

# Application of Agglomerative Hierarchical Clustering Method for Grouping Non-Cash Food Assistance Recipients in Ngambon Bojonegoro

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## Application of Agglomerative Hierarchical Clustering Method for Grouping Non-Cash Food Assistance Recipients in Ngambon Bojonegoro

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### ABSTRAK

Salah satu kecamatan di kabupaten Bojonegoro yang mendapatkan bantuan pangan non tunai adalah kecamatan Ngambon. Bantuan pangan non tunai yang diberikan di kecamatan Ngambon belum tepat sasaran. Hal ini dikarenakan masyarakat yang kurang mampu tidak mendapatkan bantuan, sementara masyarakat yang mampu justru mendapatkan bantuan pangan non tunai. Sehingga diperlukan penelitian dengan tujuan agar bantuan pangan non tunai yang diberikan pemerintah dapat disalurkan sesuai prosedur. Metode yang digunakan dalam penelitian ini adalah agglomerative hierarchical clustering untuk mengelompokkan penerima bantuan pangan non tunai masyarakat kecamatan Ngambon Bojonegoro. Variabel yang digunakan adalah 12 indikator bantuan pangan non tunai yang ditetapkan oleh Dinas Sosial kabupaten Bojonegoro. Data yang digunakan adalah 131 penerima bantuan pangan non tunai yang tersebar di lima desa di kecamatan Ngambon. Hasil pengelompokan dengan metode single linkage kurang relevan. Sementara itu dengan metode average linkage dan complete linkage didapatkan masing-masing lima klaster, dan dengan ward linkage didapatkan tiga klaster. Berdasarkan elbow rule didapatkan bahwa ward linkage merupakan metode pengelompokan terbaik, dengan klaster 1 berjumlah 57 orang, klaster 2 berjumlah 53 orang dan klaster 3 berjumlah 21 orang.

**Kata kunci :** agglomerative hierarchical clustering, bantuan pangan non tunai, pengelompokan

### ABSTRACT

One of the sub-districts in Bojonegoro that received non-cash food assistance was Ngambon sub-district. The non-cash food assistance provided in Ngambon sub-district has not been on target. This is because underprivileged people do not get assistance, while people who can afford it actually get non-cash food assistance. So, research is needed with the aim that non-cash food assistance provided by the government can be distributed according to procedures. The method used in this study is agglomerative hierarchical clustering to group recipients of non-cash food assistance from the people of Ngambon Bojonegoro. The variables used were 12 indicators of non-cash food assistance set by the Bojonegoro district Social Office. The data used were 131 recipients of non-cash food assistance spread across five villages in Ngambon sub-district. Grouping results with the single linkage method are less relevant. Meanwhile, with the average linkage and complete linkage methods, five clusters were obtained, and with ward linkage, three clusters were obtained. Based on the elbow rule, it was found that ward linkage is the best grouping method, with cluster 1 totaling 57 people, cluster 2 totaling 53 people and cluster 3 totaling 21 people.

**Keywords:** agglomerative hierarchical clustering, non-cash food assistance, grouping

## INTRODUCTION

Poverty is a condition where people are below the standard of living, both in terms of livelihood, income, clothing and shelter [1]. One of the government's efforts to overcome the problem of poverty is provide social assistance to the community. With this social assistance, it is hoped that the community can improve the standard of living to be more prosperous and prosperous. There are several types of social assistance provided by the Indonesian government to the poor through the Ministry of Social Affairs, including Non-Cash Food Assistance (BPNT), Family Hope Program (PKH), National Health Insurance (JKN) and Social Cash Assistance (BST) [2].

