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Data Mining Clustering Analysis of Child Growth and Development Using the K-Means Method

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Abstract: This research aims to group children based on their growth and development characteristics. This method helps identify groups of children with normal growth and development, early signs of growth and development problems, and serious growth and development problems. The stages used in this research follow the Knowledge Discovery in Database (KDD) process, which consists of data selection, data pre-processing, data transformation, data mining, and evaluation or interpretation of results. By applying the K-Means method, this research aims to provide a clearer and more detailed picture of the distribution of children's growth and development problems and assist in decision making for more appropriate interventions. The K-Means method in data mining was used to group 102 sample data into three clusters based on children's growth and development characteristics. The results of this analysis show that 38 samples fall into Cluster 1 (C1), 36 samples into Cluster 2 (C2), and 28 samples into Cluster 3 (C3). Evaluation of clustering results is carried out using Box Plot and Scatter Plot. Box Plot shows a clear distribution of data for each cluster, ensuring that the data grouping corresponds to statistical evaluation. Cluster C1 is toddlers with normal growth and development. Cluster C2 shows early signs of growth and development problems. Cluster C3 indicates serious growth and development problems.

Keywords: Child Development; Clustering; Data Mining; K-Means; Knowledge Discovery in Databases (KDD)

INTRODUCTION

Child growth and development is a complex and dynamic process, including physical, cognitive, emotional and social development (Sakti, 2020) (Cahyawati & Pande, 2022). This process begins in the prenatal period and continues until adolescence. Physical development includes the growth of a child's body such as increasing height and weight, development of gross and fine motor skills, and maturity of body organs. Meanwhile, cognitive development includes the ability to think, learn and solve problems which become increasingly complex with age. It is important for parents and caregivers to provide a supportive environment, such as balanced nutrition, appropriate mental stimulation and sufficient physical activity, to ensure children can reach their maximum potential at every stage of development. Emotional and social aspects also play an important role in children's growth and development (Gannika, 2023). Children learn to recognize and manage their emotions, develop relationships with others, and understand social norms and values through interactions with family, peers, and the surrounding environment. Consistent and positive emotional support from parents or caregivers is very important for building a child's sense of self-confidence and independence. Positive experiences in social relationships also help children develop communication, empathy and cooperation skills that are essential for their

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future lives. Therefore, holistic attention and support in all aspects of development is very necessary to ensure children's healthy and balanced growth and development (Yusuf, Al Khoeri, Herdiyanti, & Nuraeni, 2023).

Problems with children's growth and development can occur when their development does not match their chronological age, either falling behind or exceeding the expected developmental stage (Syaputri & Afriza, 2022). Children who experience developmental delays may show signs such as speech delays, difficulty in motor coordination, or immature social skills. The causes of this delay can vary, including genetic factors, nutritional deficiencies, health problems, or lack of adequate stimulation (S. Saputra, Suryani, & Pranata, 2021). This developmental delay can affect a child's ability to interact with their environment, learn at school, and carry out daily activities, which in the end can have a negative impact on their quality of life. On the other hand, children whose physical or cognitive development exceeds their chronological age may also face unique challenges. For example, a child who develops very quickly may feel isolated from his peers because of differences in interests and abilities. These children may face pressure to perform better and face high expectations from parents or teachers, which can lead to stress and anxiety. In addition, emotional development that is not in line with intellectual development can cause problems in managing emotions and social relationships. Therefore, it is important for parents, educators and health professionals to monitor children's overall growth and development and provide appropriate support so that children can reach their maximum potential in a balanced and healthy manner.

Growth and development problems that occur in early childhood can be a major obstacle to their growth and health. Children who experience developmental delays or acceleration may face various challenges, such as difficulties in learning, interacting with peers, and carrying out daily activities. This problem can be caused by various factors, including genetics, environment, nutrition, and health. If not addressed properly, growth and development problems can have a long-term impact on a child's quality of life, including their academic and emotional potential. Therefore, early monitoring and intervention is very important to ensure that every child gets the opportunity to grow and develop optimally. The author will conduct research on growth and development analysis of children aged 0-5 years to identify children who have growth and development problems and those who experience normal development. This research aims to provide a better understanding of the factors that influence children's growth and development and ways to detect and treat problems early. By knowing more about children's growth and development conditions, it is hoped that appropriate interventions can be implemented to support each child's optimal development, so that they can reach their full potential and enjoy a healthy and happy life.

