International Journal of Academic Multidisciplinary Research (IJAMR)
ISSN: 2643-9670
Vol. 6 Issue 12, December - 2022, Pages: 87-92

Grouping the Average Per Capita Expenditure a Week Based on Vegetable Type in West Java Province in 2021 Using Complete Linkage Cluster Analysis

Marcelena Vicky Galena[1], Dessy Nur Aisyah[2], Irma Ayu Indrasta[3], Marshanda Aprilia[4]

[1,2,3,4]Statistics, Faculty of Science and Technology, Universitas Airlangga
Email : [1]marcelena.vicky.galena-2021@fst.unair.ac.id, [2]dessy.nur.aisyah-2021@fst.unair.ac.id, [3]irma.ayu.indrasta-2021@fst.unair.ac.id, [4]marshanda.aprilia-2021@fst.unair.ac.id

Abstract: Based on the results of Basic Health Research on 2018 shows that 95.5% of the population aged ≥ 5 years consume less vegetables and fruits. Meanwhile, in West Java Province, 98.2% of the population aged ≥ 5 years does not consume vegetables and fruits. The proportion is even higher when compared to the proportion nationally. Lack of consumption of vegetables and fruits can affect the supply of fiber, vitamins, and minerals that are needed by the body. Although the interest in vegetable consumption of Indonesians is still relatively low, in Indonesia vegetables are still one of the mandatory menus in daily consumption. Quoting from the Central Agency on Statistics, the average per capita expenditure a month for vegetable consumption tends to increase every year. The peak occurred in March 2021 with a per capita expenditure of IDR 53,864 per month. By analyzing data on per capita expenditure according to the type of vegetables in West Java Province in 2021 using the cluster analysis method, it is hoped that it can help optimize plantation yields so that the quality of vegetables in West Java Province is better. If every region in Indonesia can optimize the quality of vegetables, it is expected that the consumption interest of the Indonesian people will also increase and the country's per capita income from vegetable commodities will also increase.

Keywords— Vegetable, Consumption, Expenditure

1. INTRODUCTION

Vegetables are foodstuffs derived from plant parts such as leaves, stems, and flowers [1]. In vegetables there are various kinds of nutrients including fiber, water, vitamins, and minerals. In general, vegetables derived from roots such as tubers and potatoes contain a lot of starch and carbohydrates, while green vegetables have a lower sugar content, and vegetables in the form of leaves contain a lot of vitamins, water, and minerals [2].

Based on the results of Basic Health Research on 2018 shows that 95.5% of the population aged ≥ 5 years consume less vegetables and fruits [3]. The proportion is even higher when compared to the proportion nationally. Lack of consumption of vegetables and fruits can affect the supply of fiber, vitamins, and minerals that are needed by the body. Sources of fiber, vitamins, and minerals found in vegetables and fruits are indispensable for the body to achieve a healthy diet in accordance with balanced nutrition guidelines [4].

Although the interest in vegetable consumption of Indonesians is still relatively low, in Indonesia vegetables are still one of the mandatory menus in daily consumption. As shown by the Central Agency on Statistics [5], the average per capita expenditure on vegetable spending was IDR 48,654 per month in September 2021. However, this amount decreased by 9.67% when compared to March 2021, which was IDR 53,864 per month. Although per capita expenditure in one month of vegetable spending decreased, vegetables are still the food commodity with the highest expenditure after finished food and beverages, cigarettes, and grains, which is 8.41% of the total per capita expenditure on food in one month. If you look at the trend, the average per capita expenditure a month on vegetable consumption tends to increase every year. The peak occurred in March 2021 with a per capita expenditure of IDR 53,864 per month [6].

Based on data from the Central Agency on Statistics, the average per capita expenditure a week by vegetable type in 2021 in West Java Province can be grouped by region and type of vegetable. So that it can be known which groups have the lowest, middle, and highest per capita expenditures from both regional groupings and vegetable jalis. The grouping will then be analyzed and then conclusions and suggestions can be obtained to optimize plantation yields so that the quality of vegetables in West Java Province is better, so as to increase the interest in vegetable consumption of the Indonesian people and can increase the country's per capita income from vegetable commodities.

