



Application of the K-Means Clustering Method to Cluster Stunting Cases Based on Family Economics in Langkat Regency

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Abstract

Stunting in children is a serious health issue that has long-term impacts on the quality of human resources in Indonesia. Langkat Regency is one of the regions with a high prevalence of stunting. Family economic factors, such as parents' occupation and housing conditions, are suspected to play a significant role in influencing children's nutritional status. However, there is still a lack of data-based studies that specifically cluster stunting cases based on these factors. To address this need, this study applies the K-Means Clustering method to group stunted children based on three main variables: parents' occupation, housing status, and causes of stunting. This algorithm was chosen for its effectiveness in identifying hidden patterns within medium-sized data. The clustering process involved data transformation, determining the number of clusters, calculating distances using Euclidean Distance, and iterative processing to obtain the optimal centroid. The implementation was carried out using MATLAB R2014b software with stunting data obtained from the PPKB-PPA Office of Langkat Regency for the years 2023–2024. The results of the study yielded three main clusters representing the family's economic condition and its relationship to stunting. The patterns found indicate that children from families with unstable jobs and inadequate housing tend to be more vulnerable to stunting. These findings provide a strong foundation for the formulation of more targeted policies in addressing stunting by local governments.

Keywords: Economic Condition, Euclidean Distance, K-Means Clustering, Langkat Regency, MATLAB, Stunting.

1. Introduction

Technological developments have brought about significant changes in data management and provided various significant benefits for relevant agencies and specific groups. Information processed using technology produces accurate and fast data, which can reduce human error and increase the effectiveness of data management processes, so that the data received is accurate and transparent. Technology is also needed in agencies such as PPKB-PPA to monitor and address stunting issues.

Stunting is a condition in which a child's height is lower than the standard for their age due to chronic malnutrition, repeated infections, or a long-term lack of emotional and social support. *Stunting* is a major health problem in Indonesia because it can negatively impact a child's physical development and thinking skills, ultimately affecting the quality of future human resources. According to data from the World Health Organization (WHO), Indonesia is among the countries with a high prevalence of *stunting*, making addressing this issue a national priority.

Despite various efforts, the prevalence of stunting in Indonesia remains relatively high. Basic Health Research (Riskesdas) data showed a figure of 35.6% in 2010, increasing to 37.2% in 2013, and although it decreased slightly in Nutritional Status Monitoring (PSG) to 29.0% in 2015, this figure rose again to 29.6% in 2017—still above the WHO threshold. A 2017 World Bank report even estimated economic losses due to stunting to reach 3–11% of Indonesia's Gross Domestic Product (GDP), or the equivalent of IDR 300 to IDR 1,210 trillion per year, indicating that stunting is not only a health issue, but also a serious economic problem [1].

Malnutrition in *stunting* occurs from pregnancy to the beginning of the baby's life, but the symptoms of *stunting* are only seen after the child is two years old. The problem of *stunting* is a serious public health issue because it is related to the increased risk of disease, death, and obstacles to children's motor and mental development. Therefore, the handling and prevention of *stunting* is very important to ensure optimal and healthy child growth and development [2]

Indonesia occupies the fifth position as the country with the highest prevalence of stunting in the world, especially in the Southeast Asian region. Compared to other middle-income countries, the stunting rate in Indonesia is still quite high. Until 2021, there are only six provinces that have managed to reduce stunting rates below WHO standards (20%), namely DKI Jakarta, DI Yogyakarta, Bali, Lampung, Riau Islands, and Bangka Belitung Islands (Adityaningrum et al., 2021). This fact shows that the majority of Indonesian regions are still facing major challenges in overcoming stunting, including Lalat Regency.

Langkat Regency is one of the regions in Indonesia that still faces stunting problems with a high prevalence rate. Efforts to prevent stunting require a deep understanding of the underlying causes, one of which is the family's economic condition, which influences their ability to meet children's nutritional and health needs. Data-driven analysis methods, such as K-Means Clustering, can serve as an effective approach to identify patterns of association between family economic conditions and stunting incidence, thereby providing a basis for more targeted interventions.