Bojonegoro Regency is one of the districts receiving social assistance in Indonesia. One type of social assistance received by Bojonegoro district is Non-Cash Food Assistance (BPNT). In Bojonegoro district, Non-Cash Food Assistance is a continuation of the Poor Rice Program (Raskin) which has been renamed the Prosperous Rice Program (Rastra). Non-Cash Food Assistance is assistance originating from the government in the form of goods to be given to people who are entitled to receive. This assistance is given 14 times in one year. Non-Cash Food Assistance in the form are 15 kg of rice with an exchange price of Rp. 1,600.00/kg and cash of Rp. 150,000.00 [3]. In Bojonegoro district, Non-Cash Food Assistance is a new thing. Therefore, in the process of implementation, there are still many problems. In Bojonegoro district, Non-Cash Food Assistance is a new thing. Therefore, in the process of implementation, there are still many problems [4]. This is a problem, especially in Ngambon sub-district. Many people objected to the decision and protested to the Ngambon sub-district [5]. This problem still has not found a solution. This is because the data used by the Ngambon sub-district comes from the Bojonegoro Regency Social Office which is likely that the data has not been updated. Therefore, a study is needed to group recipients of Non-Cash Food Assistance communities, especially in Ngambon Bojonegoro, so that it is right on target for aid beneficiaries.

For the grouping recipients of non-cash food assistance, several indicators are needed in accordance with the criteria of beneficiaries, especially non-cash food assistance. Based on research conducted by Parhusip (2019), the criteria used for the eligibility selection process for Non-Cash Food Assistance recipients are non-monetary variable poverty criteria. Meanwhile, based on Sugianto & Maulana (2019), the indicators used for grouping recipients of Non-Cash Food Assistance are using indicators from the Central Statistics Agency. And based on research conducted by Saputra et al. (2021), to group recipients of Non-Cash Food Assistance using nine criteria, namely house area, income, floor type, wall type, lighting source, water type, source of medical expenses, fuel and savings. Meanwhile, in this study, the indicators used to group recipients of Non-Cash Food Assistance are the criteria used by the Social Office of Bojonegoro district in determining beneficiaries of assistance, especially for non-cash food assistance.

To group recipients of non-cash food assistance, one technique that can be used is clustering techniques. Clustering is one technique in machine learning to group different objects so that clusters with members who have the same characteristics will be obtained [9]. Clustering as an exploratory procedure consists of two methods, namely hierarchical clustering and non-hierarchical clustering. There are two methods in hierarchical clustering, namely the division method and the agglomerative method [10]. Divisional methods are computationally intensive and have limited applications in the social sciences, while agglomerative methods have been implemented in many standard software packages. There are several techniques in the agglomerative method including single linkage, average linkage, complete linkage and ward linkage.

This study will use the agglomerative hierarchical clustering method to group recipients of Non-Cash Food Assistance in Ngambon Bojonegoro. Previously, there have been many studies using the Agglomerative hierarchical clustering method, including by Randriamihamison et al., (2021), Rong (2020) dan Wu et al. (2021). From some of these studies, the results obtained in the use of the Agglomerative hierarchical clustering method are that the resulting levels more

structured and the desired cluster is not widely displayed in the dendogram. In addition, the use of the Agglomerative hierarchical clustering method is more efficient in the use of time. This is because the output produced in the form of levels or hierarchies to facilitate storage.

The purpose of this study is to obtain the results of grouping recipients of non-cash food assistance in Ngambon, Bojonegoro. From this research, hoped that it will be useful for Bojonegoro district government agencies in supervising the distribution of non-cash food assistance and targeting recipients of non-cash food assistance. It is hoped that the assistance provided by the government can be distributed correctly in accordance with established procedures. Not only that, the government can also evaluate the recipients of non-cash food assistance so that it can create a breakthrough program in the development of social assistance disbursed by the government.

## METHOD

The source of data in this study came from the Bojonegoro Regency Social Office. The data used is in the form of data on aid beneficiaries in 2021 as many as 131 recipients along with indicators of non-cash food assistance in Ngambon Bojonegoro. Furthermore, from these data, a field survey was conducted for each beneficiary of non-cash food assistance in Ngambon sub-district. The variables used are shown in Table 1 below.

