by a large population will require a larger area, which will cause problems with nature. A large population with fast growth but low quality will slow down the achievement of ideal conditions between the quantity and quality of the population and the increasingly limited natural and environmental carrying capacity. Increasing the economy by opening factory construction needs to pay attention to the natural environment. These problems are the responsibility of the community, especially local governments in East Java. The reciprocal relationship of these problems can be used for clustering sustainable industrial development in East Java Province.

2. METHODS

The location of this research is in East Java, with a research focus on cluster analysis of sustainable industrial development in East Java. As for answering the formulation of the problems that exist in this study, a quantitative descriptive research method will be used, namely the data obtained from a sample of the study population is analyzed in accordance with the statistical methods used and then interpreted.

The data collection through secondary data collection activities by doing collection of institutional data from offices, agencies and related institutions in the regions, documentation including:

- a. Number of industrial companies
- b. Number of MSMEs
- c. Gross Regional Domestic Product

- d. PDRB Per Capita
- e. per capita GDP rate.
- f. Unemployment rate
- g. Poverty level
- h. Crime Level
- i. Gini ratio
- j. Human Development Index (HDI)
- k. Green open space ratio (RTH)
- l. Air quality index (IKU)

2.1. Cluster Analysis using the K-Means Method

Clustering data is one method *Data Mining* which is unsupervised. There are two types of clustering data that are often used in the data grouping process, namely hierarchical (hierarchical) clustering data and non-hierarchical (non-hierarchical) clustering data. K-Means is a non-hierarchical data clustering method that attempts to partition existing data into one or more clusters / groups.

The K-Means method partitions data into clusters / groups so that data that has the same characteristics is grouped into the same cluster and data that has different characteristics is grouped into other groups. The purpose of this clustering data is to minimize the objective function set in the clustering process, which generally seeks to minimize variations within a cluster and maximize variation between clusters. Because in this study the clusters will be used to rank a certain category, the inter-cluster warning will be carried out by looking at the average of each centroid. The reasons for using the K-Means algorithm are among others because this algorithm has a high enough accuracy to the object size.

Clustering data using the K-Means method in this study is generally carried out with the following basic algorithm.

1. Determine the number of clusters
2. Allocate data into clusters randomly
3. Calculate the centroid / average of the data in each cluster
4. Allocate each data to the nearest centroid / average
5. Return to Step 3, if there is still data moving clusters or if the change in the centroid value is above the specified threshold value or if the value change in the objective function used is above the specified threshold value
6. Find the average value of the highest centroid and then the cluster under it is determined based on the closest to farthest distance for each cluster.

To facilitate calculations, the K-Means method clustering will use the XLSTAT software.

2.2. Analysis *Klassen* Typology

This modified *Klassen* Typology Analysis Tool was used to determine the description of the sustainable development patterns of each region. This typology of *Klassen* is carried out by dividing the regions based on two sustainable development indicators, namely the results of the development cluster and the results of the sustainable cluster.

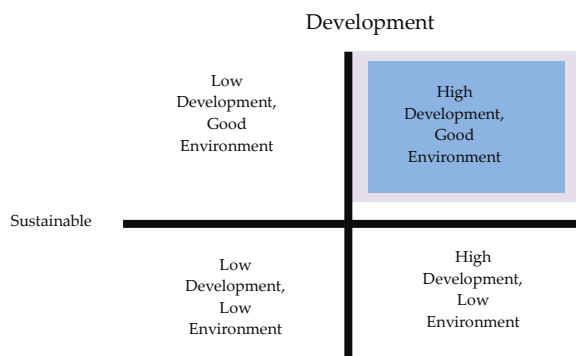


Figure 1. Typology of Sustainable Development

3. RESULTS AND DISCUSSION

3.1. Population, Environment and Economy

East Java population growth during the 2000-2010 period reached 0.76 percent. Population census data in 2010 shows the total population of East Java reached 37,476,757 people, with details of those who live in urban areas as many as 17,832,733 people (47.58 percent) and in rural areas as many as 19,644,024 people (52.42 percent). Referring to BPS data in the 2017 East Java book, the total population of East Java in 2016 from the projection results is 39,075,152 people or an increase of 0.59% compared to 2015 which was 38,847,561 people.