2. Litelatur Riview

2.1. Stunting

Stunting is a condition in which a child's growth is stunted, resulting in a height that is lower than the standard for their age. Stunting is caused by chronic malnutrition, particularly during the first 1,000 days of life or approximately 2 years and 9 months, as well as recurrent infections, chronic malnutrition, and inadequate care. In this case, stunting has far-reaching impacts, not only on physical growth but also on cognitive development, health, and future productivity. Children who experience stunting are more susceptible to illness, have lower learning abilities, and may face long-term health issues. Children who experience stunting generally have shorter heights than their peers, accompanied by reduced muscle mass and physical strength. In addition, they may face difficulties in social interaction, experience low self-confidence, and have a higher risk of degenerative diseases such as diabetes, hypertension, and heart disease in adulthood. Stunting can also hinder brain development, resulting in decreased learning ability.

There are several characteristics that can be used to identify children with stunting. Physically, children show shorter height than the standard for their age, low weight, and slow or stagnant growth. In terms of development, children may experience cognitive delays such as learning difficulties, as well as frequent illnesses due to a weak immune system. Motor development delays, such as delayed sitting, crawling, or walking, are also indicators that a child is experiencing stunting. The causes of stunting in children are multifactorial. Inadequate and unbalanced nutrition is the main cause, often exacerbated by recurrent infectious diseases such as diarrhea and pneumonia. Limited access to health services and lack of attention to healthy eating patterns also contribute to this condition. An unclean environment increases the risk of children contracting infections, while economic constraints limit families' ability to provide nutritious food. The combination of these factors makes stunting a complex problem that requires a comprehensive approach.

2.2. Family Economy

Condition Family economic conditions play a major role in preventing stunting in children. Families with good financial capabilities are better able to meet nutritional needs, access health services, and provide adequate education for their children. Thus, family economics plays a key role in influencing children's health and quality of life.

Conversely, families with weaker economic conditions often struggle to meet basic needs, which can increase the risk of stunting. Therefore, efforts to improve family economic conditions are an important step in reducing stunting rates and enhancing the quality of life for future generations.

2.3. Data Mining

Data mining is the process of discovering patterns, relationships, or other interesting information from large data sets through the use of various analysis techniques and algorithms. In the context of information systems, data mining is used to identify patterns and trends that can aid in better decision making. This process involves a series of steps, including data collection, data cleaning and preparation, data selection, data transformation, data mining, evaluation, and data presentation.

Data Mining is a process for extracting or digging up data and information from a large database, which was previously No known However can understandable and useful, and used for make decision very important business. *Data Mining* involving collection various technique with objective for find patterns that are not known in the data that has been collected. *Data Mining* allows users find knowledge in the database that is not Possible known its existence by the user [2] .

Data Mining is the process of discovering useful patterns from a large amount of data known as *Data Mining*. The patterns found must have meaning and provide benefits, usually in the form of economic benefits. The analyzed data can be stored in databases, data warehouses, or other types of data storage. *Data Mining* involves various fields of science such as database systems, data warehouses, statistics, machine learning, information retrieval, and high-level computing. In addition, *Data Mining* is also supported by other sciences such as artificial neural networks, pattern recognition, spatial data analysis, image databases, and signal processing [5].

2.4. Algorithm K-Means

K-Means clustering is a cluster analysis method that divides objects into a number of groups based on the nearest average. This algorithm is known for its simplicity and ease of learning, and is used to solve data clustering problems. As an evolutionary algorithm, K-Means works as its name suggests. This algorithm clusters data into k groups, where k is a given parameter. Each data is then grouped based on proximity with the group average .The average value in group counted in a way repetitive in a gradual process [3] .

2.5. Clustering

K-Means clustering is one of the most frequently used algorithms in data analysis. Algorithm This share data points become a number of cluster 'k' based size distance used for grouping. The value of 'k' must be defined by the user. The distance between data points and cluster centers is calculated, and the data points closest to the cluster centers are assigned to those clusters.

After each iteration, the center of each cluster is recalculated and this process continues until the specified number of iterations is complete or until the cluster centers no longer change. This algorithm requires high computation because each iteration calculates the distance between each data point and the center of all clusters. This makes it difficult to apply this algorithm to large data sets.