**Table 1. Research variables**

Variables	Measurement scale	Information
Residence (X <sub>1</sub> )	Categorical	Beneficiaries have daily shelter
Number of family members (X <sub>2</sub> )	Categorical	Beneficiaries live together with other family members or are alone in a household
Activities that make money (X <sub>3</sub> )	Categorical	Beneficiaries have had wage-generating activities in the past week
Food needs (X <sub>4</sub> )	Categorical	Beneficiaries are concerned about the food eaten
Food expenditure (X <sub>5</sub> )	Categorical	The expenditure used by beneficiaries to buy food is more than 2/3 of the total expenditure
Clothing needs (X <sub>6</sub> )	Categorical	Beneficiaries have purchased clothes for themselves or for other family members in the past year
House floor (X <sub>7</sub> )	Categorical	Beneficiaries have residences whose floors are made of earth
House walls (X <sub>8</sub> )	Categorical	Beneficiaries have residences whose walls are made of bamboo, wire, or wood
Toilet Washing Bath (MCK) (X <sub>9</sub> )	Categorical	Beneficiaries have a place to bathe, wash and defecate or urinate
Lighting sources (X <sub>10</sub> )	Categorical	Beneficiaries have 450/900 Watt electricity from the State Electricity Company (PLN) or not (using a tromber or torch)
Work (X <sub>11</sub> )	Categorical	Livelihoods of aid beneficiaries
House building X <sub>12</sub>	Categorical	The feasibility form of the entire house building seen from the front, back, side, right and left

In this study using the help of Python software for clustering using the Agglomerative Hierarchical Clustering method. The analysis steps to group recipients of non-cash food assistance in Ngambon, Bojonegoro using the Agglomerative Hierarchical Clustering method are as follows.

- a. Obtain descriptive statistics for the number of recipients of non-cash food assistance per sub-district

b. Perform clustering using the Agglomerative Hierarchical Clustering method with the following steps [14]

1) Calculates the distance matrix on all data pairs using the Euclidean Distance formula with the following equation

$$d_{ij} = d(x_i, x_j) = \left[ \sum_{s=1}^p (x_{is} - x_{js})^2 \right] \tag{1}$$

2) Combine two nearby groups into one data group

i) Single Linkage with equation

$$d(U, V) = \min\{d(U, V)\}; d(U, V) \in D \tag{2}$$

ii) Average Linkage with equation

$$d(U, V) = \frac{1}{n_U \times n_V} \sum d(U, V); d(U, V) \in D \tag{3}$$

iii) Complete Linkage with equation

$$d(U, V) = \max\{d(U, V)\}; d(U, V) \in D \tag{4}$$

iv) Ward Linkage with equation

$$SSE = \sum_{j=1}^p \left( \sum_{i=1}^n x^2_{ij} \right) - \frac{1}{n} \left( \sum_{i=1}^n x^2_{ij} \right)^2 \tag{5}$$

3) Update the distance matrix between data to represent between the new and remaining groups

4) Repeat steps 2 through 3 until there is only one group left

c. Choose the best cluster result by looking inside SSE with the elbow rule (sum of square error) method

d. Interpretation of best cluster results

## RESULT AND DISCUSSION

### A. Descriptive Statistics

Descriptive statistics are used to determine the description of non-cash food assistance beneficiaries in each village in Ngambon sub-district as shown in Table 2 below.

**Table 2.** Number of non-food assistance recipients' cash in each village in Ngambon sub-district

Number	Village Name	Number of Recipients
1	Bondol	23
2	Ngambon	38
3	Sengon	17
4	Nglampin	31
5	Karangmangu	22



Sum	131
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Based on Table 2, it can be seen that the total number recipients of non-cash food assistance in Ngambon sub-district is 131 recipients. The largest number of recipients of non-cash food assistance is Ngambon village, which is 38 recipients, and then Nglampin village as many as 31 recipients, Bondol village as many as 23 recipients, Karangmangu village as many as 22 recipients and at least Sengon village as many as 17 recipients.

**Grouping Results Using Agglomerative Hierarchical Clustering Method**

**1) Single Linkage**

The results of clustering using the single linkage method are obtained with the help of Python software. Dendrogram obtained from the results of the single linkage method for clustering beneficiaries of Non-Cash Food Assistance in Ngambon District as shown in Figure 1 below.

