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Analysis of Central Location Management of Grain Processing Locations Using K-Mean Clustering with Python Language

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ABSTRACT: One of the interesting topics in operational management is the selection of processing center locations. The right location will determine the efficiency of results so that product prices will be competitive when entering the consumer market. analysis of determining the center of the location can use several methods, from simply using a spreadsheet to using a programming language. In this paper, an analysis will be carried out to determine the location of the center for grain processing (RMU, Rice Milling Unit) in Malang Regency. The analysis was carried out using the K-Means Cluster method with the Python language. With the input of spatial data on the location and area of rice fields in 390 villages in Malang Regency and the central estimation point variables (K): 4, 5 and 6. The results of the analysis obtained 6 proposed cluster center locations that can be used for consideration in determining the location of agriculture-based businesses.

KEYWORDS: K-Means, RMU, Python.

I. PRELIMINARY

Resources are limited and spread according to the location where the resource is available. A business, both business goods and services, requires resources, in the form of raw materials, human resources, equipment and technology as well as the location of the company itself.

Choosing the right location will result in efficient use of resources and reduce transportation costs to consumers and ultimately make a competitive business product. According to Manahan [2018], the factors considered in site selection are: geographical location between resources, land and utility and sanitation support (electricity, water, communication), access to production raw materials and construction materials for factory construction, availability of human resources, consumer access, access to Distribution, environmental aspects (environmental disturbances and commitment to environmental safeguards with AMDAL analysis), government policies and business climate and other socio-economic aspects

For the business of processing rice agricultural products, namely grain processing (Javanese: selepan or RMU: Rice Milling Unit), the location must pay attention to the source of raw materials, namely the harvested grain which will be processed into rice. In Malang Regency, there are 5 RMUs which are relatively large spread over the areas of North Malang (in Singosari and Lawang), West (Ngantang), Central (Kepanjen), East (Pakis, Turen) and South (Dampit, Bantur, Pagak). In this area the supply of grain is sourced from village land around RMU. In Malang Regency, there is an area of rice fields, namely 44,272 ha spread over 390 villages. The input data are in the form of coordinates and area of rice fields as shown in Table 1.

The analysis in this paper uses the cluster analysis method, the K-Means Cluster method with the Python programming language. The analysis factors are: the number of program lines that show how efficient the language code is, the execution time of the analysis that shows the speed of completing calculations and the achievement of the cluster center coordinates that describe the accuracy of the location of the RMU with the nearest village center which is assumed to be ideal for the establishment of the RMU.

The programming language uses a data science language (Data Science) which is commonly used in data analysis, namely Python, for the R language it has been analyzed previously (Nasri, 2022). Some considerations are simple, easy to get the source of the program, easy installation, and it is open (free open source, but there are paid for the premium and commercial versions).

Table 1. Input Data

No	Village	Input Data			Subdistrict
		Longitude [1)]	Latitude	Rice field area (ha) [2)]	
1	Gunungrejo	112.613.727	-7.802.484	118	Singosari

2	Ardimulyo	112.676.586	-7.879.632	57	Singosari
3	Randuagung	112.676.483	-7.864.596	60	Singosari
4	Toyomarto	112.649.448	-7.842.823	120	Singosari
...	...	...	...	...	...
390	Tegalgondo	112.597.508	-7.916.187	133	Karangploso
Jumlah Desa: 390			Total Luas:	44.272	

Source:

1) Primary Data from the map,

2) Secondary data from the Malang Regency Food Security Service

Data can be downloaded at: https://www.kaggle.com/nasriaw/lokasi-desa-luas-baku-sawah-kabmalang-2016

II. THEORY FRAMEWORK AND LITERATURE STUDY

The data are generally scattered following the pair of variable attributes. In production data, for example, the variable x represents the production attribute and the variable y represents the price attribute, the variables x and y can be described through a Cartesian diagram so that it can more easily understand the nature of the relationship between variables.

The relationship between variables in the distribution of data can be a correlation, regression or group relationship according to the nature and similarity (similarity). Dissimilarity means that there is a distance, the more similar the closer the distance and vice versa the more distant the more dissimilar.

Analysis of the center of the distribution (centroid of cluster) is used to determine the distribution grouping and find the center point. Dongkuan, [2015], classifies many categories of cluster analysis, some of which are BIRCH, CLARA, CURE, DBSCAN and K-Means.

K-Means clustering according to Teknomo [2007], is an algorithm for classifying or grouping objects based on attributes into K groups. According to Maria [2021], K-Means clustering divides the group of objects of observation into several groups (numbers) that have similar characteristics (similar characteristics).

