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Implementation of K-Means Clustering Algorithm in Determining Classification of the Spread of the COVID-19 Virus in Bali

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Abstract

The COVID-19 virus or also known as SARS-Cov-2 is an infectious disease caused by the Coronavirus which attacks the human respiratory system. The COVID-19 case has affected all provinces in Indonesia, including Bali. There is a total of 7481 cases in Bali and this is due to the lack of understanding of the community towards the COVID-19 prone areas in Bali. Therefore, it is necessary to group the areas prone to COVID-19 in Bali. One of the clustering algorithms is K-Means, this algorithm uses several groups for the placement of some data with a partition system. The grouping will be carried out using data from the Bali COVID-19 Task Force website on September 18, 2020, using RapidMiner application. The results obtained divided Bali into 3 clusters with Denpasar as the center of the highest spread of COVID-19 in Bali as the red zone, then Badung, Buleleng, Bangli, Gianyar, and Karangasem in the yellow zone, and other districts in the green zone.

Keywords: *Covid-19, K-means Clustering, Clustering, Data Mining, Bali*

1. Introduction

The COVID-19 virus or also known as SARS-Cov-2 (Severe Acute Respiratory Syndrome Coronavirus 2) is an infectious disease characterized by symptoms in the acute respiratory tract. This virus is a large family of Coronaviruses that commonly attack animals. The virus, which was first discovered in the city of Wuhan, China, spreads through human-to-human contact, through droplets of fluid from the mouth and nose when an infected person coughs or sneezes, similar to the way flu is transmitted. Diseases caused by this virus are the same as MERS (Middle East Respiratory Syndrome) and SARS (Severe Acute Respiratory Syndrome*)*[1] .

The spread of the COVID-19 virus is spreading rapidly to various parts of the world, including Indonesia. In early March 2020, in Indonesia, there were 2 reported positive cases of COVID-19 for the first time. And until September 2020, it was recorded that 236,519 people had tested positive for COVID-19 (source: covid19.go.id)[2] . The spread of the COVID-19 virus is almost evenly distributed in all provinces in Indonesia, including Bali Province, where up to 7481 positive cases of COVID-19 have been recorded in Bali (source: data collection.baliprov.go.id)[3] . This puts Bali in the 8th position with the highest positive cases of COVID-19 in Indonesia.

The high number of positive cases of COVID-19 in Bali is certainly troubling for many people, the rapid spread of the virus, and also causing negative impacts in various fields. This of course needs to be prevented to reduce the rate of spread of COVID-19 cases in Bali. The lack of understanding of the Balinese people regarding the COVID-19 prone areas in Bali and awareness of implementing health protocols are one of the factors in the increasing positive cases of COVID-19 in Bali. To overcome this problem, it is necessary to group the areas prone to COVID-19 in Bali.

K-Means is a clustering algorithm that is included in the Unsupervised learning group which is used to group data into several groups with a partition system. This algorithm can accept data whose class label is unknown and then group it. The K-Means algorithm can consist of several clusters that have a central point called Centroid. In the application of the K-Means algorithm, the input received can be in the form of data and the desired number of clusters[4] .

In previous research by (Nayuni Dwitri et al, 2020) using the K-means algorithm to classify data on the spread of COVID-19 in Indonesia. The K-means algorithm divides the data into 3 clusters based on the highest level of the spread of COVID-19, in which DKI Jakarta Province is the center of the cluster so that it is considered the red zone with the highest spread of COVID-19. Judging from the results of previous research, it is hoped that this study can classify areas prone to COVID-19 in Bali based on 4 variables, namely the number of cases, the death rate, the number of people recovering, and the number of people who are being isolated so that they can inform the public not to visit or more be vigilant when visiting that area.

1.1. Data Mining

Data mining is a process of automatically searching for useful information in large data storage areas. Data mining is an analysis of data to find clear relationships and conclude that they were not previously known in a way that is currently understood and useful for the owner of the data[5] . Descriptive mining, which is the process of finding important characteristics of data in one database. Data mining techniques including descriptive mining are clustering, association, and sequential mining.