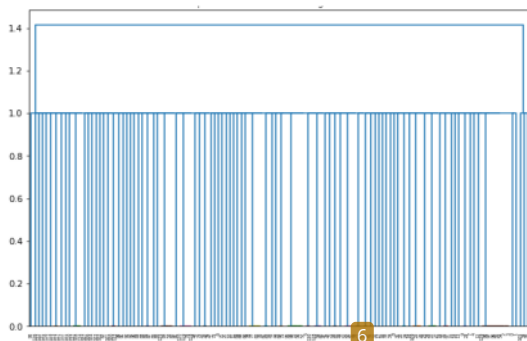


Figure 1. Results of dendrogram with single linkage method

Based on the dendrogram in Figure 1 show that the results of clustering using the single linkage method produce 2 homogeneous clusters. The results of clustering using this single linkage method cannot describe the state of existing data. This is in contrast to a hierarchical agglomeration cluster validation where clusters should be heterogeneous between one cluster and another cluster member. Meanwhile, the results of clustering using the single linkage method are homogeneous.

In addition to generating a dendrogram to obtain clustering results, with the help of Python software can also produce labeling array. This labeling array shows how many clusters have been formed and knows who the members of the cluster have formed. The results of the labeling array for clustering recipients of Non-Cash Food Assistance in Ngambon District are shown in Figure 2 below.

```
array([1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1],
      dtype=int64)
```

Figure 2. Labeling array results using the single linkage method

Based on the labelization array in Figure 2 produces two labels, namely 0 and 1. This means that the clustering of Non-Cash Food Assistance recipients in Ngambon District is divided into two, namely cluster 1 and cluster 2. Cluster 1 consists of 3 recipients of Non-Cash Food Assistance, 1 person from Ngambion Village, 1 person from Karangmangu Village and 1 person from Nglampin Village. Meanwhile, cluster 2 consists of 128 recipients of Non-Cash Food Assistance. 3 people from cluster 1 do not carry out activities that make money, live alone, and meet all the criteria set by the Social Service. Therefore, cluster 1 is called the cluster that is eligible to receive non-cash food assistance and cluster 2 is called the cluster that is not eligible to receive non-cash food assistance. However, judging from the cluster tree that is formed, the cluster that is formed does not represent the existing data conditions. Therefore, use of the single linkage method in data on recipients of Non-Cash Food Assistance in Ngambon Regency is less relevant.

2) *Average Linkage*

Just like in single linkage, the average linkage method also uses Python software. Dendrogram for clustering recipients of Non-Cash Food Assistance using the average linkage method as shown in Figure 3 below.

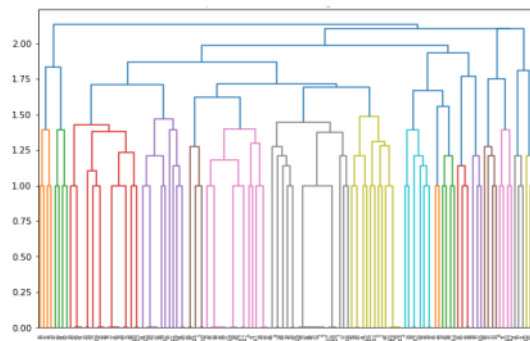


Figure 3. Dendrogram results using the average linkage method

Based on the dendrogram in Figure 3, the clustering of Non-Cash Food Assistance recipients in Ngambon District resulted in five clusters that were heterogeneous between one cluster and another. To find out the members of each cluster can be seen from the results of the labeling array as shown in Figure 4 below.

```
array([1, 1, 1, 1, 0, 1, 1, 1, 3, 1, 2, 2, 1, 3, 3, 3, 4, 4, 1, 1, 1, 2,
       1, 1, 1, 1, 1, 1, 1, 1, 3, 4, 4, 0, 0, 0, 0, 0, 0, 1, 1, 4, 0,
       0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 2, 1, 1, 1,
       1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1,
       3, 0, 4, 4, 4, 1, 1, 1, 1, 1, 1, 1, 1, 2, 2, 3, 1, 0, 1, 1, 1, 1,
       1, 1, 3, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1],
      dtype=int64)
```