From several previous literature studies, some of which are presented in Table 2, Weighted K-Means Clustering analysis has been used to classify agricultural characteristics. In agriculture, it is generally used to determine areas (clusters) according to location characteristics, among others, based on the similarity of plant species, the distribution of agricultural infrastructure, for example the location of providing tractors, fertilizers, pesticides and location characteristics and other supporting facilities.

Rita et al [2016], conducted an analysis study of rice areas in North Sumatra Province with variables of standard area, planted area, harvested area and productivity. The analysis uses Principal Component analysis, Factor Analysis and Cluster Analysis with the K-Means method using the Euclidean Distance. The results of the study found 3 areas (clusters) proposed for agricultural development in North Sumatra Province

Dian et al [2017], made a study of the grouping of provinces in Indonesia based on average food crop production using the K-Means Cluster Method. The results of the study show that there are 3 clusters of proposed development areas.

Vijay [2018], made a K-Means customer segmentation analysis in python. The data uses Mall customer data with 2 variables. The results of the analysis produce mall customer segmentation clusters on the variables of Annual income and Spending score.

Parawendi [2020], used Weighted K-Means Clustering analysis to determine the location of a food franchise warehouse with location variables (geospatial data: longitudinal and latitude) in 119 cities throughout Java and data on the number of residents respectively. The results of the analysis: there are 3 areas that are proposed to be the center of the warehouse.

Nasri [2022], conducted an analysis of determining the location of grain processing using K-Means. Using 2 variables, namely coordinate data (longitude and latitude) and data on the area of rice fields. The analysis uses R language, with an alternative cluster center of 4,5,6,7,8 it is known that at K=5 it produces a proposed RMU cluster center that can be used to represent 5 areas in Malang Regency.

In the previous study, for the calculation of similarity with the 'distance' between the variables, both variables according to their attributes and the actual distance in terms of the distance between locations measured from the calculation of the spatial distance using the longitude and latitude data. In addition to spatial distance, clusters can also be analyzed in the form of segmentation with non-spatial distance variables as well as the nature of the variable attributes, such as the analysis conducted by Vijay [2018].

Table 2. Summary of Past Studies and Previous Studies, Methods, Variables, Inputs and Outputs.

No	Relevant Research	Method, Variable,	Input	Output and Programming Language
1	Rita, [2016] Agricultural Cluster in North Sumatra Province	1. K-Means 2. 3 Variables, Planted Area, Yield and Productivity, Euclidean method distance measurement.	1. planted area, land area, harvested area and productivity; 2. Commodities: rice plants; 32 Cities in North Sumatra	1. Results: 3 central rice clusters in North Sumatra, 2. Semi-manual with SPSS
2	Dian [2017], Cluster of food crops in Indonesia	1. K-Means, 2. 1 variable average food crop production, Euclidean method distance calculation.	1. Average production of food crops; 2. commodities: rice, corn, soybeans, peanuts, sweet potatoes; 33 provinces.	1. Results: 5 clusters according to commodities in Indonesia, 2. SPSS 16.0,
3	Vijay Choudhary, [2018]	1. K-Means, 2. 2 variables in Mall customer segmentation,	1. Annual income 2. Spending scores.	1. Results: Cluster Income and Spending score, 2. Python language,
4	Parawendi, [2020] Cluster warehouse eating in P Java	1. K-Means, 2. 2 variables: coordinates and population, Haversine distance calculation method.	1. City coordinates in Java P (latitude, longitude), 2. City population	1. The results of the coordinates of the dining warehouse cluster center in P Java, 2. R language
5	Miftahudin, [2020], The use of character measurement methods.	1. 1 variable 2. Comparing 3 methods of measuring distance: Euclidian, Manhattan and Haversine,	1. Itenas center coordinates (latitude, longitude), 2. employee location coordinates (latitude, longitude).	1. Result: distance and coordinates of Itenas location and employee coordinates, 2. C language
6	Nasri, M [2022], RMU business location cluster in Malang Regency	1. K-Means, 2. 2 coordinate variables and rice field area	1. The coordinates of the location of rice fields in Malang Regency (latitude, longitude), 2. The area of rice fields in each village.	1. The results of the coordinates of the RMU business cluster center, 2. R language

For the calculation of spatial distance, Rita et al [2016], use the distance variable, namely the average distance between cluster members using the Euclidean distance method, while Parawendi [2020] uses the Harvestine distance method, which calculates based on longitudinal spatial data (longitude) and latitude (latitude). . Previous studies were carried out manually (spreadsheet/excel) or using programming such as C language, SPSS, while Parawendi [2020] and Nasri [2022] used R programming language.