This research will be carried out using data mining techniques, especially the clustering model with the K-means method, to analyze the growth and development of children aged 0-5 years. The K-means method is an effective clustering algorithm for grouping data based on similar characteristics (Indah, Sari, & Dar, 2023). In the context of this research, children's data will be grouped into several clusters that describe different growth and development categories, such as normal development, developmental delay, or accelerated development. The use of the K-means method allows researchers to identify patterns and trends in data efficiently, as well as helps in classifying children based on their level of development. By applying the K-means method, data collected from various sources, including medical records, developmental observations, and demographic data, will be analyzed to identify groups of children with similar growth and development characteristics. The results of this clustering will provide valuable insight into the distribution of growth and development problems in the population studied, as well as assist in designing more targeted interventions for each group. It is hoped that this research can make a significant contribution to the field of children's health by providing a powerful analytical tool to detect and overcome early growth and development problems, thereby supporting children's optimal development.

Data mining is the process of discovering patterns, trends, and relationships in hidden and previously unknown big data, using a variety of analytical techniques and algorithmic tools. The main goal of data mining is to transform raw data into meaningful and useful information for decision making. This process involves several stages, including data collection, data cleaning, data transformation, data

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analysis, and interpretation of results. Techniques commonly used in data mining include clustering, classification, regression, association rules, and anomaly detection. By leveraging advanced computing capabilities, data mining allows researchers and professionals to explore data in greater depth and gain insights that are not easily visible through traditional analysis methods. The use of data mining has expanded in various fields, such as business, health, marketing, finance, and social sciences. In business, data mining is used to analyze customer behavior, improve marketing strategies, and optimize business operations. In the health sector, data mining helps in diagnosing diseases, identifying risk factors, and predicting treatment outcomes. Meanwhile, in the financial sector, this technique is used to detect fraud, manage risk and develop credit models. The advantage of data mining lies in its ability to handle large and complex volumes of data, and provide insights that can be applied to increase effectiveness and efficiency in various domains.

The K-means method is a popular and efficient clustering algorithm used in data mining to group data based on similar characteristics. This algorithm works by dividing the dataset into K clusters, where each data point is placed in the cluster that has the closest centroid, namely the middle point of the cluster. This process begins with random initialization of K centroids, then data points are allocated to the closest centroids based on Euclidean distance. Once all data points are allocated, the new centroid is recalculated as the average of all data points in the cluster. This step is repeated until the centroid position does not change significantly or reaches convergence. The result is the division of the dataset into different clusters with minimization of intra-cluster variance and maximization of inter-cluster variance. One of the advantages of the K-means method is its simplicity and computational speed, making it very suitable for large datasets. However, this algorithm has several weaknesses, such as sensitivity to the selection of the number of clusters (K) which must be determined beforehand and dependence on initial initialization of centroids which can affect the final clustering results. To overcome the initialization problem, techniques such as K-means++ can be used to select better initial centroids. Despite this, the K-means method remains the preferred choice in many applications, including market segmentation, image analysis, and document clustering, because of its ability to provide intuitive and easy-to-interpret results.

LITERATURE REVIEW

Data mining is the process of discovering hidden and previously unknown patterns, trends and relationships in big data, using various analytical techniques and algorithmic tools (Sinaga, Marpaung, Tarigan, & Tania, 2023) (Abas et al., 2023). The main goal of data mining is to transform raw data into meaningful and useful information for decision making (Pratama, Yanris, Nirmala, & Hasibuan, 2023). This process involves several stages, including data collection, data cleaning, data transformation, data analysis, and interpretation of results (Aji & Devi, 2023). Techniques commonly used in data mining include clustering, classification, regression, association rules, and anomaly detection (A. D. Saputra, Hindarto, & Santoso, 2023). By utilizing advanced computing capabilities, data mining allows researchers and professionals to explore data in greater depth and gain insights that are not easily visible through traditional analysis methods (Alam, Alana, & Juliane, 2023). The use of data mining has expanded in various fields, such as business, health, marketing, finance, and social sciences (Hasibuan, Sihombing, & Nasution, 2023). In business, data mining is used to analyze customer behavior, improve marketing strategies, and optimize business operations. In the health sector, data mining helps in diagnosing diseases, identifying risk factors, and predicting treatment outcomes. Meanwhile, in the financial sector, this technique is used to detect fraud, manage risk and develop credit models. The advantage of data mining lies in its ability to handle large and complex volumes of data, and provide insights that can be applied to increase effectiveness and efficiency in various domains.