Figure 4. Labeling array results using the average linkage method

Based on the results of the labelization array using the average linkage method, five labels are obtained, namely 0, 1, 2, 3, and 4. This means that the cluster results formed from recipients of non-cash food assistance are five clusters, namely cluster 1, cluster 2, cluster 3, cluster 4 and cluster

5. The members of each cluster are cluster 1 with 21 people, cluster 2 with 88 people, cluster 3 with 6 people, cluster 4 with 8 people and cluster 5 with 8 people. From each cluster member, characteristics of non-cash food assistance recipients can be obtained. The characteristic of cluster 1 is that the recipients of Non-Cash Food Assistance in Ngambon District all meet the criteria set by the Social Service. Meanwhile, for cluster 2, the recipients of non-cash food assistance meet 80 percent of the criteria set by the Social Service and 20 percent of the criteria set by the Social Service were not meet. For cluster 3, most recipients of non-cash food assistance meet 60 percent of the criteria set by the Social Service and 40 percent did not meet the criteria set by the Social Service. Furthermore, for cluster 4, most of the recipients of Non-Cash Food Assistance meet 40 percent of the criteria set by the Social Service and 60 percent of the criteria set by the Social Service were not meet. And for cluster 5, almost all criteria set by the Social Service are not meet by the recipients of Non-Cash Food Assistance. Based on the characteristics of each cluster, cluster 1 is called a cluster that is very eligible to receive non-cash food assistance, for cluster 2 is called a cluster that is quite eligible to receive Non-Cash Food Assistance, cluster 3 is called a cluster that is worth of receiving Non-Cash Food Assistance, cluster 4 is called a cluster that is not eligible to receive Non-Cash Food Assistance and cluster 5 is called a cluster that is not eligible to receive Non-Cash Food Assistance.

3) **Complate Linkage**

The results of the dendrogram use the complete linkage method as shown in Figure 5. Based on Figure 5, it can be seen that the clustering results for Non-Cash Food Assistance beneficiaries in Ngambon District are five heterogeneous clusters. Dendograms generated using the complete linkage method have a neater arrangement and each cluster has a fairly tight error distance between one cluster and another.

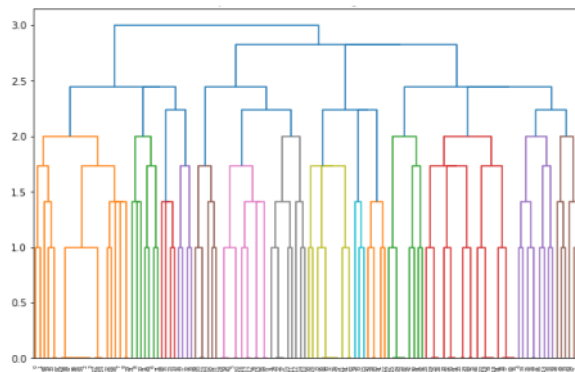


Figure 5. The results of the dendrogram using the complete linkage method

The members of each cluster formed from data on recipients of Non-Cash Food Assistance in Ngambon District can be seen in the results of the labeling array as shown in Figure 6 below.



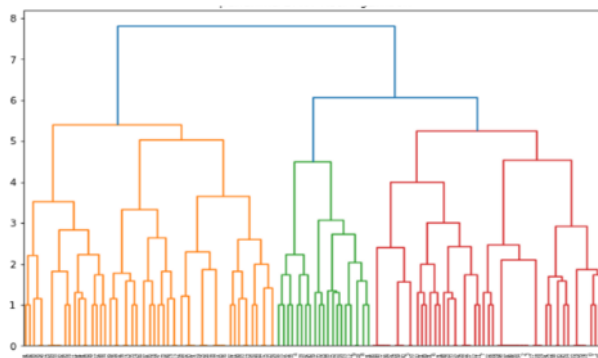
```
array([[1, 1, 1, 1, 0, 2, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1,
        2, 0, 0, 0, 0, 2, 2, 1, 1, 2, 1, 1, 0, 0, 0, 0, 2, 3, 3, 3, 0, 0,
        0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 3, 3, 3, 2, 2, 3, 4, 3, 0, 0,
        0, 1, 1, 1, 3, 1, 3, 3, 0, 0, 0, 0, 0, 0, 3, 0, 0, 1, 0, 0, 2, 2,
        1, 0, 0, 0, 0, 3, 3, 3, 1, 1, 1, 4, 4, 4, 4, 2, 2, 3, 1, 0, 1, 0,
        2, 2, 2, 2, 0, 2, 2, 2, 0, 0, 0, 3, 3, 4, 1, 0, 3, 1, 2, 1, 2],
        dtype=int64)
```

