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Mapping Millennial Farmers Based On Technology Usage In South Sulawesi Using The 2023 Agricultural Census Data

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Abstract

Millennial farmers can be an indicator of the level of recovery in the agricultural sector and demonstrate the use of digital technology, which is expected to create productive and sustainable modern agriculture. This research aims to map millennial farmers who use technology and those who do not use technology in each district of South Sulawesi. The method used is cluster analysis using the K-Means method, after which the cluster results are plotted. The research results show that the millennial farmer cluster consists of 3 clusters based on the use of digital technology. Cluster 1 consists of districts/cities with the second-highest number of millennial farmers using digital technology in South Sulawesi. The same goes for millennial farmers who don't use digital technology. Meanwhile, cluster 2 consists of districts/cities with the lowest number of millennial farmers using digital technology. The same goes for the number of millennial farmers who do not use digital technology. Cluster 3 is a cluster consisting of districts/cities with the highest number of millennial farmers using digital technology and those not using digital technology.

Keywords: Digital Technology; Mapping; Millennial Farmers

1. Introduction

Indonesia is known as an agricultural country and has natural resources that can be produced into its own energy sources. One of them comes from the agricultural sector. This potential resource has not been followed by the growth of farmer regeneration. Data from the Ministry of Agriculture shows that there was a decrease in the number of workers in the agricultural sector by 1,080,722 people from 2017 to 2018 [1]. Whereas the potential of natural resources requires qualified human resources and has a commitment to develop the agricultural sector which is one of the success factors of sustainable agricultural development. But what happened was the phenomenon of aging farmers. Most parents in rural areas do not want their children to work as farmers as their current work and there is a view among young people that the agricultural sector has a less prestigious image with technology that is not advanced and cannot provide adequate income [2].

According to the results of the study[3], the age structure of farmers in Indonesia is 60.8% above 45 years old with 73.97% only having a primary school education, and the ability to apply new technology is still low. The majority of the agricultural sector in Indonesia also still uses traditional technology and technology adoption is still low, while in the industrial and service sectors technology is so advanced that many young people are interested in working in the sector. The regeneration of agricultural actors in Indonesia is slow and relatively low, and a solution needs to be found immediately. This problem is an urgent issue that needs a solution. So that the mapping of millennial farmers is something that needs to be done in order to get solutions according to the conditions of the location being mapped. Millennial farmers can be an indicator of the level of regeneration in the agricultural sector

and show the utilization of digital technology which is expected to create productive and sustainable modern agriculture.

Based on the Regulation of the Minister of Agriculture of the Republic of Indonesia Number 4 of 2019 concerning Guidelines for the Movement of Agricultural Human Resources Development Towards the World Food Barn 2045, Millennial Farmers are farmers aged 19 years to 39 years, and/or farmers who are adaptive to digital technology. Digital technology includes the use of modern agricultural tools and machinery (alsintan), the use of internet/smartphones/information technology, the use of drones, and/or the use of artificial intelligence. So, this paper, which is the result of data processing from the 2023 agricultural census, aims to describe the mapping of millennial farmers who use technology with those who do not use technology in each district in South Sulawesi. The results of this study can be used as a basis for developing programs and policies for the development of the agricultural sector, especially millennial farmers based on the similarity of clusters in the future.

2. Methodology

The data used is the 2023 Agricultural Census data taken from BPS South Sulawesi Province. The object observed is the number of millennial farmers who use technology with those who do not use technology. The data covers 24 districts/cities in South Sulawesi Province. The method used in this research is cluster analysis using the K-Means method, then the cluster results are biplotted to see the characteristics of the area based on the use of technology among millennial farmers. The stages of data analysis were carried out as follows:

a. Data exploration.
b. Election of the number of clusters using the Silhouette method [4] with the formula written in Eq. (1).

$$s(i) = \frac{b(i)-a(i)}{\max\{a(i),b(i)\}} \quad (1)$$

Where $s(i)$ the *Silhouette score* of cluster a and cluster b.

c. Clustering using the K-Means method is an algorithm that assigns each item to the cluster that has the closest centroid (mean) [5]. The distance between an observation and its centroid is calculated using the Euclidean distance whose formula is written in Eq. (2).

$$d_{ij} = \sqrt{\sum_{k=1}^{p}(x_{ik} - x_{jk})^2} \quad (2)$$

Where d_{ij} is the distance between the *i-th* observation and the *j-th* observation, x_{ik} is the value of the *i-th* observation on the *k-th* variable, x_{jk} s the value of the jth observation in the *k-th* variablw, p is the number of variables observed [6].

d. Determination of cluster characteristics by calculating the average value of each variable in each cluster.
e. Visualization of cluster results using thematic maps performed on RStudio statistical software with the spplot function [7].
f. fPlot the cluster results, which is a two-dimensional graph that displays the object of observation and the variables under study. [8].