The K-means method is a popular and efficient clustering algorithm used in data mining to group data based on similar characteristics (Asriningtias, Wulandari, Persijn, Rosyida, & Sutawijaya, 2023). This algorithm works by dividing the dataset into K clusters, where each data point is placed in the cluster that has the closest centroid, namely the middle point of the cluster (Wijaya, Dharma, Heyneker, & Vanness, 2023). This process begins with random initialization of K centroids, then data points are allocated to the closest centroids based on Euclidean distance (Andi, Juliandy, & David, 2023). Once

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all data points are allocated, the new centroid is recalculated as the average of all data points in the cluster. This step is repeated until the centroid position does not change significantly or reaches convergence. The result is the division of the dataset into different clusters with minimization of intra-cluster variance and maximization of inter-cluster variance. One of the advantages of the K-means method is its simplicity and computational speed, making it very suitable for large datasets (Aldo, 2023). However, this algorithm has several weaknesses, such as sensitivity to the selection of the number of clusters (K) which must be determined beforehand and dependence on initial initialization of centroids which can affect the final clustering results. To overcome the initialization problem, techniques such as K-means++ can be used to select better initial centroids. Despite this, the K-means method remains the preferred choice in many applications, including market segmentation, image analysis, and document clustering, because of its ability to provide intuitive and easy-to-interpret results.

METHOD

Research analyzing child growth and development using the K-Means Clustering method aims to group children aged 0-5 years based on their developmental characteristics. This method allows the identification of patterns in the data that can reveal significant differences between groups of children with normal development and those who may require special intervention. The clustering process with K-Means will divide the data into several clusters, where each cluster represents a different development category. In this way, researchers can gain deeper insight into the factors that influence children's growth and development and provide a basis for more targeted intervention recommendations.

This research stage follows the Knowledge Discovery in Database (KDD) framework, which involves a series of systematic steps to extract knowledge from big data. The KDD process begins with the stage of selecting relevant and quality data, followed by data cleaning to remove noise and inconsistencies. Next, the data is transformed into a format suitable for analysis, then the K-Means algorithm is applied to perform clustering. Once the clusters are formed, the final step is the interpretation and evaluation of the results to assess the quality and usefulness of the information obtained. With the KDD approach, it is hoped that this research can produce accurate and valuable findings regarding child growth and development, as well as making a significant contribution to the field of child health.

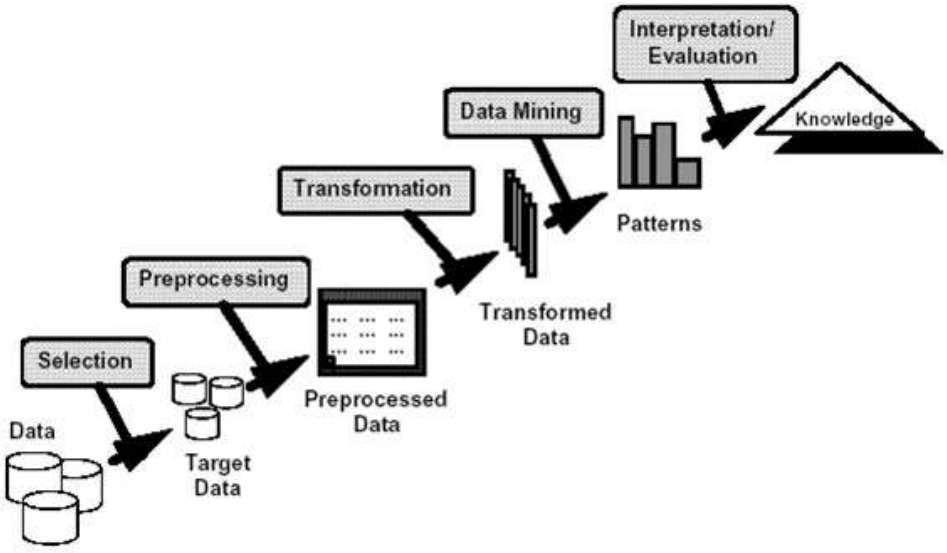

Fig 1. Knowledge Discovery in Database (KDD) Workflow

Source. https://medium.com/@shawn.chumbar/kdd-process-in-data-science-a-beginners-guide-426d1f0fc062

