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WEBSITE DESIGN FOR NUTRITION STATUS CLASSIFICATION OF TODDLERS USING UI/X WITH K-MEDOIDS ALGORITHM

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ABSTRACT

Nutritional needs in Indonesia vary based on age, gender, physical activity, and an individual's health condition. According to Regulation of the Minister of Health of the Republic of Indonesia No. 28 of 2019, the Recommended Dietary Allowance (RDA) issued by the Ministry of Health provides guidelines on daily energy (calorie) requirements. For infants aged 0 to 12 months, the required intake is 550–725 kcal. The toddler phase (0–5 years old) is a golden period of growth, during which physical and brain development occurs rapidly. Malnutrition during this period can lead to growth disorders such as stunting, which has long-term effects on a child's health and intelligence. To determine a toddler's nutritional status, it is essential to classify their status based on weight and height ratio, commonly measured using Body Mass Index (BMI). BMI is used to determine whether a child's weight falls into the normal, underweight, or obese category. Therefore, regular monitoring is necessary to detect nutritional problems early, enabling proper intervention. This study aims to develop a website using the k-medoids algorithm to assess toddlers' nutritional status. The calculation process in this study, which involves 30 toddler data samples, determines the number of toddlers in each cluster: normal nutrition status, undernutrition, and obesity. The study also applies a Confusion Matrix to evaluate the clustering performance, including accuracy, precision, and recall. The evaluation results show that the k-medoids algorithm performs perfectly, achieving 100% accuracy for all clusters. This indicates that k-medoids successfully classifies the data into clusters without errors.

Keywords: Website, Classification, Toddler Nutritional Status, K-Medoids Algorithm, UI/X

1. INTRODUCTION

Nutrition is a basic food substance needed to support life, namely for the growth and health of the body. Balanced nutrition is a daily diet consisting of foods with sufficient nutritional content and according to the body's needs [1]. Am These foods contain the right nutrients in the right amount, according to a person's gender, age, and health condition, so that the body can function properly and stay healthy. Until now, nutrition plays a very important role in supporting the growth and development of toddlers. Nutritional status is a measure of success in fulfilling children's nutritional needs, indicated by the child's weight and height. This is used as a reference for determining nutritional health status [2].

Toddlerhood, or children under the age of five, is a crucial period in a child's development. During this stage, toddlers experience rapid physical growth, such as walking, talking, and social interaction. Proper nutrition and supportive environmental stimulation are essential to ensure optimal growth and development during this period. In addition to physical and cognitive growth, emotional and social development are also a major focus during toddlerhood [3].

Toddler Nutritional Status is a condition of the body as a result of food consumption and use of nutrients. Nutrition is one of the most important things in supporting the growth and development of toddlers. If the nutritional status of toddlers is not met, health complications will occur. Such as toddlers having a height shorter than the standard for their age due to long-term malnutrition, toddlers having a weight that is much lower than their height, toddlers having excess weight due to consumption of foods

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high in sugar and fat, and lack of physical activity, Iron deficiency which causes a lack of red blood cell production in the body, Decreased Immune Function and Susceptibility to Disease, Psychological and Cognitive Development Disorders. If this happens continuously it will become a serious problem [4].

The K-Medoids algorithm is a partition clustering method to group a set of (n) objects into a number of (k) clusters. The K-Medoids algorithm uses objects in the object set to represent a cluster. The object selected to represent a cluster is called a medoid [5]. K-Medoids is one of the statistical approaches that can be used to perform such clustering. K-Medoids is an algorithm used to determine medoids as the center point in a group (cluster) [6].

Based on previous research conducted by [7] This study successfully grouped data on malnourished toddlers in West Java Province into three clusters using the K-Means and K-Medoids algorithms. The optimal cluster is to use 3 clusters consisting of cluster 1 (high), 2 (moderate) and cluster 3 (low). These clusters can be used to assist the government in decision making and policy making to address nutritional problems in West Java.

Therefore, based on the problems above, it is necessary to design a website for classifying infant nutritional status to monitor the situation based on several supporting indicators to support innovation and public understanding of the importance of nutrition for toddlers. By creating this website, it is hoped that the public will be able to measure nutritional indicators for children under five, especially those related to conditions of malnutrition and stunting on a regular basis.