2.6. Dinas PPKB-PPA

The Population Control, Family Planning, and Women's Affairs, Child Protection Agency (PPKB-PPA) of Langkat Regency is a local government agency with the primary responsibility of controlling population growth, promoting family planning programs, and protecting and empowering women and children. This agency plays a crucial role in supporting national policies related to family development and birth rate control, thereby fostering a healthier, more prosperous, and more competitive society.

3. Research Methodology

Research methodology is a systematic scientific procedure or set of steps for obtaining relevant data to support the research process. In conducting this research, the author followed a sequential and systematic research methodology to produce reliable research that is scientifically valid, with the following stages:

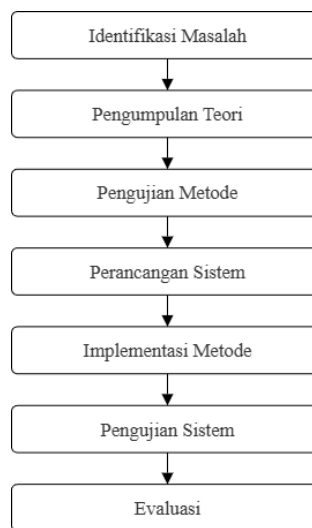


Fig. 1: Methodology Flow Study

3.1. Research Design

This study uses a quantitative method with a descriptive analytical approach. The focus is to identify the influence of family economic factors, such as parental employment, residential status, and causes of stunting, on the prevalence of stunting in Langkat Regency. The K-Means Clustering algorithm is used to group data based on similar characteristics so that meaningful patterns of relationships can be found.

3.2. Population and Research Sample

The study population consists of all cases of stunting recorded in Langkat District during the period 2023–2024. The sample was selected using purposive sampling, specifically cases with complete data on parental employment, residential status, and causes of stunting. The data was sourced from the Langkat District PPKB-PPA Office.

3.3. Techniques and Instruments Data collection

Data was collected through official government documentation and processed into a dataset format for analysis purposes. Research variables included parents' occupations, residential status, and causes of stunting. All data was processed and coded into numerical data to facilitate processing using the K-Means algorithm.

3.4. Data Analysis Tools

Data analysis was performed using the K-Means Clustering algorithm run through MATLAB R2014b software. This method includes determining the optimal number of clusters, initializing the centroid, calculating the Euclidean distance, and iteratively updating the centroid until the results are stable. Visualization was performed using a 3D graph of the clustering results.

3.5. Research Model

The research model used is a clustering model, where stunting case data in Langkat Regency will be grouped into several clusters based on similar characteristics of family economic factors, including parental occupation, residential status, and causes of stunting. The results of this clustering will provide a more detailed picture of the relationship between family economic conditions and stunting prevalence rates. The information obtained can be used by the Langkat Regency PPKB-PPA Office and other relevant parties to design more targeted stunting management policies and programs.

3.6. Input Data

The data used in the system comes from the Population Control, Family Planning, Women's Empowerment, and Child Protection Agency (Dinas PPKB-PPA) of Langkat Regency. The data is first stored in Microsoft Excel format as an initial or temporary storage medium. Subsequently, the data will be processed and transformed according to the transformation values of each variable, as explained in the previous chapter. An explanation of the types of data that can be entered into the system, along with the variables and their transformation values, is as follows:

1. Input data
 - File name : Stunting data
 - Number of data : 510
 - Variable : - X = Parents' Occupation
 - Y = Residence Status
 - Z = Causes of Stunting
2. Cluster group : 3 clusters
3. Data transformation values on variables :

Table 1: Data Transformation Values on Variables

No	Variables	Transformation	Transformation Value
1	Parents' Jobs	Not working	1
		Housewife/househusband	2
		Odd jobs	3
		Day laborer	4
		Farmer	5
		Fisherman	6
		Driver	7
		Craftsman	8
		Merchant	9
		Entrepreneur	10
		Guide	11
		Private employee	12
		Teacher	13
		Retired	14
2	Residence Status	Renting	1
		Leasing	2
		Company Facilities	3
		Company Housing	4
		Own Property	5
3	Causes of Stunting	Normal	1
		Malnutrition	2
		Chronic malnutrition	3
		Short stature/short	4
		Short stature/very short	5
		Low birth weight (LBW)	6
		Chronic illness	7
		Anemia	8
		Frequent illness	9
		Down syndrome	10

4. Implementation

The implementation phase is the stage of applying and testing the new system, which includes the process of applying and testing the application directly in actual operational conditions. In this phase, implementation is the final step in the process of applying the clustering method to the data grouping system, in accordance with the design that has been made previously. The implementation process is carried out using MATLAB R2014b software, with the clustering algorithm coded so that the system can perform data clustering systematically in accordance with the data clustering process stages. Based on the design results obtained, the clustering method was successfully implemented using the K-Means algorithm.