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Selection	:	The stages carried out to collect and select data that will be used in this research.
Preprocessing	:	The steps taken were to clean the data and select data that was suitable for use in this research.
Transformation	:	This stage is carried out to change the data into a format that is in accordance with the provisions of this research.
Data Mining	:	This stage is the stage carried out to design the model that will be used in this research. Not only that, at this stage the grouping results will also be obtained.
Interpretation/Evaluation	:	This stage is the stage carried out to evaluate the method used in this research.

RESULT

Selection

This stage is the data collection stage that will be used to conduct this research. With data, research can be carried out well in accordance with existing regulations. The data that will be used is data obtained from the Perlayuan Community Health Center. The data can be seen in the table below.

Table 1. *Research Sample Data*

Child's Name	Number of Months	Weight	Height
Adi Nugraha	43	12	89.9
Aditya Pramudya Siregar	13	12.2	82.5
Agus Setiawan	12	12.2	80.4
Ahmad Fauzan Siregar	47	13.7	92.8
Alvin Wijaya	17	9.5	79.8
Andi Pratama Siregar	33	7.5	75.8
Andi Saputra	57	12.5	97.6
Andini Putri	36	10.7	88
Anisa Rachma Siregar	25	9.5	81.4

In the table above is the data that will be used as research sample data. The data used was 102 data. The table above is only a sample. This sample data will later be used for research and analysis in data mining.

Preprocessing

This stage is a data cleaning process, this process is an important stage. Because the data that has been obtained cannot be used immediately, the data will be selected for suitability, so the data that has been selected can now be used.

Transformation

This stage is the stage that will be carried out to compile and change the data format. This is done because the data that has been obtained and has been selected does not necessarily match the format desired in this research, so the data will be arranged in an appropriate format that has been determined in this research. The data format that will be used is file.xlsx which will be the data format for this research.

Data Mining

Clustering Model Planning

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This model was designed so that research sample data could be analyzed. For this model, the author carried out the design in the Orange application. The method that will be used is the K-Means method.

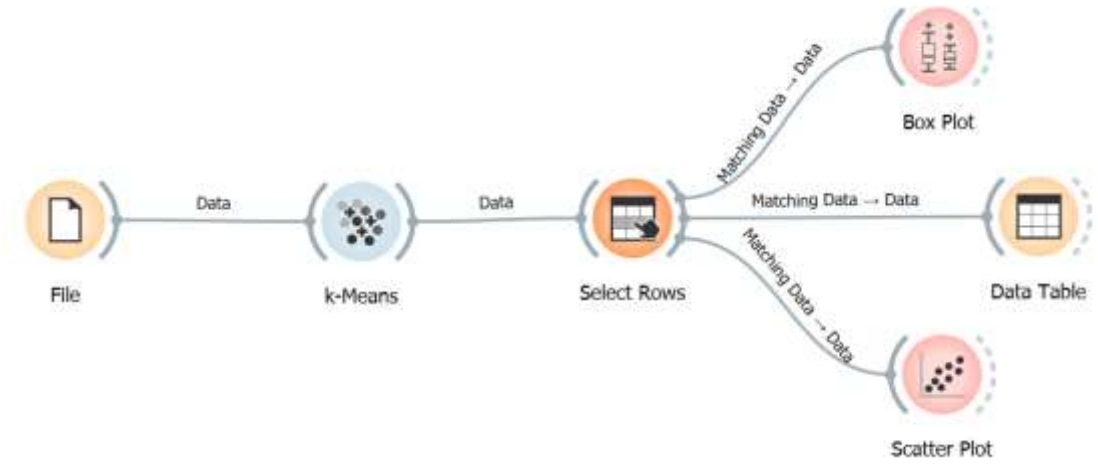

Fig 2. K-means Method Design Model

The image above is a design pattern designed to be used for clustering sample data. The model above was designed using human applications in data mining. The clustering method used is the K-Means method. The method can be seen in the blue widget. For the cluster results carried out by the author using the model above, he will use 3 clusters, so the results will be C1, C2, and C3.