3. Result and Discussion

Millennial Farmer Data

Based on the ST2023 results, millennial farmers aged 19-39 years, both using and not using digital technology, were 272,817 people or 26.17% of the total farmers in South Sulawesi Province of 1,042,647 people. millennial farmers aged 19-39 years, using digital technology were 175,732 and those who did not use digital technology, were 97,085 people. Meanwhile, farmers who are more than 39 years old and use digital technology are 552,643 people (53 percent) and farmers who are less than 19 years old and use digital technology are 1,167 people (0.11 percent). More details are presented in the following data:

Table 1 Number of Farmers Aged 19-39 Using Digital Technology and not Using in South Sulawesi Province (people), 2023

No	Name of Region	Using Digital Technology	Not Using Digital Technology	Total
1	Makassar	368	1.237	1605
2	Gowa	17.543	5.623	23166
3	Soppeng	4.500	2.324	6824
4	Sidrap	9.155	1.240	10395
5	Luwu Timur	6.829	4.484	11313
6	Maros	7.493	3.654	11147
7	Palopo	869	751	1620
8	Kepulauan Selayar	770	4.515	5285
9	Pare-Pare	418	207	625
10	Takalar	8.524	2.033	10557
11	Barru	2.540	1.225	3765
12	Bulukumba	6.522	10.168	16690
13	Bone	21.761	10.255	32016
14	Tanah Toraja	3.270	4.849	8119
15	Sinjai	5.714	5.257	10971
16	Pinrang	10.999	2.775	13774
17	Enrekang	9.784	1.421	11205
18	Luwu	7.652	5.104	12756
19	Luwu Utara	9.283	4.499	13782
20	Toraja Utara	2.850	3.557	6407
21	Wajo	12.326	3.284	15610
22	Bantaeng	6.452	5.133	11505
23	Pangkep	6.281	5.853	12134
24	Jeneponto	13.829	7.637	21466

Source: Census of Agriculture, 2023

Data Exploration

Table 2 Descriptive Statistics of Data on the Number of Millennial Farmers Who use Digital Technology and do not use digital technology

Use of Technology	Nilai Minimum	Mean	Maximum Score
Using Technology	Soppeng (45)	6812	Bone (21761)
Tidak Menggunakan Teknologi	Luwu (5104)	3786	Bone (10255)

Table 2 shows that Soppeng Regency has the fewest millennial farmers using digital technology in the entire South Sulawesi region. Meanwhile, the millennial farmer who uses the most digital technology is Bone District. Meanwhile, Luwu Regency is the Regency that does not use the least digital technology, while Bone Regency, despite being an area that uses a lot of digital technology, is also the area with the most millennial farmers who do not use digital technology.

Cluster Analysis

The first step taken in cluster analysis is to determine the number of clusters to be formed. The number of clusters formed is determined by the Silhouette method. The Silhouette coefficient is used to see the quality and strength of the cluster, how well an object is placed in a cluster. The Silhouette method uses the average cluster value to estimate the optimum cluster value. The higher the average value, the better the cluster [9].