Through this system, the Population Control, Family Planning, Women's Empowerment, and Child Protection Agency (Dinas PPKB-PPA) of Langkat Regency analyzes and categorizes data on stunting cases based on family economic conditions. The application of the K-Means Clustering method in this system aims to identify hidden patterns in the data, enabling decision-making processes to be conducted more accurately and data-driven. As a result, the outcomes of this system's implementation are expected to serve as a foundation for formulating more effective policies or programs, such as the distribution of social assistance or health education outreach to families classified as high-risk for stunting, as part of the efforts to address stunting in Langkat District.

4.1. Results

a. Results with 3 Clusters

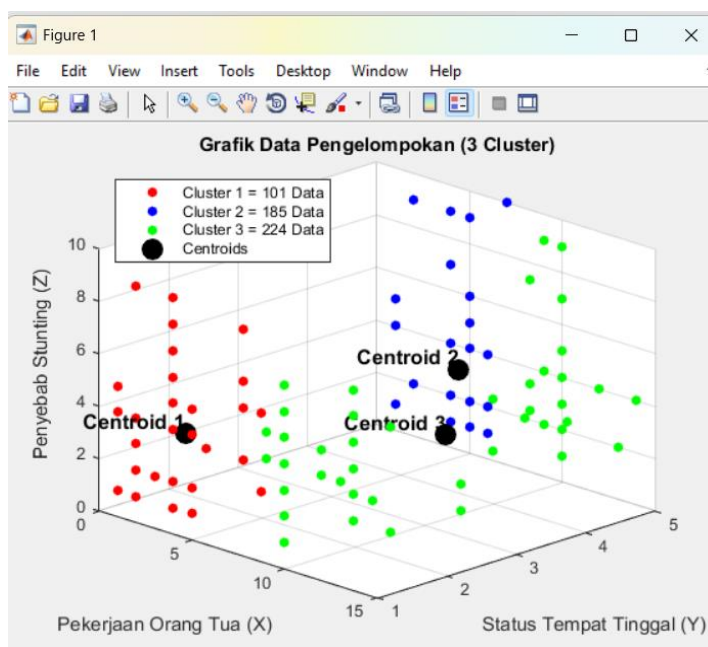


Fig. 2: Chart results of the grouping process

The results of the system testing phase are output data obtained after processing input data using MATLAB R2014b software. This process was carried out to evaluate the implementation of the K-Means Clustering method in the system. The following is the data from the clustering of stunting cases based on family economic conditions in Langkat Regency, which was processed using the K-Means Clustering method to identify groups with similar characteristics.

Table 2: Data Transformation Values on Variables

No	Cluster Center	Variables			Amount of Data
		X	Y	Z	
1	Centroid 1	3.6931	1.2574	3.5446	101
2	Centroid 2	4.4000	5,0000	3.0703	185
3	Centroid 3	10.2321	3.2634	3.2813	224

From the data grouping results shown in the table above, which were obtained through a testing process using predetermined input data and processed with the help of MATLAB R2014b software, it can be concluded that:

- a. In group 1, which consists of from 101 stunting case data based on condition economy families in the Langkat Regency, can identified that cases in group This generally can categorized based on variables Parents' Occupation as Day laborer (BHL), with characteristics of the status of residence of the Renting, as well as factor The cause of stunting is Short stature/short.