**Figure 6.** Labeling array results using the complete linkage method

Based on the results of the labeling array using the complete linkage method as shown in Figure 6, it can be seen that there are four labels produced, namely label 0, label 1, label 2, label 3 and label 4. So that the results of clustering formed are 5, namely cluster 1, cluster 2, cluster 3, cluster 4 and cluster 5. Based on Figure 6, it can be seen that the members for cluster 1 are 46 people, cluster 2 is 38 people, cluster 3 is 21 people, cluster 4 is 19 people and cluster 5 is 7 people. When viewed from the results of the dendrogram and labeling array, it can be seen that cluster 1 and cluster 2 dominate more, followed by cluster 3, cluster 4 and cluster 5. The recipients of Non-Cash Food Assistance in Ngambon District are mostly included in cluster 1. Based on the characteristics obtained, cluster 1 is called a cluster that is very eligible to receive Non-Cash Food Assistance. This is because recipients of Non-Cash Food Assistance meet the requirements set by the Social Service. However, there are still some recipients of Non-Cash Food Assistance who are members of clusters 4 and 5. Cluster 4 and cluster 5 are categorized as not eligible to receive Non-Cash Food Assistance. This is because it does not meet the criteria for beneficiaries set by the Social Service.

**4) Ward Linkage**

To get the results of clustering along with the members of each cluster, it can be seen from the dendrogram and labeling array. The results of dendrogram using the ward linkage method for clustering recipients of Non-Cash Food Assistance in Ngambon District as shown in Figure 7 below.



**Figure 7.** Dendrogram results using the Ward Linkage method

Based on results of the dendrogram as shown in Figure 7, it can be seen that the clustering results for recipients of Non-Cash Food Assistance in Ngambon District resulted in 3 heterogeneous clusters. The resulting arrangement of dendograms is very neat and each cluster has a fairly tight error distance between each other. In addition, the resulting cluster has a high heterogeneity between one cluster and another. This can be seen from the color of the resulting dendrogram.

Furthermore, for members of each cluster formed using the ward linkage method, it can be seen from the results of the labeling array as shown in Figure 8 below.

```
Out[7]: array([[1, 1, 1, 1, 2, 1, 1, 1, 2, 2, 1, 1, 1, 2, 2, 2, 2, 0, 1, 0, 1,
              1, 1, 0, 0, 0, 1, 1, 2, 1, 2, 2, 2, 0, 0, 0, 0, 2, 1, 1, 2, 0,
              0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0,
              0, 1, 1, 1, 2, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0,
              2, 0, 2, 0, 0, 0, 1, 1, 1, 1, 0, 0, 0, 1, 2, 1, 2, 1, 0, 1, 0,
              1, 1, 2, 0, 0, 0, 0, 1, 1, 1, 0, 1, 0, 1, 0, 0, 1, 1, 1, 1],
              dtype=int64)
```

Figure 8. Labeling array results using ward linkage method

Based on the labelization array in Figure 8 shows that the clustering results in three labels, namely 0, 1 and 2. This means that there are 3 clusters formed, namely cluster 1, cluster 2 and cluster 3. Clustering using the ward linkage method obtained results in the form of the first cluster, which is a cluster that is very eligible to receive Non-Cash Food Assistance totaling 57 people. Cluster 2 is a cluster that is quite eligible to receive Non-Cash Food Assistance totaling 53 people. Cluster 3 is a cluster that is not eligible to receive Non-Cash Food Assistance totaling 21 people.