Clustering Results

At this stage, it is the result of clustering that has been carried out previously using a design model that has been designed in datamining. The author presents the results in table form which can be seen in the table below.

Table 2. *Clustering results using the K-Means Clustering Method*

Child's Name	Number of Months	Weight	Height	Clustering
Adi Nugraha	43	12	89.9	C2
Aditya Pramudya Siregar	13	12.2	82.5	C3
Agus Setiawan	12	12.2	80.4	C3
Ahmad Fauzan Siregar	47	13.7	92.8	C2
Alvin Wijaya	17	9.5	79.8	C1
Andi Pratama Siregar	33	7.5	75.8	C1
Andi Saputra	57	12.5	97.6	C2
Andini Putri	36	10.7	88	C3
Anisa Rachma Siregar	25	9.5	81.4	C1
Ardi Susanto	13	11.2	82.4	C3
Arif Hidayat Nasution	56	14	98	C2
Ayu Indah	46	11.5	91.5	C2
Bambang Suharto	45	12	89.9	C2
Bima Aditya Nasution	53	13.5	93.4	C2
Budi Prasetyo	19	7.8	74	C1
Budi Santoso	34	10.4	85.5	C3
Danang Rahmat Nasution	46	12	89.9	C2
Dani Setiawan	58	13	92	C2
Dedi Irawan	14	12	82.9	C3

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Della Rachma Rambe	54	14	96.5	C2
Dewi Anggraini	35	10.4	85.5	C3
Dewi Sartika	24	9.5	81.4	C1
Dian Purnama	7	11	81.2	C1
Didi Supriyadi	18	10.5	77	C1
Dimas Pratama	40	11.4	91.3	C2
Dina Cahaya Rambe	49	12	93.7	C2
Dinda Arini Siregar	10	9.8	78.2	C1
Dini Lestari	58	12.5	97.6	C2
Doni Pratama Nasution	2	9.5	81.4	C1
Dwi Puspita Nasution	26	9.8	79	C1
Eka Febri Rambe	11	12.1	90.1	C3
Eka Putri	25	9.8	79	C1
Evi Lestari	13	11.2	81.8	C3
Evi Yuliana	18	9.5	79.8	C1
Fajar Pratama	13	11.8	92.1	C3
Fajar Rizky Nasution	42	12	89	C2
Farhan Syahputra	11	10.8	79.1	C1
Fathur Rahman	39	11.5	91.5	C2
Fauzi Syahputra	36	12	88.6	C2
Fikri Ramadhan	5	11	87.2	C3
Fikri Syahputra Siregar	43	12	89.9	C2
Fitra Saputra Rambe	18	9.5	81.4	C1
Fitri Yuliana	18	9.5	81.4	C1
Fitriani Wulandari	47	11.4	91.3	C2
Galih Pramudya Rambe	12	9.5	81.4	C1
Gina Amelia	5	9.5	81.4	C1
Hana Putri Siregar	20	7.8	74	C1
Hendra Kurniawan	29	7.5	75.8	C1
Hendra Kurniawan Rambe	50	13.7	92.8	C2
Indah Permatasari Rambe	12	9.5	81.4	C1
Intan Permata	12	12.3	90.1	C3
Irfan Maulana	60	13.5	93.4	C2
Joko Santoso	42	11.7	87.2	C2
Laila Amira Siregar	14	12.3	90.1	C3
Laila Mahardika	1	9.5	81.4	C1
Lina Marlina	28	9.5	81.4	C1
Lintang Fajrina Nasution	2	9.5	81.4	C1
Lukman	22	9.5	79.8	C1
Maya Alisya Siregar	39	10.4	85.5	C3
Maya Salsabila	15	12.1	90.1	C3
Muhammad Farhan Nasution	16	11.8	92.1	C3
Nabila Sari Siregar	37	13	90	C2
Nadia Lestari Rambe	31	10.7	88	C3
Nadya Safira Siregar	10	11	81.1	C1
Niken Maharani Nasution	35	10.4	85.5	C3
Nining Rahayu	43	11.7	87.2	C2
Nisa Rahmawati	47	12	93.7	C2
Novi Andriana	12	10.3	79.2	C1