- b. In group 2, which consists of from 185 stunting case data based on condition economy families in the Langkat Regency, can identified that cases in group This generally can categorized based on variables Parents' Occupation as Day laborer (BHL), with Residential Status Characteristics Own Property, and factor the cause of stunting is Chronic malnutrition.
- c. In group 3, which consists of from 224 stunting case data based on condition economy families in the Langkat Regency, can identified that cases in group This generally can categorized based on variables Parents' work as Entrepreneur, with Residential Status Characteristics Company Facilities, as well as factor The cause of stunting is Chronic malnutrition.

b. Results with 4 Clusters

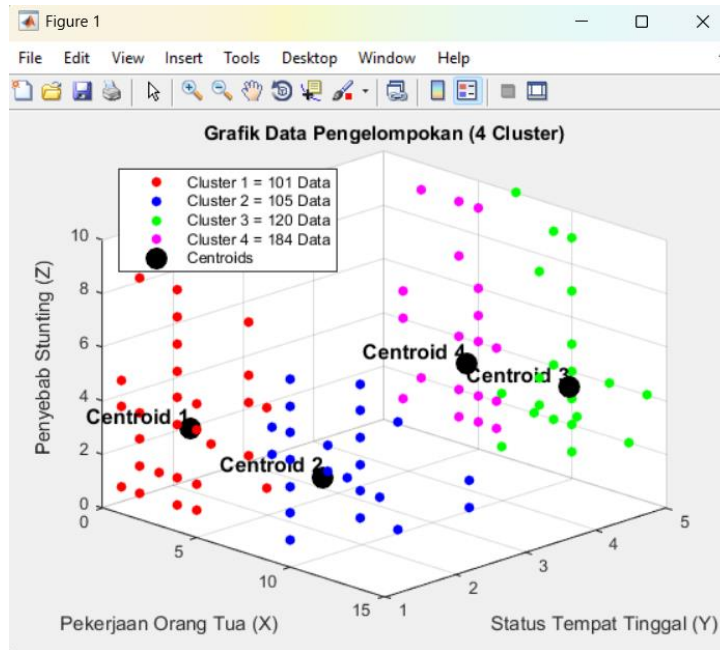


Fig. 3: Clustering results with 4 clusters

The results of the system testing phase are output data obtained after processing input data using MATLAB R2014b software. This process was carried out to evaluate the implementation of the K-Means Clustering method in the system. The following is the data from the clustering of stunting cases based on family economic conditions in Langkat Regency, which was processed using the K-Means Clustering method to identify groups with similar characteristics.

Table 3: Data Cluster Center with 4 Centroids

No	Cluster Center	Variables			Amount of Data
		X	Y	Z	
1	Centroid 1	3.6931	1.2574	3.5446	101
2	Centroid 2	10.2667	1.3905	3.0857	105
3	Centroid 3	10.1750	4.9167	3.5083	120
4	Centroid 4	4.3859	5.0000	3.0326	184

From the data grouping results shown in the table above, which were obtained through a testing process using predetermined input data and processed with the help of MATLAB R2014b software, it can be concluded that:

- a. In group 1, which consists of from 101 stunting case data based on condition economy families in the Langkat Regency, can identified that cases in group This generally can categorized based on variables Parents' Occupation as Day laborer (BHL), with characteristics of the status of residence of the Renting, as well as factor The cause of stunting is Short stature/short.
- b. In group 2, which consists of from 105 stunting case data based on condition economy families in the Langkat Regency, can identified that cases in group This generally can categorized based on variables Parents' work as Entrepreneur, with characteristics of the status of residence of the Renting , as well as factor The cause of stunting is Chronic malnutrition.
- c. In group 3, which consists of from 120 stunting case data based on condition economy families in the Langkat Regency, can identified that cases in group This generally can categorized based on variables Parents' work as Entrepreneur, with Residential Status Characteristics Own Property, and factor the cause of stunting is Short stature/short.
- d. In group 4, which consists of from 184 stunting case data based on condition economy families in the Langkat Regency, can identified that cases in group This generally can categorized based on variables Parents' Occupation as Day laborer (BHL), with Residential Status Characteristics Own Property, and factor the cause of stunting is Chronic malnutrition.