2. REVIEW OF LITERATURE

2.1 Per Capita Expenditure

Per capita expenditure is a cost incurred for the consumption of all family members divided by the number of household members that has been adjusted to purchasing power parity. Spending data can reveal household consumption patterns in general using indicators of the

proportion of expenditure on food and non-food. The composition of household expenditures can be used as a measure to assess the level of economic well-being of the population. The lower the percentage of expenditure on food to total expenditure, the better the level of welfare.

2.2 Multivariate Analysis

The multivariate analysis method is a method in statistics with the aim of analyzing variables in a data where the variables are interconnected with I = 1, 2, ... n and j = 1, 2, ..., p [7]. Multivariate data with *n* observations on *p* variables can be displayed as follows.

$$X = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1k} & \dots & x_{1p} \\ x_{21} & x_{22} & \dots & x_{2k} & \dots & x_{2p} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{j1} & x_{j2} & \dots & x_{jk} & \dots & x_{jp} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \dots & x_{nk} & \dots & x_{np} \end{bmatrix} \quad (1)$$

Matrix X contains data from all variables where n rows and p columns [8].

2.3 Cluster Analysis

Cluster Analysis is a multivariate method that aims to group n objects into k clusters with k<n based on p changes (variables) so that the observation units in one cluster have more homogeneous characteristics than observation units in other clusters. The objectives of this cluster analysis are:

1. Grouping objects on the basis of similarity or inequality
2. Is a method that is often used if there is no hypothesis to be tested
3. Grouping based solely on the fact of the data

There are 2 types of cluster analysis methods, namely hierarchical cluster analysis and non-hierarchical analysis. In the cluster hierarchy method, there are two basic types, namely agglomerative and divisive.

1. Agglomerative
   Each object is considered as a cluster of its own, then two similar clusters will be combined, and so on.
2. Divissive
   It started from a large cluster consisting of all objects. Next, the least similar objects are separated, and so on

In agglomerative there are five methods that are quite well known, namely: Single Linkage, Complete Linkage, Average Linkage, Ward's Method, Centroid Method.

- Single Linkage
  Based on the minimum distance. Starting with two objects separated by the shortest distance, they will be placed in the first cluster, and so on. This method is also known as the closest neighbor approach.
- Average Linkage
  Average linkage treats the distance between two clusters as the average distance between all pairs of items where one member of that pair belongs to each cluster.
- Complete Linkage
  Complete linkage clustering produces many of the same ways as single linkage clustering, except for: at each stage, the distance (similarity) between the clusters is determined by the distance (similarity) between the two elements, one of each of the most distant clusters.
- Ward's Method
  The distance between the two clusters in this method is based on the total sum of square of two clusters on each variable.
- Centroid Method
  The distance between the two clusters in this method is based on the centroid distance of the two clusters in question [9].

2.4 Average Linkage Method

The Average Linkage method calculates the distance of two clusters called sa average distance where the distance is calculated on each cluster by the following equation:

$$d_{(UV)W} = \frac{\sum_i \sum_k d_{ik}}{N_{(UV)} N_W} \quad (2)$$

where is the distance between object $d_{ik} i$ in the cluster *(UV)* and object *k* in *cluster W*. Medium and successive are the number of objects in the$N_{(UV)} N_W$ *cluster (UV*) and (*W) (*Johnson and Wichern, 2007).

3. METHOD

This research is a type of qualitative research. According to Saryono in 2010 [10] qualitative research is research used to investigate, discover, describe, and explain the quality or specialness of social influences that cannot be explained, measured, or described through a quantitatical approach. This research was carried out in December 2022 with data sources obtained from the Central Agency on Statistics regarding the average per capita expenditure a week according to the type of vegetables in 2021 in West Java Province [11].

This study aims to analyze per capita expenditure by type of vegetables in 2021 in West Java Province using the cluster analysis method, which then the results of the analysis can provide insights to optimize plantation yields so that the quality of vegetables in West Java Province is better, so as to increase interest in vegetable consumption of the Indonesian people and can increase the country's per capita income from vegetable commodities.