1.2. Clustering

Clustering is a method of grouping data as seen from the similarity or proximity. The cluster has a different meaning from the group. Groups are similar conditions while clusters do not have to be similar, but the grouping is based on the similarity of the existing samples. For example, using the Euclidean distance formula. The Euclidean distance is the shortest in a data set to the centroid. Clustering is unsupervised learning, namely the process of dividing a group of data sets into clusters based on the similarities of the various attribute values of the data set. This aims to speed up computation time by acquiring quality clusters. A cluster is a set of data objects in the same cluster that are similar to one another and separated from other cluster objects[6] .

1.3. K-Means Clustering

The K-means clustering algorithm is a data analysis method or data mining method that performs the modeling process without supervision (unsupervised) and is one of the methods that performs data grouping with a partition system. Two types of data clustering are often used in the process of grouping data, namely hierarchical and non-hierarchical, and k-means is a non-hierarchical or partitional clustering data clustering method. In classifying the data into several groups with several Clusters. Data are selected into several groups with predetermined criteria and then collected into one cluster, where each cluster has a central point called Centroid. Here are the steps to perform the optimization using the K-Means algorithm[7] :

a) Determine the number of clusters (k) desired
b) Determine the center point (Centroid) randomly
c) Calculate the distance of each point closest to the centroid using Euclidean Distance following formula:

$$J = \sum_{i=1}^{k} \sum_{j=1}^{n} \left\| x_j - C_i \right\|^2 \qquad (1)$$

Explanation:

J = the distance between data point and centroid
Xj^i= j^{th} to the data in the i^{th} cluster
Ci = the i^{th} centroid in the i^{th} cluster

d) Recalculated center of the cluster members in the cluster, and then update the cluster center with the following formula:

$$V_{ij} = \frac{1}{Ni} \sum_{k=0}^{Ni} Xk \qquad (2)$$

Keterangan:

V_{ij} = The average centroid in the i^{th} cluster for the j^{th} variable

$\mathrm{N_i}$ = Number of members of the $\mathrm{i^{th}}$ cluster
ik = Index from cluster
j = Variable index
X_{kj} = The k^{th} data value and the j^{th} variable for the cluster

e) Recalculate each object using the new cluster center (new centroid), this is the initial stage of opening a new iteration. If cluster members do not experience cluster movement again, the clustering process is declared complete. However, if cluster members experience displacement, then return to step C until cluster members do not move again.

2. Research Methods

The methodology of this research article is simulation-based. Fig. 1 shows the stages of the research carried out in this article.

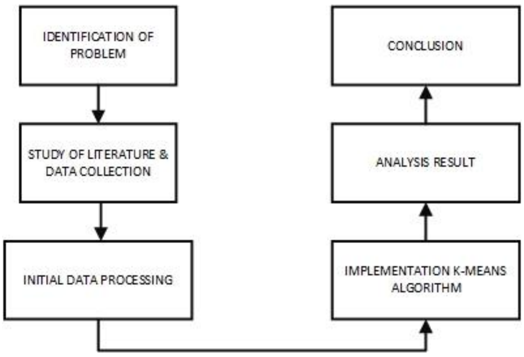

IDENTIFICATION OF PROBLEM
STUDY OF LITERATURE & DATA COLLECTION
INITIAL DATA PROCESSING
IMPLEMENTATION K-MEANS ALGORITHM
ANALYSIS RESULT
CONCLUSION

Figure 1. Flowchart Research Stages

2.1. Identification of Problem

In this research, problem identification aims to classify the area in the province of Bali by the high cases of Covid-19 there, whether it's about the number of people positive Covid-19, the number of people who died, the number of people who recovered, and the number of people who are in the isolation process. It is intended that we know which areas are the vulnerable cases Covid-19 in Bali so that it can increase our self-awareness to the dangers of this virus.

2.2. Study of Literature & Data Collection

In this stage, the literature study to deepen the basic knowledge related to the method of data collection was appointed and, where data obtained is the data distribution COVID cases-19 in Bali. The data were sourced from the official website of the Task Force COVID Bali [3], which is composed of four variables: the number of positive votes, the number of deaths, the number of people cured, and the number of people in the healing process or being isolated. The following is the latest data obtained on September 18, 2020.