c. Results with 5 Clusters

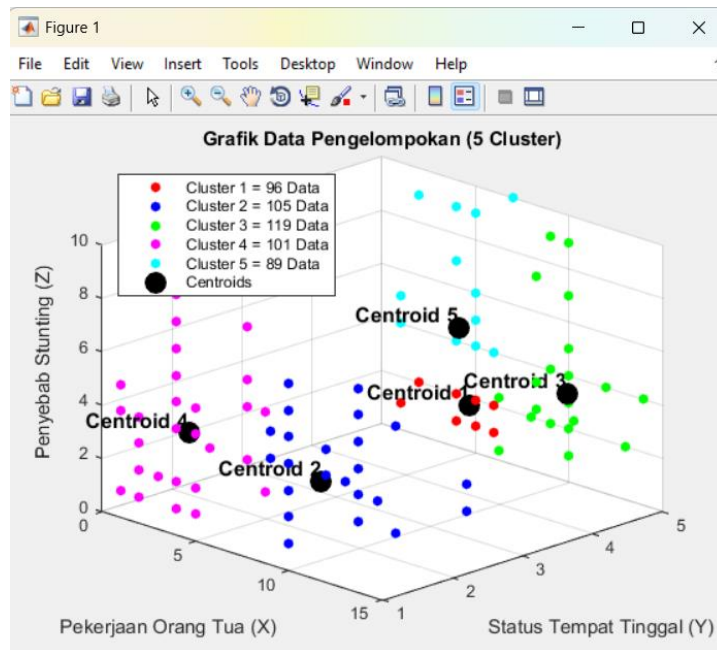


Fig. 4: Clustering results with 5 clusters

The results of the system testing phase are output data obtained after processing input data using MATLAB R2014b software. This process was carried out to evaluate the implementation of the K-Means Clustering method in the system. The following is the data from the clustering of stunting cases based on family economic conditions in Langkat Regency, which was processed using the K-Means Clustering method to identify groups with similar characteristics.

Table 4: Data Cluster Center with 5 Centroids

No	Cluster Center	Variables			Amount of Data
		X	Y	Z	
1	Centroid 1	4.6875	5,0000	1.7396	96
2	Centroid 2	10.2667	1.3905	3.0857	105
3	Centroid 3	10.2017	4.9160	3.4538	119
4	Centroid 4	3.6931	1.2574	3.5446	101
5	Centroid 5	4.0899	5,0000	4.5056	89

From the data grouping results shown in the table above, which were obtained through a testing process using predetermined input data and processed with the help of MATLAB R2014b software, it can be concluded that:

- In group 1, which consists of from 96 stunting case data based on condition economy families in the Langkat Regency, can identified that cases in group This generally can categorized based on variables Parents' Occupation as Farmers, with Residential Status Characteristics Own Property, and factor the cause of stunting is malnutrition.
- In group 2, which consists of from 105 stunting case data based on condition economy families in the Langkat Regency, can identified that cases in group This generally can categorized based on variables Parents' work as Entrepreneur, with characteristics of the status of residence of the Renting, as well as factor The cause of stunting is Chronic malnutrition.
- In group 3, which consists of from 119 stunting case data based on condition economy families in the Langkat Regency, can identified that cases in group This generally can categorized based on variables Parents' work as Entrepreneur, with Residential Status Characteristics Own Property, and factor the cause of stunting is Chronic malnutrition.
- In group 4, which consists of from 101 stunting case data based on condition economy families in the Langkat Regency, can identified that cases in group This generally can categorized based on variables Parents' Occupation as Day laborer (BHL), with characteristics of the status of the residence of the Renting, as well as factor The cause of stunting is Short stature/short.
- In group 5, In group 5, which consists of from 89 stunting case data based on condition economy families in the Langkat Regency, can identified that cases in group This generally can categorized based on variables Parents' Occupation as Day laborer (BHL), with Residential Status Characteristics Own Property, and factor the cause of stunting is Short stature/very short.