The distance calculation method, according to Dongkuan [2015], there are several distance functions, namely: Milonksi, Standardized Euclidean, Cosine, Pearson Correlation and Mahalonobis distance. For the earth's surface (sphere) which has longitude and latitude coordinates, the distance calculation can use the haversine method [Miftahudin, 2020], which better describes the distance of 2 points on the earth's surface as the location of a place on a map (map).

Yusuf [Miftahudin, 2020], in his study, using the Haversine method of calculating distances, showed better accuracy and speed than the Euclidean and Manhattan methods. Table 2, shows a summary of several previous researchers and the methods used in this paper.

In this paper, determining the location of the RMU cluster center using K-Means Clustering analysis, 2 Variables: Coordinates (latitude, longitude) and Rice Field Area. Haversine distance measurement method with Python programming language. The initial analysis of the cluster center, K taken 4, 5 and 6 with consideration of needs in the region and the division of zones, where in Malang Regency, the southern region widens to the West and East.

III. RESEARCH METHODS

This research is an applied research of statistical analysis to get a comparison of the calculation of the cluster center with the weight K-means method, using the Python language. The

object of research is the distribution of rice fields in 390 villages throughout Malang Regency which is represented by a coordinate point in the area (polygon) of each village.

The calculation of the cluster center follows the weight K-means algorithm. According to Teknomo [2007] the calculation is principally carried out through iteration steps until it is stable, that is, no object members leave the cluster group. More details, Kevin Arvai [2020]. For the K-Means Cluster algorithm, there are 6 steps to calculate the k-means, namely:

1. Determine the number of clusters,
2. Randomly initialize the center k,
3. Repeat
    a. calculate the distance of each point to the closed center
    b. count new cluster points for each cluster
4. Until the position of the cluster center does not change.

For its application, the methodology in this study is explained as follows

1. The data uses primary data in the form of coordinates in 390 villages throughout Malang Regency, obtained from field taking by calibrating coordinates via HP and matched on the openstreet map,
2. Secondary data on the area of rice fields, obtained from the Department of Food Security, Malang Regency, namely the number of RMU 355 spread over 390 villages with an area of 46,272 hectares of agricultural land for food crops. The results of data processing as shown in table 1.
3. The steps for calculating and writing the program are as follows:
    a. Start, prepare a laptop that has the python program installed, to write code, you can use a text editor. We recommend installing a GUI (Graphical User Interface) based editor, such as Visual Studio Code, Spyder or an executable editor: jupyter notebook.
    b. Process: write the code for the python language program, as follows:
        i. *Import the required libraries, in Python using the pandas and matplotlib.pyplot and os libraries.*

```
import pandas as pd
import matplotlib.pyplot as plt from
time import process_time
import os
t1_start = process_time()
```

        ii. Read data: location_desa.csv, can be downloaded here: https://www.kaggle.com/nasriaw/location-desa-wide-baku-sawah-kabmalang-2016

```
dataset = pd.read_csv('lokasi_desa.csv')
```

        iii. Calculating Sum Square Error (SSE), in python wscc (Within-Cluster Sum of Square, Using sklearn cluster library with wcss function:

```
from sklearn.cluster import KMeans
kmeans = KMeans(init='k-means++')
wcss=[]
for i in range(1,11):
  kmeans = KMeans(n_clusters= i, init='k-means++',
random_state=0)
  kmeans.fit(X)
wcss.append(kmeans.inertia_)
```

        iv. Calculating the optimal number of K cluster centers using the ELBOW Method, by giving K initiation between 7 - 10 and describing the results so that optimal K = 5 is obtained (see Figure 3.a), with program code:

```
plt.plot(range(1,11), wcss)
plt.title('The Elbow Method')
plt.xlabel('no of clusters')
plt.ylabel('wcss')
plt.show()
```

        v. To be able to calculate the difference in program execution speed, we take K=4, 5, 6, and calculate the k-means model. The python language uses the sklearn.cluster package.

```
kmeansmodel = KMeans(n_clusters= 5, init='k-means++', random_state=0)
y_kmeans= kmeansmodel.fit_predict(X) #For unsupervised learning,y_kmeans is the final model
```