Table 1. Data on the Spread of COVID-19 di Bali

Indeks	Province	Positive Case	Dead Case	Healed Case	In Treatment/Isolation
1	Badung	1144	28	724	392
2	Bangli	668	28	598	42
3	Buleleng	776	25	689	62
4	Denpasar	2128	39	1850	239
5	Gianyar	837	31	604	202
6	Jembrana	207	5	180	22
7	Karangasem	695	20	508	167
8	Klungkung	579	8	550	21
9	Tabanan	447	13	316	118

2.3. Initial Data Processing

At this stage, the data obtained from the official website of the Bali COVID-19 Task Force [3] will be processed using the K-Means Clustering method. The data can be converted into an integer data format so that data can be processed in the program. The program is used in the processing of this data using the Rapid Miner application to determine the grouping data so that it can display the final results of grouping clustering.

2.4. Implementation K-Means Algorithm

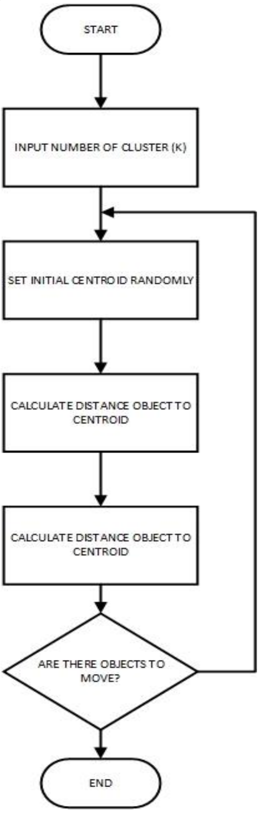

START
INPUT NUMBER OF CLUSTER (K)
SET INITIAL CENTROID RANDOMLY
CALCULATE DISTANCE OBJECT TO CENTROID
CALCULATE DISTANCE OBJECT TO CENTROID
ARE THERE OBJECTS TO MOVE?
END

Figure 2. Flowchart K-Means Algorithm

At this stage the K-Means algorithm is used for the data grouping process, where the data obtained is then processed in several stages as follows:

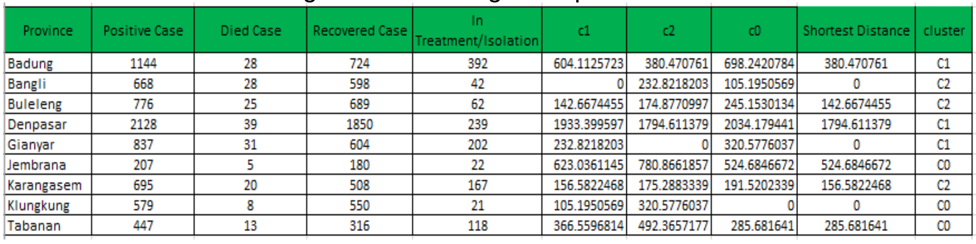
1. Determine the number of clusters (k) desired
2. Determine the center point (Centroid) randomly
3. Calculate the distance of each point closest to the centroid using the equation formula (1).
4. Recalculate the cluster center with the members of the cluster, then update the cluster center with the equation formula (2)
5. Recalculate each object using the new Cluster center (new Centroid), this is the initial stage of opening a new iteration. If Cluster members do not experience Cluster movement again, the Clustering process is declared complete. However, if Cluster members experience displacement, then return to step C until Cluster members do not move again.

3. Result and Discussion

3.1 Manual Calculating Process

At this stage, a manual calculation process is carried out in Microsoft Excel using the K-Means algorithm which can be seen as follows:

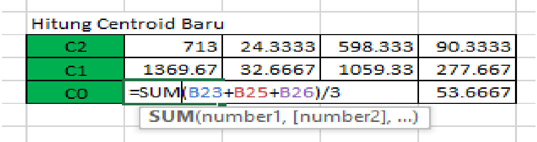
1. Determine the initial centroid from the data in **Table 1.** Data on the Spread of COVID-19 di Bali, the initial centroid selected here is C0 (Klungkung), C1 (Gianyar), and C2 (Bangli).
2. Calculate the distance of all data with each centroid using the formula equation (1), then group each data by centroid based on the closest distance between the data and the centroid according to the following example:



Province	Positive Case	Died Case	Recovered Case	In Treatment/Isolation	c1	c2	c0	Shortest Distance	cluster
Badung	1144	28	724	392	604.1125723	380.470761	698.2420784	380.470761	C1
Bangli	668	28	598	42	0	232.8218203	105.1950569	0	C2
Buleleng	776	25	689	62	142.6674455	174.8770997	245.1530134	142.6674455	C2
Denpasar	2128	39	1850	239	1933.399597	1794.611379	2034.179441	1794.611379	C1
Gianyar	837	31	604	202	232.8218203	0	320.5776037	0	C1
Jembrana	207	5	180	22	623.0361145	780.8661857	524.6846672	524.6846672	C0
Karangasem	695	20	508	167	156.5822468	175.2883339	191.5202339	156.5822468	C2
Klungkung	579	8	550	21	105.1950569	320.5776037	0	0	C0
Tabanan	447	13	316	118	366.5596814	492.3657177	285.681641	285.681641	C0

Figure 3. Calculating Data Distance with Centroid

3. Update the center of the existing centroid using the formula equation (2). Then if the value at the centroid point changes, iterate again until the center point of the centroid does not change.



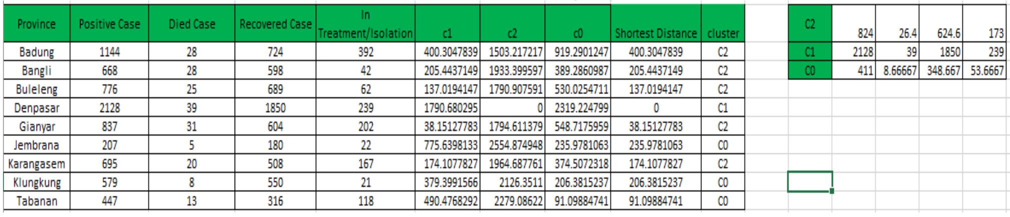
Hitung Centroid Baru

C2	713	24.3333	598.333	90.3333
C1	1369.67	32.6667	1059.33	277.667
C0	=SUM(B23+B25+B26)/3			53.6667

SUM(number1, [number2], ...)

Figure 4. Updating the Center Point Centroid

4. The final result can be seen in the following figure:



Province	Positive Case	Died Case	Recovered Case	In Treatment/Isolation	c1	c2	c0	Shortest Distance	cluster
Badung	1144	28	724	392	400.3047839	1503.217217	919.2901247	400.3047839	C2
Bangli	668	28	598	42	205.4437149	1933.399597	389.2860987	205.4437149	C2
Buleleng	776	25	689	62	137.0194147	1790.907591	530.0254711	137.0194147	C2
Denpasar	2128	39	1850	239	1790.680295	0	2319.224799	0	C1
Gianyar	837	31	604	202	38.15127783	1794.611379	548.7175959	38.15127783	C2
Jembrana	207	5	180	22	775.6398133	2554.874948	235.9781063	235.9781063	C0
Karangasem	695	20	508	167	174.1077827	1964.687761	374.5072318	174.1077827	C2
Klungkung	579	8	550	21	379.3991566	2126.3511	206.3815237	206.3815237	C0
Tabanan	447	13	316	118	490.4768292	2279.08622	91.09884741	91.09884741	C0

C2	824	26.4	624.6	173
C1	2128	39	1850	239
C0	411	8.66667	348.667	53.6667

Figure 5. Final Result of Manual Calculation

3.2 The Calculation Process with the RapidMiner Application

At this stage the implementation of the K-Means algorithm is carried out in the Rapid Miner application which can be seen as follows:

1. Import data into the RapidMiner application, where the data is input in the form of an excel sheet

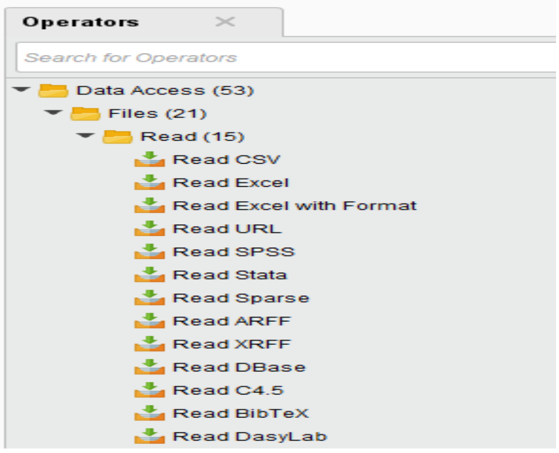
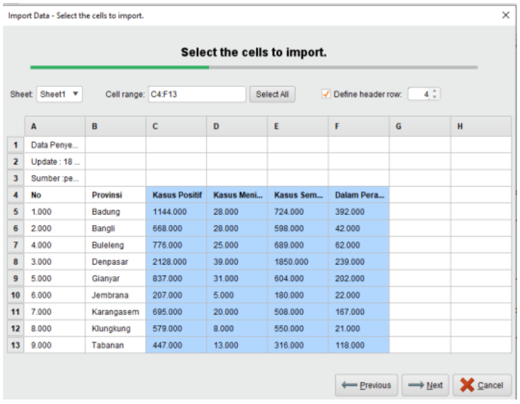


Figure 6. Import Data

2. Select the data range to be used, because the K-Means algorithm can only recognize INT (Integer) data types, so the data range blocks are integer types, from ranges C4 to F13.


Import Data - Select the cells to import.
Select the cells to import.
Select All
Previous
Next
Cancel

Sheet: Sheet1
Cell range: C4:F13
☑ Define header row: 4

	A	B	C	D	E	F	G	H
1	Data Penye...							
2	Update : 18 ...							
3	Sumber :pe...							
4	No	Provinsi	Kasus Positif	Kasus Meni...	Kasus Sem...	Dalam Pera...		
5	1.000	Badung	1144.000	28.000	724.000	392.000		
6	2.000	Bangli	668.000	28.000	598.000	42.000		
7	4.000	Buleleng	776.000	25.000	689.000	62.000		
8	3.000	Denpasar	2128.000	39.000	1850.000	239.000		
9	5.000	Gianyar	837.000	31.000	604.000	202.000		
10	6.000	Jembrana	207.000	5.000	180.000	22.000		
11	7.000	Karangasem	695.000	20.000	508.000	167.000		
12	8.000	Klungkung	579.000	8.000	550.000	21.000		
13	9.000	Tabanan	447.000	13.000	316.000	118.000		

Figure 7. Imported Data Adjustments.

3. Determine the data processing model, then select the K-Means Model

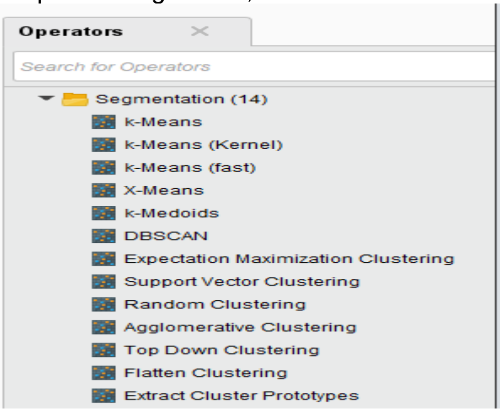
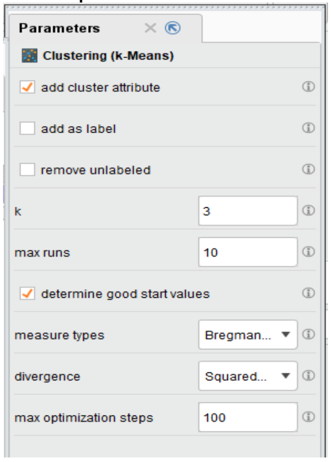


Figure 8. Selection of the K-Means Model

4. Then on the parameter tab input, the number of clusters (k) specified, in this study using 3 clusters to group data into 3 categories, namely the red zone for the cluster with the largest data on the spread of COVID-19, the yellow zone for the cluster with moderate COVID-19 spread data. and the green zone with the smallest data on the spread of COVID-19. Then determine the maximum number of processes performed and the maximum number of iterations performed.