5. Conclusions and Suggestion

5.1. Conclusion

Based on the results of research and testing conducted in the application of the K-Means Clustering method to group stunting cases based on family economic conditions in Langkat Regency, the following conclusions were drawn as the conclusion of this thesis:

1. The K-Means Clustering method is proven effective in grouping child stunting data become a number of groups based on similarity characteristics economy family. In research this, used three variables main, namely Parental Occupation (X), Residential Status (Y), and Causes of Stunting (Z). Grouping done use device MATLAB R2014b software with the total data is 510.
2. Based on implementation system grouping use K- Means Clustering algorithm on 510 child stunting case data obtained from the PPKB-PPA Service of the Langkat Regency, results testing with using 3 clusters produces three cluster centers (centroids) as following:
 - a. The results of the clustering process carried out use device MATLAB R2014b software shows that cluster 1 consists of from 101 data, with point the center (centroid) is at coordinates (3.6931; 1.2574; 3.5446).
 - b. The results of the clustering process carried out use device MATLAB R2014b software shows that cluster 2 consists of from 185 data, with point the center (centroid) is at coordinates (4.4000; 5.0000; 3.0703).
 - c. The results of the clustering process carried out use device MATLAB R2014b software shows that cluster 3 consists of from 224 data, with point the center (centroid) is at coordinates (10.2321; 3.2634; 3.2813).

Overall, there were 510 data points that were successful grouped in the clustering process.

3. The results of data grouping in this study produced group segmentation based on variables such as parents' occupation, residential status, and causes of stunting. Each cluster has unique characteristics and can provide deeper insights into the relationship between family socioeconomic conditions and the risk of stunting in children. Through these results, relevant parties, namely the PPKB-PPA Office, can develop more targeted and effective programs and policies according to the needs of each group.
4. Based on results testing using 5 clusters shows more patterns complex, can Conclusions are drawn as following :
 - a. Group A has a centroid point of (4.69; 5.00; 1.74). The value of 4.69 for the Parent Occupation variable indicates that the majority work as farmers. The value of 5.00 for Residential Status shows that all members of the group own their Own Property. The value of 1.74 for the Cause of Stunting points to the category of malnutrition. In general, this group has a stable residential background, but the potential for mild nutritional problems remains.
 - b. Group B has a centroid point of (10.27; 1.39; 3.09). The value of 10.27 for Parent Occupation indicates a predominance of Entrepreneur. The value of 1.39 for Housing Status indicates that the majority are still renting. The value of 3.09 for Causes of Stunting points to the category of chronic malnutrition. This indicates that this group tends to have self-employment but unstable housing conditions.
 - c. Group C has a centroid point of (10.20; 4.92; 3.45). The value of 10.20 for Parental Occupation indicates a predominance of Entrepreneur. The value of 4.92 for Housing Status points to the category of Own Property. The value of 3.45 for Causes of Stunting points to the category of chronic malnutrition. This group is relatively more stable in terms of housing, but still faces nutritional issues.
 - d. Group D has a centroid point of (3.69; 1.26; 3.54). The value of 3.69 for Parental Employment indicates that the majority work as daily laborers (BHL). The value of 1.26 for Housing Status indicates that the majority are still renting. The value of 3.54 for Causes of Stunting points to the category of Short stature/short. This group represents a more economically vulnerable condition with limited housing ownership.
 - e. Group E has a centroid point of (4.09; 5.00; 4.51). The value of 4.09 for Parental Occupation indicates that the majority work as daily laborer (BHL). The value of 5.00 for Housing Status indicates that all group members own their Own Property. The value of 4.51 for Causes of Stunting indicates a predominance of issues related to Short stature/very short. This group is relatively secure in terms of housing ownership, but the level of health issues is quite serious.

Thus, the clustering results are not only useful for descriptive analysis, but also serve as a strategic basis for planning policies to combat stunting in Langkat Regency more effectively and efficiently.

5.2. Suggestion

Based on results and findings in study Here are some suggestions that can be given for study continuation and development system to front and author give some suggestions are expected can lower stunting rates in the district steps and for help formulate Policies and programs at the PPKB-PPA Service include :

1. In the future, it is hoped that this data grouping system can be developed into a more efficient application that can be used by more users.
2. For future research, it is recommended that the data used cover a wider geographical area and involve more diverse socioeconomic characteristics. This is so that the grouping process produces a more representative segmentation that is able to describe the actual conditions of society as a whole.
3. Future research should focus on analyzing trends and dynamics in changes to family economic conditions and their impact on stunting on a regular basis. With this approach, the data grouping system can adapt to social and economic changes occurring in society. Additionally, continuous monitoring of stunting cases in Langkat Regency can assist in formulating more effective and targeted strategies for reducing stunting.

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