        vi. Calculating cluster center

```
print(kmeansmodel.cluster_centers_)
```

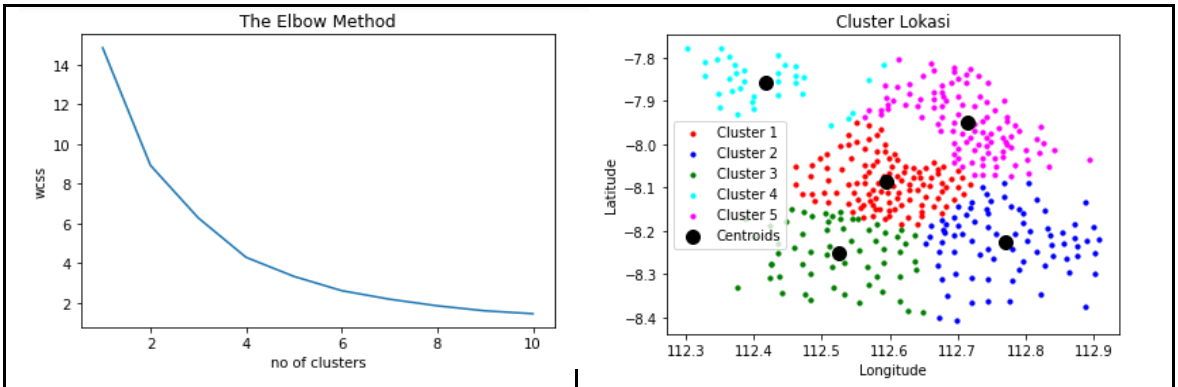
    c. Output, calculation output: Cluster center coordinates at 5 cluster points, each longitude and latitude, Python provides the sklearn-cluster library or package to be used in the analysis.
    d. Repeat step b for K=5 and K=6.
4. The results of the coordinates are tabled (table 3) and the results are depicted, as in Figure 3.

```
plt.scatter(X[y_kmeans == 0, 0], X[y_kmeans == 0, 1], s = 10, c = 'red', label = 'Cluster 1')
```

```
plt.scatter(X[y_kmeans == 1, 0], X[y_kmeans == 1, 1], s = 10, c = 'blue', label = 'Cluster 2')
plt.scatter(X[y_kmeans == 2, 0], X[y_kmeans == 2, 1], s = 10, c = 'green', label = 'Cluster 3')
plt.scatter(X[y_kmeans == 3, 0], X[y_kmeans == 3, 1], s = 10, c = 'cyan', label = 'Cluster 4')
plt.scatter(X[y_kmeans == 4, 0], X[y_kmeans == 4, 1], s = 10, c = 'magenta', label = 'Cluster 5')
#plt.scatter(kmeans.cluster_centers_[:, 0], kmeans.cluster_centers_[:, 1], s = 50, c = 'black', label = 'Centroids')
plt.scatter(kmeansmodel.cluster_centers_[:, 0], kmeansmodel.cluster_centers_[:, 1], s = 100, c = 'black', label = 'Centroids')
plt.title('Cluster Lokasi')
plt.xlabel('Longitude')
plt.ylabel('Latitude')
plt.legend()
plt.show()
```

5. Conclusion and Done

The results of the analysis of the cluster center with the Elbow Method (K=1-10) and produce the optimum cluster point at K=5.



3.a. Elbow analysis chart, K 1-10 | 3.b. Cluster center distribution image, K=5

Figure 3. Output Analysis of Running Python Programs.

IV. ANALYSIS OF DATA RESULTS AND DISCUSSION

The distribution of rice fields follows the slope and watershed, generally in low areas between Gunung Kawi, Mount Semeru, Mount Arjuna, highlands of Batu City area to the west. The distribution of location points can be seen in Figure 3.a.

The results of the calculation of the cluster center are as follows:

1. The number of clusters, K=4, the center of the cluster are:
   a. West Malang Cluster, around Ngantang District,
   b. North-East Malang Cluster, around Pakis District.
   c. Central Malang Cluster, around the District of Kepanjen District, the Capital of Malang Regency
   d. South-East Malang Cluster, around Dampit District.
2. Number of Clusters, K=5, cluster centers are:
   a. West Malang Cluster, around Ngantang District,
   b. North-East Malang Cluster, around Pakis District.
   c. Central Malang Cluster, around Pakisaji District,
   d. South-West Malang Cluster, around Pagelaran District,
   e. South-East Malang Cluster, around Dampit District.
3. Number of Clusters, K=6, Cluster center:
   a. West Malang Cluster, around Ngantang District,
   b. North Malang Cluster, around Singosari District.
   c. East Malang Cluster, around Tumpang District,
   d. Central Malang Cluster, around Pakisaji District,
   e. South-West Malang Cluster, around Pagelaran District,
   f. South-East Malang Cluster, around Dampit District.