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Nurul Hidayah	24	9.8	79	C1
Putri Annisa Nasution	45	13.7	92.8	C2
Putri Ayu	36	11.7	87.2	C3
Rahmawati Fauziah	25	9.5	81.4	C1
Raka Nugraha	38	12	89	C2
Rani Kusuma	47	13.7	92.8	C2
Rendi Saputra Nasution	55	13	92	C2
Reza Fahmi Siregar	36	9.8	84	C3
Ria Anggraini Nasution	29	9.5	81.4	C1
Rian Fadli Siregar	12	12.1	90.1	C3
Rian Saputra	11	12.1	80.3	C3
Ririn Puspita	48	12	93.7	C2
Rizal Fahmi Rambe	31	10.7	84.1	C3
Rizki Permana Siregar	19	10.5	77	C1
Rizky Hidayat	44	13	90	C2
Roni Setiawan	53	14	96.5	C2
Rudi Setiawan	16	7.8	74	C1
Selvi Amira Rambe	41	13	90	C2
Sherly Amanda Nasution	0	9.5	81.4	C1
Silvia Putri Nasution	11	9.5	81.4	C1
Siti Khadijah	45	12	93.7	C2
Sri Wahyuni	38	10.4	85.5	C3
Surya Pratama	49	13.7	92.8	C2
Taufik Hidayat	35	9.8	84	C3
Tia Permata	4	9.9	87.8	C3
Vina Lestari	10	9.5	81.4	C1
Wahyu Ananda Nasution	37	12	88.6	C2
Wahyu Ramadhan	0	9.5	81.4	C1
Wulan Dewi Siregar	37	10.7	88	C3
Wulan Putri Rambe	21	7.8	74	C1
Wulan Sari	11	9.5	81.4	C1
Yoga Pratama Rambe	60	13	92	C2
Yuni Kristina	21	9.5	79.8	C1
Zainal Arifin	33	10.7	88	C3

The table above is the cluster results obtained using the K-Means method. The results of the analysis using data mining methods on 102 sample data show that the data is divided into three groups: 38 samples are in group C1, 36 samples are in group C2, and 28 samples are in group C3. Group C1 includes children with normal growth and development, indicating that they have good nutritional intake and growth appropriate to their age standards. Group C2 consists of children who show early signs of growth and development problems, such as malnutrition or minor health problems that require further monitoring. Group C3 includes children who experience serious growth and development problems, including stunting or health conditions that require immediate medical intervention. By identifying these groups, prevention and intervention efforts can be more effective and targeted.

Interpretation/Evaluation

Interpretation/Evaluation is a stage carried out to see and determine the evaluation of the cluster results that have been obtained using the K-Means method. The results will be assisted with the help of a previously designed model. For these results, use the Box Plot widget and Scatter Plot widget.

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Box Plot Results

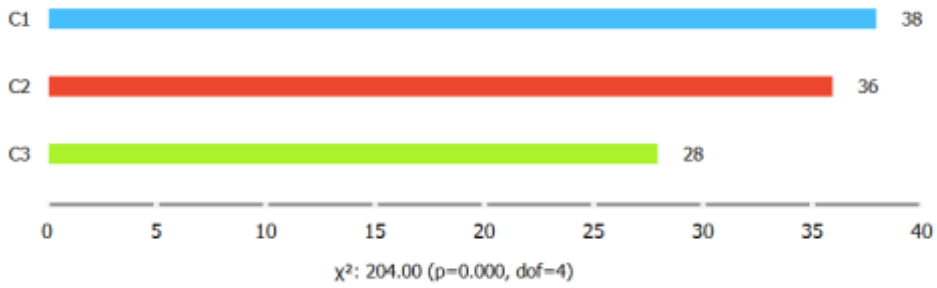

Fig 3. Box Plot Results

The results of the Box Plot analysis of 102 sample data show a clear distribution for each cluster, namely 38 samples in C1, 36 samples in C2, and 28 samples in C3, which indicates the validity of the data grouping. Box Plots help depict the data range, median, and outliers of each cluster, ensuring that the division into C1, C2, and C3 is appropriate to the statistical evaluation and analysis performed. Cluster C1 includes children with normal growth and development, indicated by consistent data ranges and high medians. Cluster C2 consists of children who show early signs of developmental problems, with a wider data range and few outliers. Cluster C3 includes children with serious developmental problems, characterized by a lower median and a range of data showing large variations. The use of a Box Plot validates that the data grouping results have been carried out correctly and provides an easy to understand visual depiction of the distribution and characteristics of each cluster.