Rapid population growth can lead to changes in consumption and production patterns to meet various needs such as energy and electricity or housing and transportation to employment. Fulfilling these various needs, directly or indirectly, will in turn put various pressures on the quality and quantity of natural resources and the environment. Furthermore, to see the economic activity of East Java in 2017, the Gross Regional Domestic Product (GRDP) measurement tool was used.

The East Java economy in 2017 as measured by PDRB at current prices reached Rp. 2,019.2 trillion, an increase of Rp. 164.16 trillion compared to 2016 which amounted to Rp. 1,855.04 trillion. This figure contributes 14.61 percent to the Gross Domestic Product

(GDP) based on the 2017 national current price of IDR 13,064.5 trillion. Meanwhile, East Java's GDP in 2017 at constant prices reached IDR 1,482.15 trillion, an increase of IDR 76.91 trillion compared to GRDP at constant prices in 2016 of IDR 1,405.24 trillion. East Java's GRDP at constant prices also contributed 17.43 percent to the 2017 national constant price GDP of IDR 9,530.30 trillion.

The Central Statistics Agency (BPS) of East Java Province noted that the East Java economy in 2017 grew by 5.45 percent in terms of production. GRDP growth was driven by all business fields, with the highest growth occurring in the field of providing accommodation and food and drink with the highest growth at 7.91 percent, followed by mining and quarrying at 7.47 percent, and information communication at 6.92 percent. The structure of the East Java economy according to business fields in 2017 was dominated by three main business fields, namely the processing industry with a contribution of 29.03 percent. Followed by the agriculture, forestry and fisheries sectors by 12.80 percent; and wholesale-retail trade and car-motorcycle repairs by 18.18 percent.

Seeing the economic growth of East Java which has a large enough contribution to the national economy shows that its economic activities are a buffer for the national economy. The industrial and trade sectors have a large enough role, thus contributing to national growth. However, it must be admitted that this fairly good economic growth has not been accompanied by satisfactory environmental management performance.

The results of the 2017 Environmental Quality Index (IKLH) study issued by the Ministry of Environment and Forestry, show that the environmental conditions of East Java are in the very poor category (IKLH value 60.70). The IKLH value is a composite index from the calculation of the air quality index (IKU) of 85.49; water quality index (IKA) of 49.17; and the land cover quality index (IKTL) of 50.70.

3.2. Industrialization Cluster

The industrialization scale clustering in East Java in this study uses two variables, namely the number of industrial companies and the number of MSMEs. Taking into account the labor absorption and production output of the two variables, industrial companies are given a weight of 1 for the labor and production output variables, while MSMEs are given a weight of 0.1 for labor absorption and 0.01 for production output. So that for each real number of MSMEs, the absorption weight of labor and the weight of production output will be multiplied.

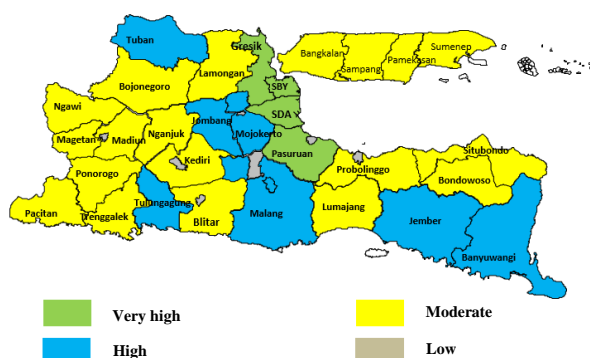
$$\text{Indeks Industrialisasi UMKM} = 0.001n$$

n = the real number of MSMEs in each region

The results of the classification for the industrialization aspect show that Pasuruan Regency,

Sidoarjo Regency, Gresik Regency and Surabaya City occupy the highest cluster. This means that the four regions are regions with the highest industrialization levels in East Java.

Judging from its structure, the four regions included in the very high industrialization cluster are regions with an average number of industrial companies of 873.25 and an average number of MSMEs of 212,305. Sidoarjo is the region with the largest number of industrial companies with 978 industrial companies, while the highest number of MSMEs in the very high cluster is occupied by the City of Surabaya with the number of MSMEs reaching 212,305.