Cluster analysis is a type of statistical analysis that aims to group objects based on the similarity of characteristics between these objects. The objects will be grouped into one

or more groups (clusters) so that the objects in one group will have similarities with each other [12]. The complete linkage method is a method that uses the maximum distance between groups. The use of this method will provide one solution in its completion, which is based on a measure of similarity in the distance technique used.

The results of the data that have been processed and analyzed will then be discussed based on theoretical reviews so that conclusions and suggestions can be obtained to help optimize plantation yields so that the quality of vegetables in West Java Province is better, so as to increase the interest in public vegetable consumption. If every region in Indonesia can optimize the quality of vegetables, it is expected that the consumption interest of the Indonesian people will also increase and the country's per capita income from vegetable commodities will also increase.

4. RESULTS AND DISCUSSION

The results of the cluster analysis of the complete linkage hierarchy in the grouping of per capita expenditure a week regarding vegetables in West Java are divided into 3 clusters. In this cluster analysis, 2 analyses are carried out, namely observation cluster analysis and variable cluster analysis. The following are the output and interpretation results of the complete linkage hierarchy cluster analysis on the Minitab.

- Observation Cluster Analysis

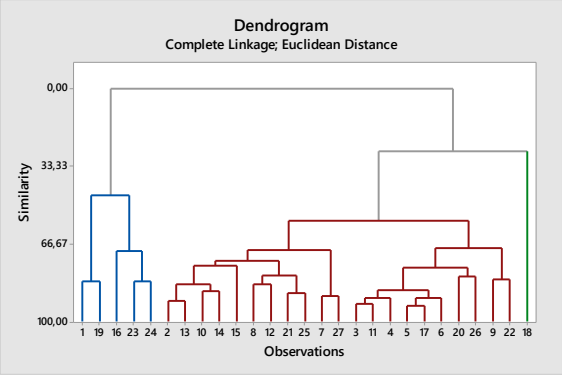

Fig. 1. Dendogram Output of Observation Cluster Analysis

Final Partition

	Number of observations	Within cluster sum of squares	Average distance from centroid	Maximum distance from centroid
Cluster1	5	3594943	827,617	1054,54
Cluster2	21	8146487	603,336	895,08
Cluster3	1	0	0,000	0,00

Fig. 2. Output of Final Partition Analysis of Observation Cluster

Distances Between Cluster Centroids

	Cluster1	Cluster2	Cluster3
Cluster1	0,00	2224,34	2612,17
Cluster2	2224,34	0,00	1993,04
Cluster3	2612,17	1993,04	0,00

Fig. 3. Output Distances Between Cluster Centroids Analysis Cluster Observations

Based on the dendogram output results from the observation cluster using the Minitab software above, there are 3 different clusters marked with color differences. Blue is the first cluster containing 5 regions, red is the second cluster containing 21 regions, and green is the third cluster containing 1 region. Here are which regions are members of each cluster when viewed based on dendograms.

Table 1: Results of Observation Cluster Analysis

Cluster Type	Cluster Members	Characteristic
Cluster 1	Bogor Region (1), Bogor City Area (19), Bekasi Region (16), Bekasi City Area (23), Depok City Area (24)	The area is a relatively densely populated area so that the interest and purchasing power of the people in the cluster is also high.
Cluster 2	Sukabumi Region (2), Subang Region (13), Majalengka Region (10), Purwakarta Region (14), Karawang Region (15), Kuningan Region (8), Indramayu Region (12), Bandung City Area (21), Cimahi City Area (25), Ciamis Region (7), Banjar City Area (27), Cianjur Region (3), Sumedang Region (11), Bandung Region (4), Garut Region (5), West Bandung Region (17), Tasikmalaya Region (6),	The areas in cluster 2 contain mostly sparsely populated areas because many residents of the region have jobs in the area that is in cluster 1 so that cluster 2 has a small interest and purchasing power in vegetables.

	Sukabumi City Region (20), Tasikmalaya City Area (26), Cirebon Region (9), Cirebon City Area (22)	
Cluster 3	Pangandaran Region (18)	The area in cluster 3 is categorized as an area that emphasizes more on other sectors besides vegetable plantations, namely the tourism sector. Therefore, cluster 3 is included in the cluster with an average per capita expenditure not too small or medium

The resulting interpretation is that when viewed based on centroid values in cluster 1 consisting of 5 regions, are the areas where the average per capita expenditure a week is considered the largest. When viewed based on centroid values in cluster 2 consisting of 21 regions where the average per capita expenditure a week is considered the smallest compared to other regions. When viewed from the centroid value in cluster 3 consisting of 1 region, the average per capita expenditure a week is considered not too small or medium.