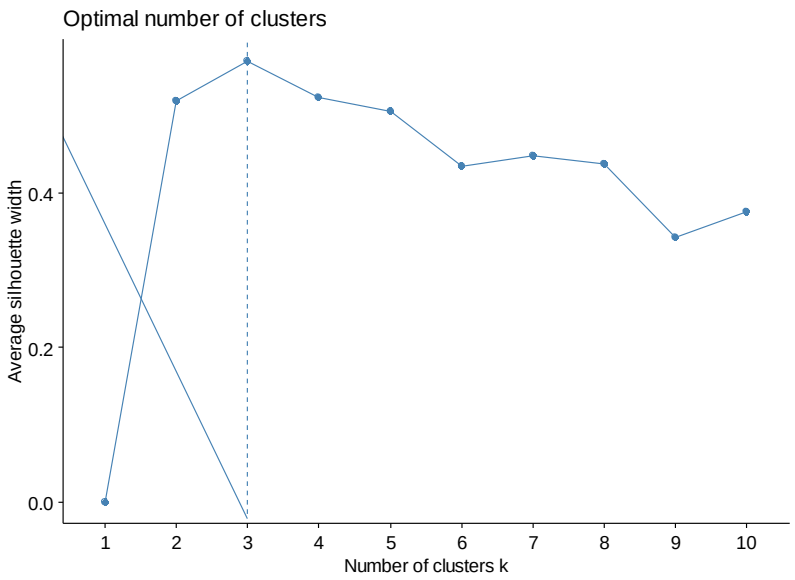

Figure 1 Selection of Number of Clusters

The Silhouette method graph in Figure 1 shows the optimal number of clusters formed, which is 3 clusters. The plot of clusterization results is shown in Figure 2 below:

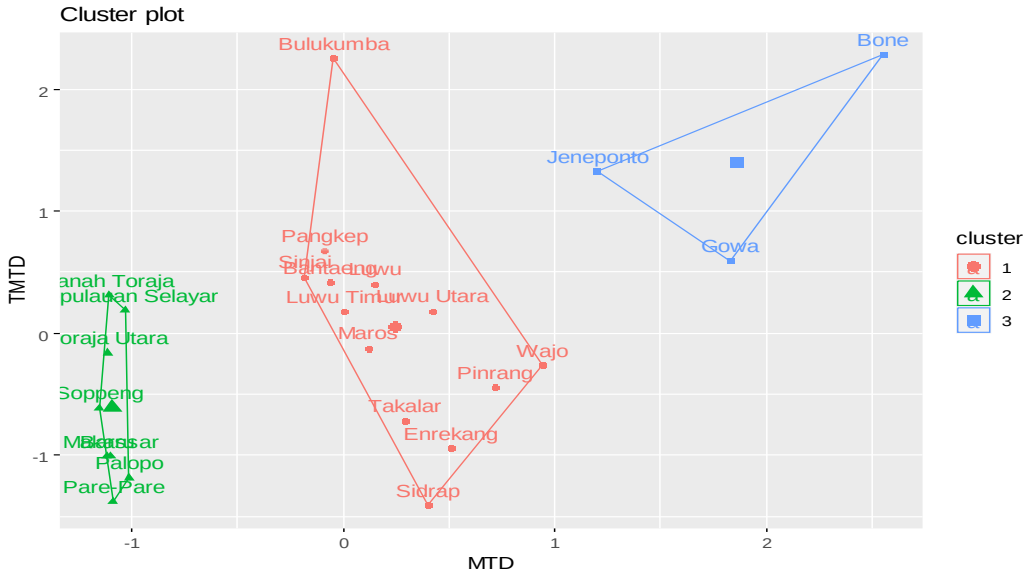

Figure 2. Clustering plot

The figure above shows that cluster 1 consists of 13 districts, cluster 2 consists of 9 districts and cluster 3 consists of 3 districts. And the size of the cluster goodness is 80.6%. The characteristics of each cluster are shown in Table 3. Here:

Table 3 Cluster Characteristics

Cluster	Using Digital Technology	Not Using Digital Technology
1	8232	4138
2	417	2333
3	17711	7838

Table 3 shows that cluster 1 consists of districts with the second highest number of millennial farmers using digital technology in South Sulawesi. The same is true for the position of millennial farmers who do not use digital technology. Meanwhile, cluster 2 consists of districts/cities with the lowest number of millennial farmers using digital technology. Likewise, the number of millennial farmers who do not use digital technology. Cluster 3 is a cluster consisting of districts / cities with the highest number of millennial farmers who use digital technology and those who do not use digital technology. The clustering results in Figure 2 can be visualized in the form of a thematic map shown in Figure 3.