Source: BPS East Java, 2018 (Processed Data)

Figure 2. Mapping of Regency / City Industrialization Clusters in East Java

The main variable driving the industrialization of areas that are included in the high industrialization cluster is MSMEs with an average MSME in this cluster being around 245,323 and higher than the average number of SMEs in the industrialization cluster which is very high. Malang Regency is the region with the largest number of MSMEs not only in the high category of industrialization cluster but also regionally in East Java with the number of UMKM reaching 414,516.

Furthermore, the category industrialization cluster is currently occupied by 19 regions ranging from Pacitan Regency, Ponorogo Regency, Trenggalek Regency, Blitar Regency, Kediri Regency, Probolinggo Regency to all areas on Madura Island. The medium category industrialization cluster structure shows that the majority of industries are dominated by MSMEs, even though on average the number of MSMEs in this cluster is not different when compared to the high category industrialization cluster.

The medium industrialization cluster only has an average number of companies for each region of 63, far enough when compared to the high industrialization cluster which has an average number of companies of 226 and very far when compared to the average industrialization cluster category which is very high with average -The average number of industrial companies is 837.

The low category industrialization cluster is occupied by seven cities, starting from Kediri City,

Eight regions starting from Tulungagung Regency, Malang Regency, Jember Regency, Banyuwangi Regency, Mojokerto Regency, Jombang Regency, Tuban Regency, and Malang City occupy the high category industrialization cluster. When compared with the very high category industrialization cluster, it will be seen that there are quite obvious differences in characteristics. The industrialization cluster area is very high, the average number of companies is around 837 companies, while in the high industrialization cluster the average number of companies per region is only 227.

Blitar City, Probolinggo City, Pasuruan City, Mojokerto City, Madiun City and Batu City. Judging from the area and population of the seven cities in this cluster, it can be said that it is natural that the seven cities are included in the low category industrialization cluster. The average number of MSMEs in the low category industrialization cluster is only 23,524 and the average number of industrial companies is only 45.

Based on the results of clustering using the k-means method, it can be seen that there are only four regions that are included in the very high category industrialization cluster and from a geographical point of view the areas included in the cluster are areas that directly border starting from Gresik Regency, Surabaya City, Sidoarjo Regency and Pasuruan Regency. This shows that industrialization in East Java is still centralized around the city of Surabaya.

The industrialized cluster areas with a high category also show a tendency that the majority of cluster members are in the central part of East Java, which is geographically relatively close to the very high category industrialization cluster. Only Banyuwangi, Jember and Tulungagung Regencies are relatively far from areas in the highly industrialized cluster.

Geographically, the regions that occupy the industrialized cluster category are mostly in the western part of East Java, part of the horseshoe area and Madura Island. For example, the western part of East Java, such as Pacitan, has only 17 large-scale industrial companies and 181,115 MSMEs, Ngawi Regency which has 27 large-scale industries and 185,312 MSMEs.

Meanwhile, the areas on Madura Island actually have a fairly high number of UMKM industries but they have not been matched by the number of large-scale industries. Sumenep has 269,000 MSMEs but only 78 industrial companies, Sampang has 195,215 MSMEs but only 25 industrial companies. Furthermore, for the low category industrialization cluster, the majority are urban areas with a large area and not too large population so that the economic sector is not oriented towards the manufacturing sector.

The city of Probolinggo, which is the center of the low category industrialization cluster, with Pasuruan Regency which is the center of the very high category industrialization cluster, is around 795. Based on this, it can be seen that the regions in the very high category

cluster and the areas in the low category cluster have very different differences. far. Meanwhile Pamekasan, which is the cluster center for the medium category cluster, with Pasuruan Regency around 737 and Tulungagung as the cluster center for the high category industrialization cluster is about 626 with Pasuruan Regency. The average distance of each cluster center to the center of the highest cluster is 720. This data shows that between the very high clusters and the three other clusters that are quite far apart.

Looking at the results of the existing cluster centers, it can be concluded that the areas that are in the low and medium category industrialization cluster have the potential to upgrade to the cluster above. However, this does not apply to regions that exist in high clusters where the cluster center distance from the very high regional cluster center is quite far away.