- Variable Cluster Analysis

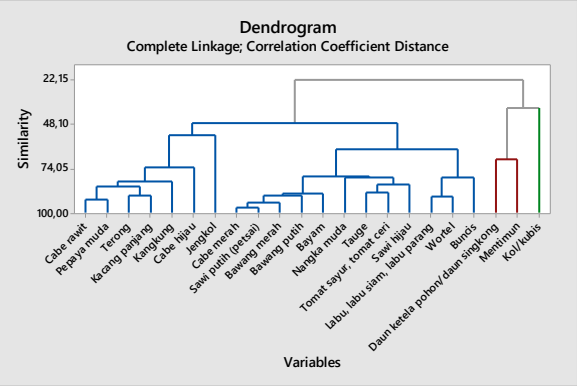

Fig. 4. Variable Cluster Analysis Dendogram Output

Amalgamation Steps

Step	Number of clusters	Similarity level	Distance level	Clusters joined		New cluster	Number of obs. in new cluster
1	21	96,7205	0,06559	3	19	3	2
2	20	93,9176	0,12165	3	4	3	3
3	19	91,8050	0,16390	1	7	1	2
4	18	90,3591	0,19282	9	14	9	2
5	17	89,7948	0,20410	3	5	3	4
6	16	89,5588	0,20882	11	16	11	2
7	15	88,4945	0,23011	3	22	3	5
8	14	88,0890	0,23822	10	15	10	2
9	13	84,3055	0,31389	1	11	1	4
10	12	83,2089	0,33582	10	18	10	3
11	11	81,2270	0,37546	1	21	1	5
12	10	79,3761	0,41248	9	17	9	3
13	9	79,2399	0,41520	8	10	8	4
14	8	78,4781	0,43044	3	8	3	9
15	7	72,9547	0,54091	1	2	1	6
16	6	68,7270	0,62546	12	13	12	2
17	5	62,8012	0,74398	3	9	3	12
18	4	54,2093	0,91581	1	6	1	7
19	3	47,4443	1,05111	1	3	1	19
20	2	38,6195	1,22761	12	20	12	3
21	1	22,1530	1,55694	1	12	1	22

Fig. 5. Output Amalgamation Steps Analysis Cluster Variables

Fig. 6. Output Final Partition Analysis Cluster Variables

The result of a variable cluster divided into three clusters was obtained that in cluster 1 it consists of 19 variables, in cluster 2 it consists of 2 variables, and in cluster 3 it consists of 1 variable. In this cluster, it is obtained what types of vegetables are members of each cluster when viewed based on dendograms. Here are what vegetables are members of each cluster when viewed based on dendograms.

Table 2: Variable Cluster Analysis Results

Cluster Name	Cluster Members
Cluster 1	Cayenne pepper, Young papaya, Eggplant, String beans, Kale, Green chilli, Jengkol, Red pepper, Chicory (petsai), Shallots, Garlic, Spinach, Young jackfruit, Bean sprouts, (Vegetable tomatoes, cherry tomatoes), Mustard greens, (Pumpkin, Siamese pumpkin, Machete pumpkin), Carrots, Chickpeas
Cluster 2	Tree kettle leaves/cassava leaves, Cucumber

Cluster 3	Cabbage/cabbage

The resulting interpretation is that when viewed based on the dendogram or final partition in cluster 1 there are 19 variables (types of vegetables) grouped based on per capita expenditure a week. In the cluster, it was found that these types of vegetables were among the types of vegetables with the highest per capita expenditure, which was 464.48. When viewed based on the dendogram or final partition in cluster 2 there are 2 variables (types of vegetables) which are grouped based on per capita expenditure a week. In the cluster, it was found that these types of vegetables were types of vegetables with a medium per capita expenditure of 270.39. When viewed based on the dendogram or final partition in cluster 1 there is 1 variable (type of vegetable) which is grouped based on per capita expenditure a week. In the cluster, it was found that these types of vegetables were among the types of vegetables with the lowest per capita expenditure of 199.52.