Judging from the dendogram and labeling array using the ward linkage method, the cluster that dominates is cluster 1. This is because the beneficiaries of Non-Cash Food Assistance in cluster 1 are very eligible to receive Non-Cash Food Assistance. Next followed by cluster 2. This is because the recipients still qualify as recipients of Non-Cash Food Assistance. There are 21 people or 16% of recipients of Non-Cash Food Assistance in Ngambon Sub-district who are categorized as not eligible to receive Non-Cash Food Assistance. This is because it no longer meet the criteria set by the Social Service. The results of clustering by four methods, namely single linkage, average linkage, complete linkage and ward linkage as shown in Table 3 below.

Table 3. Clustering results by four methods

Clustering method	Number of Clusters	Information
Single Linkage	2	Unable to describe the state of existing data.
Average Linkage	5	Cluster 1 (very eligible to receive assistance) amounted to 21 people, cluster 2 (moderately deserving of assistance) amounted to 88 people, cluster 3 (deserving of assistance) amounted to 6 people, cluster 4 (less eligible to receive assistance) amounted to 8 people and cluster 5 (not eligible to receive assistance) amounted to 8 people.
Complete Linkage	5	Cluster 1 (very deserving of assistance) as many as 46 people, cluster 2 (moderately deserving of assistance) as many as 38 people, cluster 3 (deserving of assistance) as many as 21 people, cluster 4 (less deserving of assistance) as many as 19 people and cluster 5 (not eligible to receive assistance) as many as 7 people
Ward Linkage	3	Cluster 1 (very eligible for assistance) totaled 57 people, cluster 2 (moderately deserving of assistance) numbered 53 people, cluster 3 (not eligible for assistance) totaled 21 people.

### B. Results of Comparison of Methods Using Elbow Rule

Data on recipients of Non-Cash Food Assistance in Ngambon, Bojonegoro were clustered using agglomerative hierarchy clustering. The methods used are single linkage, average linkage, complete linkage, and ward linkage. Each of these methods produces 2 clusters, 5 clusters, 5 clusters, and 3 clusters. The best clustering results are measured using elbow rule method. The elbow rule is a right line where the best cluster number of data can be seen by the elbow level of the elbow rule. In the elbow rule, the more clusters that are formed and are heterogeneous between clusters, the better the accuracy obtained. The results of the elbow rule can be seen in figure 9.

From the elbow rule for agglomerative clustering as shown in Figure 9, the elbow point of the elbow rule is indicated by point 3 or 3 cluster. When viewed at the point of cluster 1, the distance value is still very high. As well as the value of cluster 2. However, when at point 3 the black elbow rule line cluster begins to ramp up. This means that in cluster 3, the data on recipients of Non-Cash Food Assistance in Ngambon District is maximized. This is seen from the location of cluster 3 right at the elbow point (clustering ramp point). This is used to determine the best cluster results. The ramp points on the elbow rule show the best amount of clustering. The conclusion is that the best cluster from the data on recipients of Non-Cash Food Assistance in Ngambon District is 3 clusters. So the best and appropriate clustering method in this study is ward linkage method. The ward linkage method produces 3 clusters according to the measurements produced by the elbow rule.