Based on Figure 3, it can be seen that the majority of areas in East Java are supported by MSMEs. Only a few areas, especially those that fall into the very high cluster, such as Surabaya City, Pasuruan Regency, Sidoarjo Regency and Gresik Regency, whose industrial sector is supported by medium and large scale industrial companies.

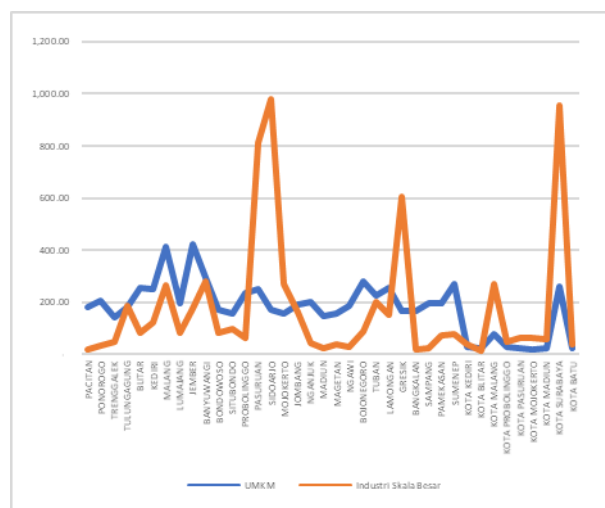
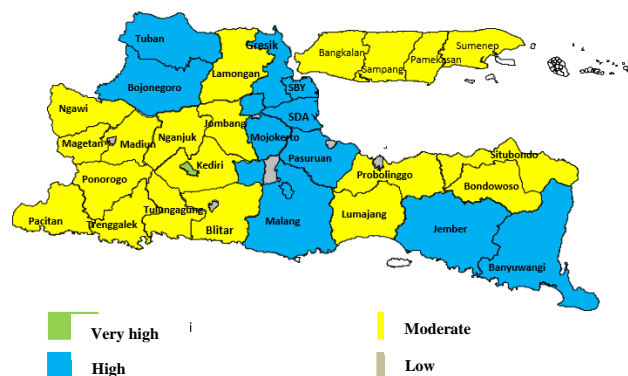


Figure 3. Industrialization index of MSMEs and Industrial Companies

3.3. Economic Aspects Cluster

Economic sector clustering uses three indicators, namely GRDP, GRDP Per capita and the rate of GRDP. Each indicator is calculated cumulatively over the last five years (2013-2017) and then the mean is calculated. The use of data for the last five years aims to find data congestion (steady). The GRDP indicator and the GRDP rate were chosen because they reflect the economic scale of a region and are able to explain how the economic scale growth in the area is, while the GDP per capita illustrates how much economic output each individual has in the region.



Source: BPS East Java, 2018 (Processed Data)

Figure 4. District / City Economic Aspect Cluster Mapping in East Java

The results of the clustering of economic aspects put Kediri City in the highest cluster in East Java and Kediri City was the only area that was included in the very high cluster category. The main driver that places Kediri City in a very high cluster is the high PDRB per capita of the area. PDRB per capita of Kediri City is the top 10 GDP per capita nationally, even in 2017 PDRB per capita of Kediri touched 379 million and is the top three nationally.

The high PDRB per capita of Kediri City, if examined further, is actually very dependent on the three large industries in the area, namely PT Gudang Garam Tbk and two sugar factories under PTPN X. The high GDP per capita is also not directly proportional to the city minimum wage (UMK) the city. The UMK of Kediri City in 2017 was only around Rp. 1,617,000. The area of Kediri City which is not too wide and only covers three sub-districts makes Kediri City quite difficult in developing large-scale industries. Therefore, to avoid pseudo economic clusters, Kediri City should diversify its economy.

Eleven regions are included in the high category economic cluster. The eleven areas are Surabaya City, Sidoarjo Regency, Gresik Regency, Pasuruan Regency, Bojonegoro Regency, Mojokerto Regency, Malang City, Banyuwangi Regency, Malang Regency, Tuban Regency and Jember Regency.

Surabaya City is an area with the highest average GRDP in East Java. The average for the last five years (2013-2017) PDRB of Surabaya City touched Rp. 325 trillion and GDP per capita reaches 107 million and is the second highest GRDP after Kediri.