5. COVER

5.1 Conclusion

Based on the analysis that has been carried out using cluster *complete linkage*, the results of grouping the average per capita expenditure a week based on the type of vegetables in West Java province in 2021 were obtained based on observation clusters and variable clusters.

a. The results of the observation cluster analysis are based on the average expenditure of the people of West Java on vegetable types by looking at the area that has the highest average per capita. Regions in West Java are grouped into 3 clusters, namely areas where the average per capita expenditure a week is considered the largest, medium, and smallest.
b. The results of the variable cluster analysis are based on the average expenditure of the people of West Java on the type of vegetables based on the type of vegetable that has the highest average per capita. The types of vegetables in West Java are grouped into 3 clusters, namely the types of vegetables with the highest, middle, and lowest per capita expenditure.

5.2 Suggestion

Thereasons that can be given to the results of the analysis that has been carried out are:

a. Analysis revenue share
   Based on the results of the analysis, optimization of vegetable growth can be carried out throughout the West Java region by taking good care of vegetable crops, such as applying quality fertilizers. The application of fertilizer in each region is expected to have good quality so that the vegetable harvest of each region has good quality as well. In addition, the government is expected to provide good quality fertilizer subsidy assistance to help increase vegetable yields in West Java.
b. For readers
   The results of this cluster analysis can be explored using other clustering methods.

6. REFERENCES

[1] D. Tansari. (2014). "Quality Ice Cream with Carrot Combination (*Daucus Carota* L.) and Tomato (*Lycopersicum esculentum mill*.)". Available: http://e-journal.uajy.ac.id/6537/.

[2] Z. Powerful. *Understanding Vegetables And 3 Kinds of Groupings* [Online]. Available: https://www.awalilmu.com/2017/09/pengertian-sayuran-dan-3-macam-pengelompokannya.html

[3] O.F.Chandry, M.Haya, A.P.Sari, "Overview of Knowledge of the Importance Consumption of Fruit and Vegetables in Age Children School in Rena Long Village," 2021.

[4] Hermina and S. P. "Overview of Vegetable and Fruit Consumption of Indonesians in the Context of Balanced Nutrition: An Advanced Analysis of the 2014 Individual Food Consumption Survey (SKMI)," *Health Research Bulletin*, *44*(3), 2016.

[5] BPS. *Per Capita Expenditure* [Online]. Available:https://sirusa.bps.go.id/sirusa/index.php/indikator/197#:~:text=Pengeluaran%20per%20kapita%20adalah%20biaya,disesuaikan%20dengan%20paritas%20daya%20beli.

[6] M. A. Rizaty. (2022, Sep. 1). *Vegetable Consumption Expenditure in Indonesia decreased as of September 2021* [Online]. Available: https://dataindonesia.id/bursa-finance/detail/expenditure-vegetable-consumption-in-indonesia-down-per-september-2021.

[7] Hidayat. (2016, Nov). *Explanation of Multivariate Analysis and Its Types* [online]. Available:https://www.statistikian.com/2016/11/analisis-multivariat.html

[8] W. Alwii and M. Hasrul, "Cluster Analysis for District/City Grouping in South Sulawesi Province Based on People's Welfare Indicators," *MSA Journal*, 35-42, 2018.

[9] A, Hidayat. (2014, March). *Full Explanation of Cluster Analysis* [Online]. Available:https://www.statistikian.com/2014/03/analisis-cluster.html.

[10] P. A. Hidayat. (202 1, April. 14). *Qualitative Research Methods* [Online]. Available: https://www.statistikian.com/2012/10/penelitian-kualitatif.html.

[11] BPS. (2021). *Average Weekly Per Capita Spending According to Vegetables (Rupiah/Capital/Week), 2021 West Java Province: Central Bureau of Statistics* [Online]. Available: https://jabar.bps.go.id/indicator/5/790/1/rata-rata-pengeluaran-perkapita-seminggu-menurut-sayur--sayuran.html.

[12] M. Kuncoro, *Research Methods for Business and Economics*, Jakarta: Erlangga.