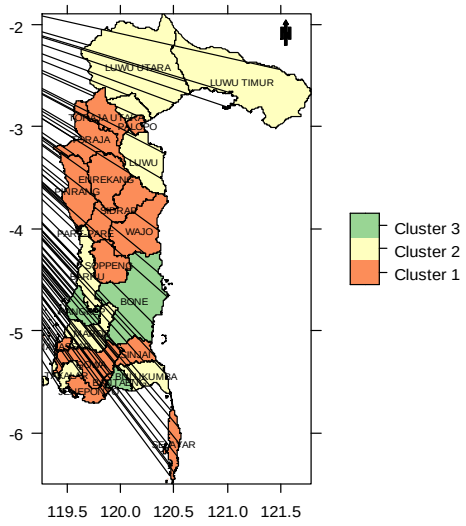

Figure 3. Visualization of clustering results with thematic maps

Figure 3 shows that the islands of Selayar, Sinjai, Gowa, Jeneponto, Soppeng, Wajo, Sidrap, Enrekang, Pare-Pare, Toraja, Palopo, Pinrang and North Toraja have the second highest number of millennial farmers using digital technology in South Sulawesi and the second highest number of millennial farmers not using digital technology. Meanwhile, Bulukumba, Luwu, North Luwu, East Luwu and Makassar are included in the lowest value cluster category that has millennial farmers using digital technology. Some of these districts also fall into the category of having the lowest number of millennial farmers who do not use digital technology. The last cluster is the region with the most millennial farmers who do not use digital technology as well as the most users of digital technology. There are only 3 regions included in this cluster, namely Bone, Pangkep and Bantaeng.

The following bivariate analysis is also used in this research, namely biplot analysis. The purpose of this analysis is to depict the districts and the use of digital technology in the data matrix together in a low-dimensional graph [10]. This depiction includes the diversity and correlation between digital technology users and those who do not use digital technology, as well as the proximity between areas where millennial farmers live which will be able to identify data groupings of digital technology users and those who do not use it.

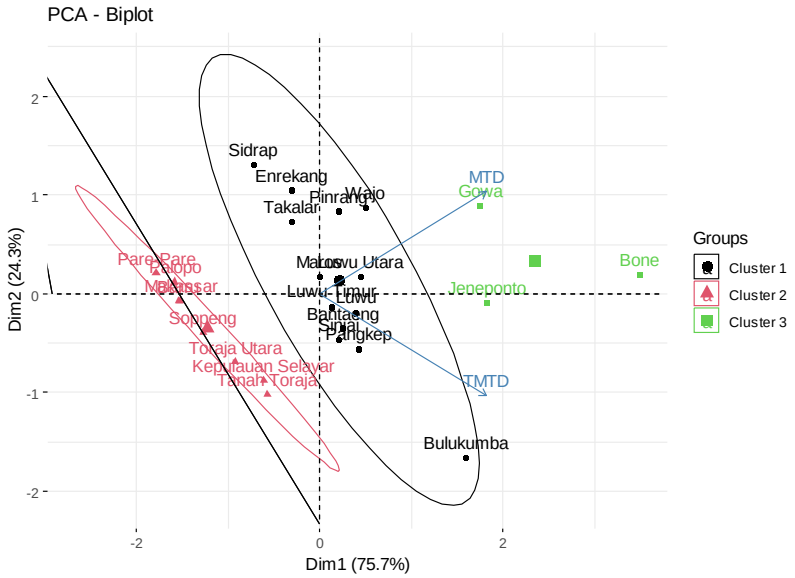

Figure 4. Biplot of clustering

Figure 4 shows that areas of the same color have similar characteristics. The length of the vector in Figure 4 indicates the use of digital technology by millennial farmers. The shorter the vector, the smaller the amount of digital technology use. Likewise for those who do not use. In addition, the vector angle in Figure 4 shows the correlation or relationship between the variables Using Digital Technology (MTD) and Not Using Digital Technology (TMTD) has a vector angle > 900, meaning that both have a negative correlation.

4. Conclusion

The 2023 Agricultural Census data in South Sulawesi based on the mapping of millennial farmers who use technology with those who do not use technology in each district in South Sulawesi consists of three clusters. Cluster 1 consists of Selayar Islands, Sinjai, Gowa, Jeneponto, Soppeng, Wajo, Sidrap, Enrekang, Pare-Pare, Toraja, Palopo, Pinrang and North Toraja. Cluster 2 consists of Bulukumba, Luwu, North Luwu, East Luwu and Makassar. Cluster 3 consists of Bone, Pangkep and Bantaeng.

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