Bojonegoro Regency is one of the areas in the very high cluster. Bojonegoro Regency is the region with the highest growth in East Java. The last five years (2012-2016) the economic growth of Bojonegoro Regency has always recorded the highest growth with an average growth of 10%, even in 2016 the economic growth of Bojonegoro reached 21%.

The rate of PDRB of Bojonegoro Regency is inseparable from the extractive industry, but in 2015 the PDRB of Bojonegoro Regency from the non-oil and gas sector also recorded the second highest rate after Surabaya City. This is an extraordinary achievement for Bojonegoro Regency. This district, which was once known as one of the underdeveloped districts, is starting to show its capacity, not only in the oil and gas sector. This is an indication of the success of Bojonegoro Regency in managing the extractive industry and diversifying its economy.

Another area that is included in the high cluster is Malang Regency, Malang Regency is an area with the largest number of UMKM industries in East Java, as many as 400,000 more MSMEs are in this southern part of East Java. Malang Regency has an average GRDP in the last five years (2012-2016) of Rp. 55.4 T and is the area with the sixth largest per capita GRDP in East Java. Meanwhile, the average PDRB per capita of Malang Regency was recorded at Rp. 20 million.

The majority of areas included in the medium cluster are areas in the industrialized cluster which are categorized as high and medium. Meanwhile, areas included in the low economic cluster are urban areas, where the majority have areas that are not too large and their economies are not supported by manufacturing.

The most striking characteristics for areas that are included in the medium and low clusters are the In GRDP and In GDP per capita values. Areas that are included in the medium economic cluster are areas that geographically have a large area and a population that is relatively more than the areas in the low cluster areas. Therefore, all areas that are included in the cluster are having a higher GRDP value when compared to the GRDP of the areas in the low cluster.

On the other hand, the GRDP per capita area in the low cluster is always higher than the GRDP per capita area in the medium economic cluster. However, the regions in the two clusters have sufficient uniformity in the average economic growth over the last five years (2012-2016).

Bojonegoro City is the cluster center for the high cluster and is about 1.98 with Kediri City as the center of the medium cluster. The distance that is not too far between the high cluster center and the very high cluster center indicates that statistically the difference between these two classes is not too far. In fact, Kediri City occupies a very high cluster only because of the GRDP per capita and it is quite low in the indicators of GRDP and GRDP growth rate. This in real terms, as we have discussed, also has no impact on the average income of residents in Kediri City.

The distance of Nganjuk Regency as the center of the medium category cluster with Kediri City is in the range of 3.31 and the distance of Probolinggo City as the center of the low category cluster with Kediri City is in the range of 3.25. Based on this, the areas that are

included in the low and medium cluster must have more effort to enter the high or even high cluster. In contrast to areas with low clusters where the cluster center is only 1.08 with a medium cluster center, the areas in the low cluster are believed to be Probolinggo City, Mojokerto City, Pasuruan City and Blitar City.

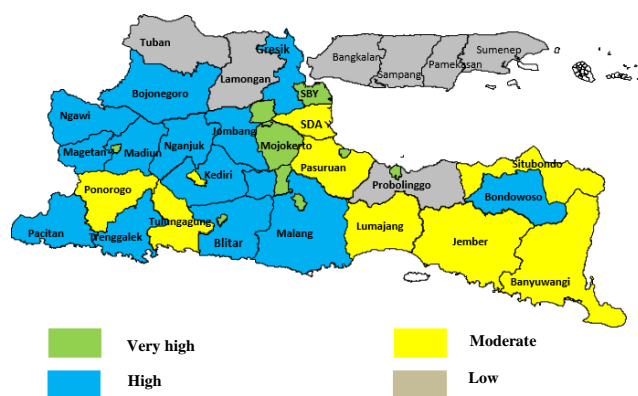
3.4 Welfare Aspects Cluster

Welfare clustering uses four variables, namely low unemployment, low poverty levels, low Gini ratio and high Human Development Index (HDI). By using these four indicators, there are nine regions in East Java which are in the very high category with Blitar City as the cluster center area.

Eight of the nine cities that are included in the very high cluster are administrative city areas and one regency. The only district that is included in the very high cluster is Mojokerto Regency.