From the analysis of the distribution of rice fields, alternative K=6 can represent the center of the location of the 6 distribution areas. Calculation results are as shown in Table 3 Cluster Center Calculation Results and Figure 3.b. Cluster Center Location Mapping with K=4, 5, and 6.

Table 3. Cluster Center Calculation Results

Cluster	Cluster=4		Cluster=5		Cluster=6	
	longitude	*latitude*	*longitude*	*latitude*	*longitude*	*latitude*
1	112,5463	-8,1711	112,5955	-8,0875	112,7715	-8,2336
2	112,6857	-7,9727	112,7696	-8,2248	112,5869	-8,1002
3	112,3978	-7,8522	112,5241	-8,2512	112,3939	-7,8486
4	112,7582	-8,2273	112,4170	-7,8558	112,5186	-8,2605
5			112,7138	-7,9498	112,6478	-7,8933
6					112,7487	-8,0197
Execution time, Seconds:		4,0959		3,2820		5,2553

The execution time in completing the calculation mainly carries out the 3rd step algorithm, which performs the iteration calculation for each iteration of the cluster center (K) specified at 390 coordinate points whose distance and SSE are calculated to the nearest cluster center which is iterated, until the position of the cluster center does not change. Respectively, K=4 takes 4.0959 seconds, K=5 takes 3.282 seconds and K=6 takes 5.2553 seconds. In the execution of the program the time achieved is still relatively long (the processor counts in units of milliseconds or thousandths of a second). For program execution time, at K = 5 it is relatively faster to complete calculations, this happens that the distribution of optimal points is concentrated in the center of the cluster, 5 points can represent the distribution. However, it is necessary to consider adding iterations with K=6 considering that the distribution in South Malang is evenly distributed from West to East

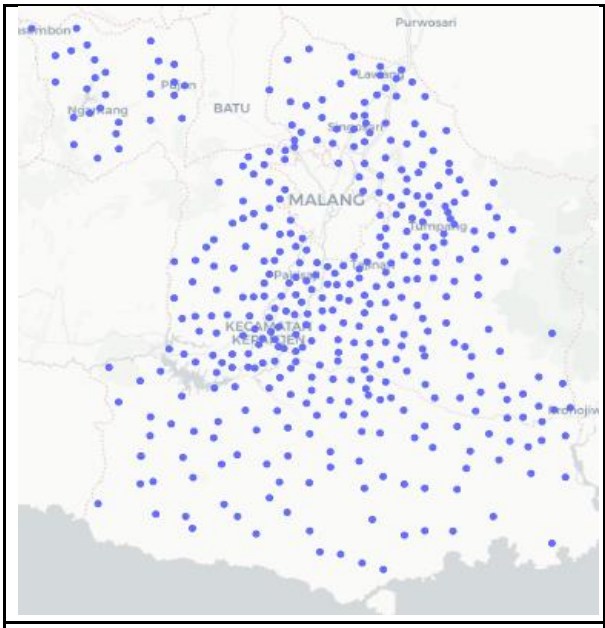


Figure 3.a. Distribution Point of Rice Field Center in Malang Regency (Source: processed by the author)

Figure 3.b. Cluster Center Location Mapping with K=4, 5, and 6 (Analysis results)

Figure 3. Rice Field Distribution Data and Calculation Results of Cluster Centers.

V. CONCLUSIONS AND IMPLICATIONS.

K-Means analysis can provide an overview of how to determine the cluster center for the distribution of data on the location of rice fields in Malang Regency. In the analysis of K=4, K=5 and K=6, the optimal program execution time is K=5, but considering the uniform distribution in the South, it is recommended that the cluster center is 6 cluster centers.

The implications of the research results can be used to give consideration and it is proposed that there are 6 central locations in Malang Regency, namely West Malang, North, Central, East, South East and South West.

The results of the analysis can be used to:

1. Determine the location of the establishment of grain processing (RMU),

2. Determine the location of the establishment of agricultural support businesses such as seed shops, fertilizers, pesticides, rental of agricultural equipment, processing businesses made from agricultural products, etc.

In this analysis, it is still necessary to study further with distribution data other than the location of rice fields, for example the distribution of tertiary irrigation, population distribution and distribution of agricultural production facilities. This can enrich considerations in determining the location of an agriculture-based business.

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25. Note: The calculation uses R programming language, namely RStudio and Python, the source program, data and results can be downloaded here. https://github.com/nasriaw/clustering-rice Rantai Pasok Prof.Dr. Manahan Siahaan, SE, MM