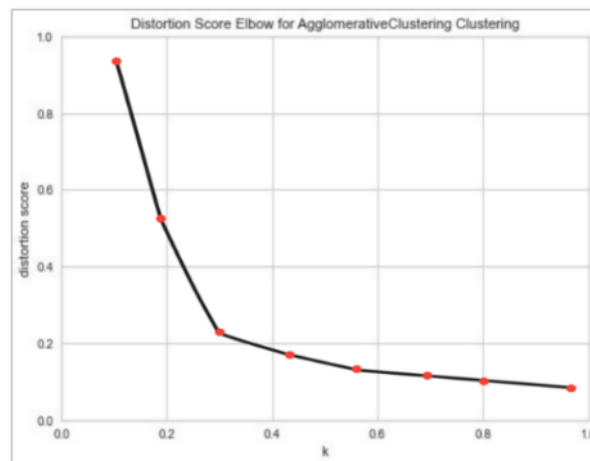


Figure 9. Elbow rule agglomerative hierarchical clustering

### C. Interpretation of the Best Grouping Results

Based on the elbow rule method, it was found that the best clustering method is to use ward linkage. The number of clusters generated using the ward linkage method is 3 clusters. The clusters formed have high heterogeneity between clusters 1, 2, and 3. A total of 131 recipients of Non-Cash Food Assistance in Ngambon District are divided into 3 clusters, namely cluster 1 category eligible to receive Non-Cash Food Assistance consisting of 57 people, cluster 2 categories moderately eligible to receive Non-Cash Food Assistance consisting of 53 people, and cluster 3 categories not eligible to receive Non-Cash Food Assistance consisting of 21 people. Overall, it can be concluded that the recipients of Non-Cash Food Assistance in Ngambon District are in accordance with the criteria set by the Social Service. This is because 84 percent of all recipients of Non-Cash Food Assistance in Ngambon District are eligible to receive the assistance. However, 16 percent of Non-Cash Food Assistance recipients in Ngambon District fall into the category of not eligible to receive Non-Cash Food Assistance.

Cluster 1 is a cluster that very eligible to receive Non-Cash Food Assistance. Cluster 1 has 57 people. 2 people from Bondol Village, 18 people from Ngambon Village, 14 people from Karangmangu, 15 people from Nglampin, and 8 people from Sengon. The beneficiaries are categorized as very eligible to receive Non-Cash Food Assistance because the beneficiaries meet the criteria set by the Social Services. This is because there are some recipients who are paralyzed and do not carry out daily activities, in the past week have not made money so they are worried about hunger in the next year, houses have dirt floors and do not have good MCK facilities. In addition, there are several beneficiaries whose houses are no longer habitable, and live in their relatives' houses.

Cluster 2 is a category eligible to receive Non-Cash Food Assistance. Cluster 2 has 53 people. From Bondol Village as many as 13 people, from Ngambon village as many as 13 people, from Karangmangu village as many as 7 people, from Nglampin village as many as 11 people, and from Sengon village as many as 9 people. The beneficiaries are categorized as eligible to receive Non-Cash Food Assistance. This is because the recipients meet the criteria set by the Social Services. The beneficiaries made money in the past week but the biggest expenditure was used to buy food, the floors of the house buildings were made of earth instead of cast or ceramics, there were some walls of houses made from red brick but there were some whose walls were half red brick and the top was covered with cassibot. In addition, the beneficiaries already have MCK facilities even though they are less crowded, and the overall house buildings are habitable.

Cluster 3 is a category that is not eligible to receive Non-Cash Food Assistance. Cluster 3 has 21 people. 8 people came from Bondol Village, 7 people came from Ngambion Village, 1 person came from Karangmangu Village, 5 people came from Nglampin Village, and none of them came from Sengon Village. The beneficiaries are categorized as not eligible to receive Non-Cash Food Assistance. This is because it does not meet the criteria set by the Social Service. The characteristics of the category that is not eligible to receive non-cash food assistance are staying at home with other family members, making money in the past week and the largest expenditure not being used to buy food. In addition, the beneficiaries are not worried about starvation in the next year, the floor of the house is made of earth but the walls of the house are made of red brick and cast concrete.

## CONCLUSION

In Ngambon sub-district, there are 131 recipients of non-cash food assistance spread across five villages, namely Bondol village, Ngambion village, Sengon village, Nglampin village and Karangmangu village. Clustering using the single linkage method is less relevant because the resulting dendogram tends to be homogeneous. Clustering with average linkage and complete linkage obtained five clusters. Meanwhile, clustering with the ward linkage method obtained three clusters. Based on the Elbow Rule, it was found that ward linkage is the best clustering method. The results of clustering using ward linkage are cluster 1 is a cluster that is very eligible to receive non-cash food assistance benefits totaling 57 people, cluster 2 clusters that are quite eligible to receive non-cash food assistance benefits totaling 53 people, and cluster 3 is a cluster that is not eligible to receive non-cash food assistance benefits totaling 21 people. In future studies, it is expected to use other clustering methods to get better results.

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# Application of Agglomerative Hierarchical Clustering Method for Grouping Non-Cash Food Assistance Recipients in Ngambon Bojonegoro

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