Based on analyses, we can be seen that the very high cluster areas for the welfare aspect have an average Gini ratio of 35.84, an HDI of 76.46, unemployment of 5.68 and an average poverty of 6.63. Gini Ratio of 35.84 means that inequality is in a moderate condition, HDI is in a high condition and the unemployment and poverty rates are quite under control.

However, what needs to be taken into account that the average poverty and unemployment rates in cluster areas are very high, which is still above 5%. Meanwhile, the HDI in the regions that are included in the cluster is very high, no more than 80%.



Source: BPS East Java, 2018 (Processed Data)
Figure 5. District / City Welfare Aspect Cluster Mapping in East Java

Several things that have been described indicate that the regions that are included in the cluster are very high in terms of welfare, actually on a global scale, are not very good. HDI which is still below 80%. The average poverty and unemployment rate is above 5% and the Gini ratio which is still above 0.3 shows that the areas included in the very high cluster are not truly prosperous.

The tall cluster is occupied by thirteen occupied by 13 regions including Pacitan, Trenggalek, Blitar, Malang, Bojonegoro and Gresik. Regions that fall into the high cluster for the welfare category have an average Gini ratio of 32.97; The average HDI was 67.03; The level of unemployment is 4.20 and the level of poverty is 13.04. When compared to areas in a very high cluster, the high cluster average Gini ratio is actually lower than the very high cluster average Gini ratio.

In addition, the average high cluster unemployment rate is also lower than the average for areas in very high clusters, but there are quite significant differences between the poverty and HDI levels. The poverty rate reached 13.04% and the HDI was only at 67.03. So the regions that are in the high cluster if they want to upgrade their status to the very high cluster, the key is on HDI and poverty reduction.

Furthermore, the cluster is currently occupied by nine regions, namely: Ponorogo, Tulungagung, Jember, Banyuwangi, Situbondo, Pasuruan, Sidoarjo and Kediri City. Kediri City is the only city in East Java that is included in the medium cluster for the welfare category. If seen from the existing data, Kediri City is quite good in dealing with unemployment and poverty, but Kediri City is quite behind in dealing with HDI and dealing with inequality. The HDI of Kediri City is only 62.5 lower than that of Kediri Regency with the HDI reached 67.9. The Gini ratio of Kediri City is also higher than the provincial average where the Gini ratio of Kediri City is 36.6.

The low category welfare cluster is occupied by seven regions with four of the seven regions being districts on Madura Island, the seven regions are Probolinggo, Tuban, Lamongan, Bangkalan, Sampang, Pamekasan and Sumenep. The main cause of the seven regions being in the low cluster is due to the low HDI in those regions. As a comparison, the average HDI of the four districts in Pulau Madura in the last five years (2013-2017) was 64.12. same.

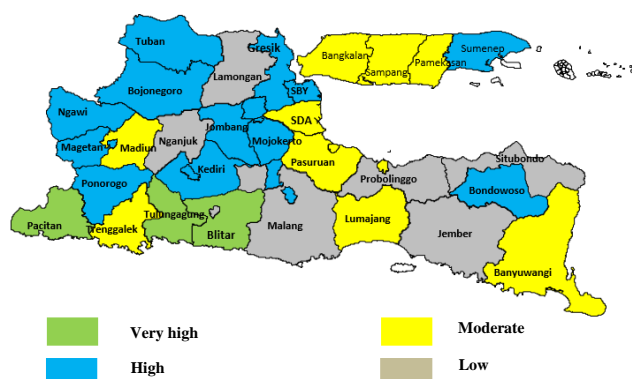
The distance of Blitar City as the center of the cluster category is very high with Nganjuk Regency as the center of the high category cluster is 9.44. The distance between Blitar City and Banyuwangi Regency as the center of the medium cluster is 13.85 and the distance between Blitar City and Tuban Regency as the center of cluster 4 is 16.274. Based on this analysis we can see that the high category cluster center with the very high category cluster center is not too far away even with an SD of 1.7 for the high category cluster, so we can conclude that every region that is in the high category cluster is quite close to the category cluster center. very high.