Box Plot Results

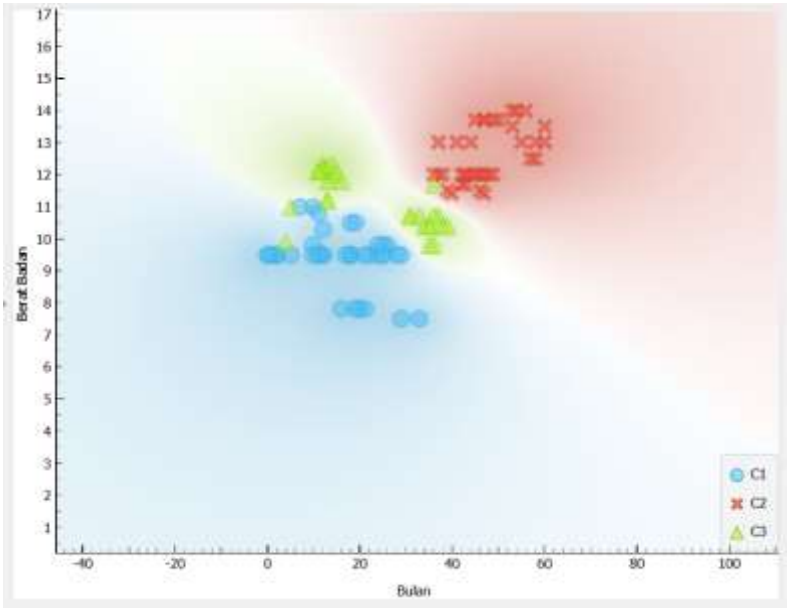

Fig 4. Box Plot Results

The results of Scatter Plot analysis of 102 sample data show a clear distribution of three clusters with different symbols and colors: 38 samples in C1 are represented by blue circles, 36 samples in C2 are represented by red Xs, and 28 samples in C3 are represented by green triangles. The Scatter Plot helps visualize the distribution of data in each cluster, with the wider and denser C1 region at the top of the graph, indicating that the majority of children in this cluster have normal growth and development. Region C2, marked with a red X, is spread more evenly around the center of the graph, indicating

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children who are experiencing early signs of developmental problems. Meanwhile, C3, which is represented by a green triangle, has a more widespread and wide distribution of data at the bottom of the graph, indicating children with serious growth and development problems. This Scatter Plot provides a clear and effective visualization of the distribution and characteristics of each cluster, facilitating identification and further analysis.

DISCUSSIONS

The results of analysis using data mining methods on 102 sample data show the existence of three different groups. Group C1 consisted of 38 samples of children with normal growth and development, indicating that they had good nutritional intake and growth according to their age standards. Group C2 included a sample of 36 children who showed early signs of growth and development problems, such as malnutrition or minor health problems that required further monitoring. Group C3 includes a sample of 28 children with serious growth and development problems, such as stunting or health conditions that require immediate medical intervention. This group division allows for more effective and targeted prevention and intervention efforts, because each group can be addressed according to their specific needs.

Research conducted by (Indah et al., 2023) also showed good results using the K-means Clustering method, which proves the effectiveness of this method in grouping data based on certain characteristics. As in your research, Indri found that K-means Clustering is able to divide data into relevant groups, which makes it easier to identify and intervene in the problems faced. Thus, Indri's research strengthens your findings that the K-means Clustering method can provide good and useful results in analyzing child growth and development data, enabling more informative and targeted decision making in dealing with children's nutrition and health problems.

CONCLUSION

Stunting is a significant issue affecting children's physical and cognitive development, with high prevalence in Asia and Africa due to factors like malnutrition, maternal health, and poor economic conditions. This research utilizes data mining methods, specifically K-Means and Naive Bayes algorithms, to classify stunted children's data into three clusters: normal growth, early signs of growth problems, and serious growth issues. The use of Box Plots and Scatter Plots demonstrates the effectiveness and accuracy of this approach. The study underscores the role of technology, such as smartphone applications, in monitoring children's growth, offering faster and more accurate results compared to traditional methods. These technological interventions can improve health services and contribute to more effective stunting prevention. Future research should focus on refining these methods and exploring further applications in child health.

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