Clustering (k-Means)
☑ add cluster attribute
☐ add as label
☐ remove unlabeled
k 3
max runs 10
☑ determine good start values
measure types Bregman...
divergence Squared...
max optimization steps 100

Figure 9. Determining parameters

5. Then select the Design tab and connect the data with the K-Means model

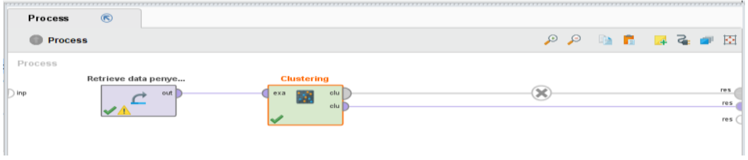
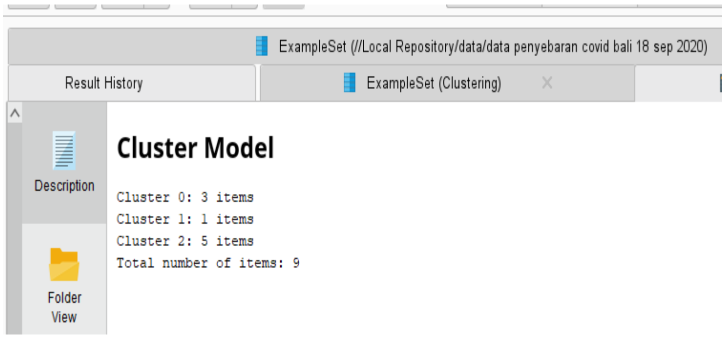


Figure 10. Connecting the K-Means Model

6. Then run the project and you will get the following results:
   A. Text View

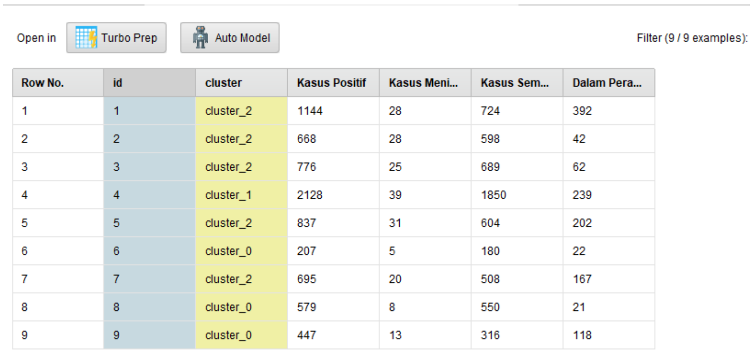

ExampleSet (//Local Repository/data/data penyebaran covid bali 18 sep 2020)
Result History
ExampleSet (Clustering)
Description
Folder View

Cluster Model

```
Cluster 0: 3 items
Cluster 1: 1 items
Cluster 2: 5 items
Total number of items: 9
```

Figure 11. Result Text View

   B. Table View



Row No.	id	cluster	Kasus Positif	Kasus Meni...	Kasus Sem...	Dalam Pera...
1	1	cluster_2	1144	28	724	392
2	2	cluster_2	668	28	598	42
3	3	cluster_2	776	25	689	62
4	4	cluster_1	2128	39	1850	239
5	5	cluster_2	837	31	604	202
6	6	cluster_0	207	5	180	22
7	7	cluster_2	695	20	508	167
8	8	cluster_0	579	8	550	21
9	9	cluster_0	447	13	316	118