The comparative analysis conducted shows that the average HDI in the last five years for regions in the high category cluster is 69.29 while the HDI average in the category cluster areas is very high with the same timeframe and measurement shows 76.46 this means that the HDI average the average adrift in the high

category cluster is 7.17. The difference between HDI for the high category and the very high category cluster is the biggest difference when compared to the average difference between the Gini ratio, poverty and unemployment. On the basis of these results, it is appropriate for the related parties to take strategic steps to improve the HDI in each of their regions.

3.5. Environmental Aspect Cluster

Area clustering based on environmental quality in this study only used two indicators, namely, the ratio of green open space (RTH) and air quality index (IKU). RTH and IKU used in this study are RTH and IKU of East Java Regency / City in 2017 based on the report of the East Java Province Environmental Agency (DLH).



Source: East Java DLH, 2017 (Processed Data)
Figure 6. District / City Environmental Aspect Cluster Mapping in East Java

Based on these two indicators, 3 districts in East Java occupy the very good cluster and 17 regions occupy the good cluster. The medium and low clusters are respectively occupied by 12 regions and four regions.

The very good cluster for the environmental category is occupied by Pacitan Regency, Tulungagung Regency and Blitar Regency. When the area has very good air quality, the average air quality in the three districts is 94.43, even Blitar Regency records air quality at 97.78. However, it should be noted that green open space for Tulungagung Regency is only 8% and Blitar Regency is at 11%, while RTH in Pacitan Regency has almost touched 30% to be exact 29.7%. This data shows that Pacitan District pays serious attention to environmental issues ranging from meeting the RTH ratio of 30% to maintaining air quality which reaches 93.05.

The good category environmental cluster occupied by 17 districts / cities has an average RTH ratio of 24% and an average IKU of 88.18. In several areas, such as Bondowoso Regency, Magetan Regency and Tuban Regency, the ratio of RTH to RTH reached 93%, 30% and 39%, respectively, however the IKU of the three regions respectively Bondowosi Regency 88.77; Tuban Regency 87; and Magetan Regency 88.41. Meanwhile,

the Surabaya City IKU reached 90.31, but the ratio of RTH in Surabaya City was only 18%.

Several other areas, such as Ponorogo Regency and Batu City, although included in the good category, the ratio of RTH and IKU in the three regions is quite low. The ratio of green open space in Ponorogo Regency is only 9% and the air quality index in the area is 86.05. RTH Batu city is at 1% and the air quality index is in the range of 87.08. In particular, Batu City as a tourist destination city should further increase the quantity of green open space and air quality in the region. However, the IKU in Batu City is not very good, it seems that it is not due to industrial factors but more due to transportation emissions.

District / City areas that are included in the environmental cluster category are generally worrying for the ratio of RTH not much different from the RTH ratio for environmental clusters in the good category, but what is striking is the low air quality in this area. The average KPI in this cluster is 83.4 with Sidoarjo Regency being the region with the lowest air quality. Sidoarjo Regency recorded IKU at 82.05 and for RTH ratio of 17%. Next, the air quality of the two districts is Pasuruan Regency with IKU at 82.25, although it is not much different from Sidoarjo Regency, Pasuruan Regency has a RTH ratio of 30%.

Sidoarjo Regency and Pasuruan Regency are two areas in which industrial clustering is an area with a very high industrialization cluster and also a fairly dense population. Therefore, Sidoarjo and Pasuruan regencies should really pay more attention to environmental issues.

Areas that are included in the low cluster have a low average ratio of RTH and IKU. The average green space ratio in this cluster is only 16% and the average KPI is 76.74. Nganjuk Regency is an area with the lowest KPI, only 75.78, but the ratio of RTH to Nganjuk Regency is 0.38%. Next is Malang Regency, which in the other three clusters shows a fairly good performance in fact for the environmental cluster it is at the bottom of the ranks. Malang Regency which is a high cluster industrialization area in fact cannot protect its environment properly, even the air quality in Malang Regency is the second worst in East Java, only above Nganjuk Regency.