Figure 12. Display of Clustering Result Data in Table

   C. Plot View

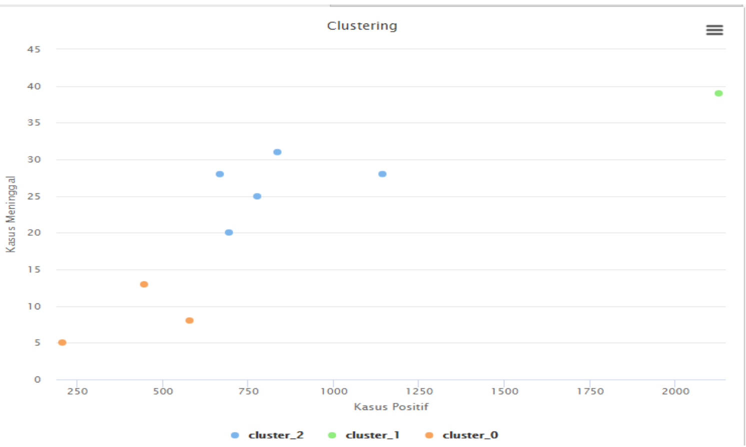


Figure 13. Results of Clustering Attributes of Positive Cases & Deaths

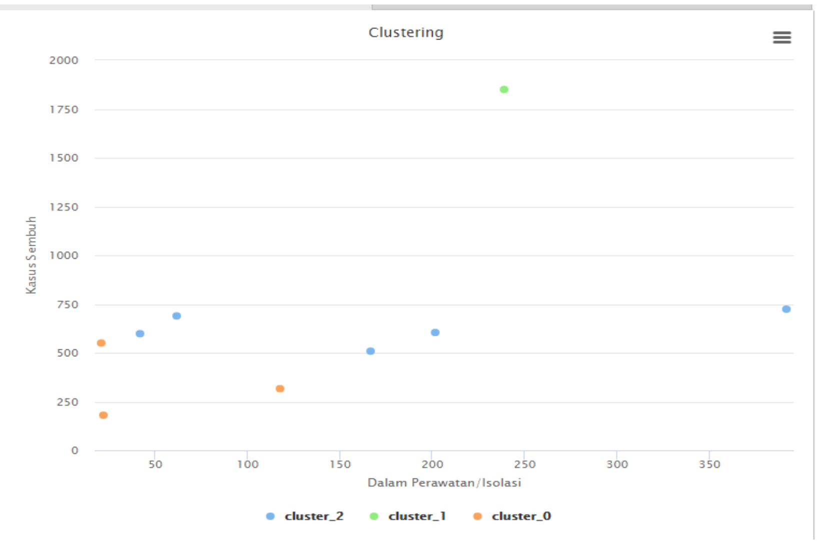


Figure 14. Results of Clustering Attributes of Cases Healed & Treatment / Isolation

4. Conclusion

Based on the results of the research conducted, the results obtained with the K-Means algorithm can group the data on the spread of COVID-19 in Bali into 3 clusters. Where from 9 district/city data, the cluster center is obtained, namely Denpasar City as the area with the highest level of COVID-19 spread so that it becomes a red zone. Then cluster two, namely Badung, Bangli, Buleleng, Gianyar, and Karangasem areas with a moderate level of distribution but the potential to become a yellow zone, so it must also be the center of government attention. And cluster zero, namely the Jembrana, Klungkung, and Tabanan areas, which are green zones with a fairly low level of COVID-19 spread.

References

[1] A.R. Setiawan, Lembar Kegiatan Literasi Saintifik untuk Pembelajaran Jarak Jauh Topik Penyakit Coronavirus 2019 (COVID-19) *Jurnal Ilmu Pendidikan*, Vol.2, No.1, 2020

[2] Satgas COVID-19 RI, Satuan Tugas Penanganan COVID-19, 17 September 2020. [Online]. Available: covid19.go.id. [18 September 2020]

[3] Satgas COVID-19 Bali, Data Sebaran Kasus COVID-19 Sampai Dengan Tanggal 2020-09-18 di (BALI), 18 September 2020. [Online]. Available: pendataan.baliprov.go.id. [18 September 2020]

[4] N. Dwitri. J. A. Tampubolon and S. Prayoga, Penerapan Algoritma K-Means Dalam Menentukan Penyebaran Pandemi COVID-19 di Indonesia *JurTI (Jurnal Teknologi Informasi)*, Vol.4, No.1, 2020

[5] E. H. S. Atmaja, Implementation of K-Medoids Clustering Algorithm to Cluster Crime Patterns in Yogyakarta *International Journal of Applied Sciences and Smart Technologies*, Vol.1, No.1, p.33-41, 2019

[6] F. M. Falahi, Penerapan Metode Clustering Untuk Pengelompokan Mahasiswa Potensial Drop Out Menggunakan Algoritma K-Means ++, Universitas Islam Negeri Sunan Ampel Surabaya, 2019

[7] J. Han. M. Kamber and J. Pei, Data Mining Concept and Techniques, Third Edition., Waltham: Elsevier Inch, 2012