Magetan Regency which is the center of the good category cluster has a distance of 4.72 with Pacitan Regency as the center of the very good category cluster. Bangkalan Regency which is the cluster center for the worrying category has a distance of 9.38 from Pacitan Regency and Jember Regency as the regional cluster center with the low category is 16.02 with Pacitan Regency. The cluster center presented shows that areas that are in the good category have great potential to be categorized as very good, as well as areas with an alarming category such as Pasuruan Regency and Sidoarjo Regency whose cluster center distance from

the good category area is around 5.4. considerable potential to improve its position.

Unlike the good and worrying areas that generally have high potential and are sufficient to move up to the above category, the areas in the environmental cluster with the low category seem to need extra effort to at least be able to make up for the good category clusters. the distance of the low category cluster center to the medium category cluster center is 11.30 this figure indicates a fairly far distance. Therefore, areas with low environmental cluster categories such as Malang Regency and Jember Regency have carried out reforms in the environmental sector both to improve the quality of IKU and RTH ratio.

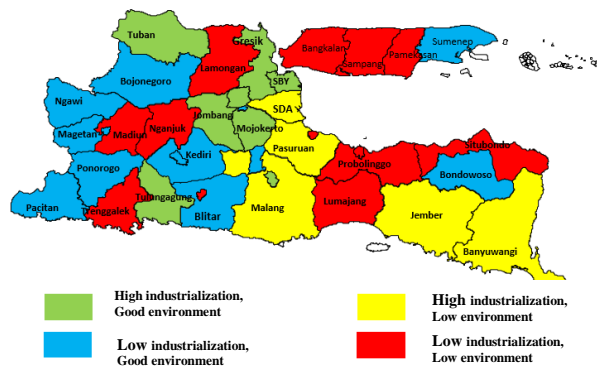
3.6. Sustainable Industrial Development Cluster

All regions with very high industrialized clusters are not included in the environmental cluster category either. Even Sidoarjo Regency and Pasuruan Regency have a worrying category in the environmental cluster, while Surabaya City and Gresik Regency still get good categories in the environmental quality cluster.

The low air quality in Sidoarjo and Gresik Regencies is one of the main reasons these two areas fall into the worrying category for environmental aspects. Therefore there must be strategic steps to overcome these problems, it is necessary to pay attention to environmentally friendly industrialization because industrialization is an important factor that affects environmental degradation. [12].

Meanwhile, some areas that are included in the high category industrial clustering are in fact unable to maintain their environment properly. Theoretically, with lower industrial activity, the environmental quality in the area could be higher, but in fact this is not the case. Malang Regency and Jember Regency which are included in the high cluster for the industrialization aspect get the low category in the environmental quality cluster. Only Tulungagung Regency recorded very good environmental quality.

Another fact in this clustering is that the three regions with the best environmental quality in East Java, namely, District, Pacitan, Tulungagung and Blitar Regency are areas with medium and high industrialization scales. However, areas with a low industrial scale such as Pasuruan city, Probolinggo City and Blitar City actually have an alarming environmental quality.



Source: data processing by K-mean method with XLStat

Figure 7. Mapping of Sustainable Industrial Development Clusters in East Java

The clustering of sustainable development that occurred in East Java shows the interaction of all the variables studied, so it needs to be considered as a precautionary principle to determine the direction of better decisions. [4]. The magnitude of economic performance has not followed sustainable development, meaning that there is a trade off between economic performance and environmental quality in the area, this is in line with the pessimistic responses of experts, both economists and environmentalists. These experts consider that sustainable development is rhetoric that cannot be carried out without trade offs between aspects [13, 14, 15].

As an effort towards sustainable development, a quality development strategy is needed, which is to keep increasing economic growth and income, but by emphasizing greater attention to equity and environmental sustainability. Mikucka, Sarracino, & Dubrow [16] states that high economic growth will improve social quality if it is followed by a decrease in income inequality. Likewise the environment which is an important variable in sustainable development [5].

4. CONCLUSION

All regions with very high industrialized clusters are not included in the environmental cluster category either. Even Sidoarjo Regency and Pasuruan Regency have a worrying category in the environmental cluster, while Surabaya City and Gresik Regency still get good categories in the environmental quality cluster.

Therefore, a sustainable development movement is needed by taking into account the aspects that influence the factors of sustainable economic development. Also, economic performance must be driven to a balance and sustainability orientation in order to achieve sustainable economic development.

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