2. MATERIALS AND METHODS

Research Methods

According to the research method is a scientific way to obtain data with certain goals and uses. The research method is closely related to the procedures, techniques, tools and research designs used. The phases of the method used in this research include:

1. Problem Identification Phase

   This research phases begins with understanding the importance of monitoring the nutritional status of toddlers as an indicator of child health and development. The main problem identified is the difficulty in classifying the nutritional status of toddlers quickly and accurately, especially when the amount of toddler data that must be analyzed is very large and diverse. Therefore, preparatory steps are needed to support the process of grouping toddler nutritional status data efficiently, so that the results can help in making more appropriate decisions.

2. Data Collection Phase

   This phase is very important in conducting research, so that the information obtained can help the researcher process to carry out further data analysis to solve research problems carried out based on relevant factual information. Data collection in this study uses secondary datasets, the use of secondary datasets is data that is already available in government institutions, international organizations and public platforms so that it can be directly accessed [7].

3. Phases of Implementing the K-Medoids Method.

   At this phase, research is conducted to facilitate the classification of toddler nutritional status quickly and accurately, so that the nutritional status of toddlers can be known more precisely through process analysis and performance evaluation of the K-Medoids algorithm. The process begins with normalizing toddler data, calculating the medoid distance using the Euclidean Distance method. The iteration process is carried out repeatedly until the medoid position does not change significantly, where to evaluate the clustering results, a confusion matrix is used which aims to measure the level of accuracy, precision, and recall of each cluster formed.

4. Results and Discussion Phase

   At this phase, the application of the K-Medoids method calculation steps is carried out, both through manual calculations and using Python, to obtain the final results of the classification of toddler nutritional status. In addition, this phases also helps in understanding the design of a data mining system that uses the K-Medoids algorithm, so that the data grouping process becomes more structured and easy to implement.

5. Conclusion Phase

   In this phase, to make a conclusion from the process based on the analysis of the results of grouping toddler data into several clusters, which describe nutritional status such as good nutrition, less nutrition,

and obesity. Therefore, the problem in classifying toddler nutritional status which was previously complex can be solved effectively.

Data Mining

Data mining is the extraction of interesting patterns from large amounts of data. A pattern is said to be interesting if the pattern is not trivial, implicit, previously unknown and useful [8]. Data mining as a process to get useful information from large database warehouses, which can be interpreted as extracting new information taken from large chunks of data that helps decision making. Data mining can find hidden trends and patterns that do not appear in simple query analysis so it can have an important part in terms of discovering knowledge and making decisions [9].

K-Medoids Algorithm

The K-Medoids algorithm or Partitioning Around Medoids (PAM) is a clustering partition method used to combine a group of n objects to form a number of k clusters [10]. The K-medoids algorithm works by finding k as representative objects to minimize the number of data object dissimilarity [11]. K-Medoids is a variation of the K-Means algorithm, where K-Medoids is more robust to outliers or data that has extreme values. The K-Medoids algorithm has the advantage of overcoming the weaknesses of K-Means which is sensitive to noise and outliers. In addition, the results of the clustering process do not depend on the order of the dataset entered [10]. There are steps in the K-Medoid algorithm to determine the center point of a cluster of k or many clusters, namely:

1. Distribute each data or object to the nearest cluster using the Euclidian distance measure
2. Randomly determine objects in each cluster to become temporary medoids
3. Calculate the distance of each object in each cluster using temporary medoids
4. Recalculate using the Iteration technique, where looking for new medoid to be compared with the temporary medoid iteration results.
5. Calculate the difference between the total new distance and the total old distance. If S>0, then the iteration stops [12].

Clustering

Clustering is the process of grouping data based on similarities or proximity between elements in a data set, where objects in one group are more similar to each other than to objects in other groups [13]. In this discussion, the author uses the Weighted Euclidean Distance method, namely by calculating the distance between two points by knowing the value of each attribute at both points.

The formula for normalizing body weight in a certain range (0 and 1) using Equation 1,

$$Normalization\ of\ Body\ Weight = \frac{Weight - min}{max - min} \quad (1)$$

description:
Weight = The individual's body weight to be normalized
min = The minimum body weight in the dataset
max = The maximum body weight in the dataset

The formula for calculating distance using Euclidean Distance (Equation 2):

$$d(x, m) = \sqrt{\sum_{i=1}^{n}(x_i - m_i)^2} \quad (2)$$

Description :
x = data
m = medoid
n = number of attributes
$x_i - m_i$ = value of the i-th attribute of the data point to be grouped (x_i) dan value of the i-th attribute of the medoid (m_i)

Confusion Matrix

Confusion matrix is a table used as a measuring tool that is useful for analyzing how good the results of the correct and incorrect classification of the prediction results that have been carried out in different classes. The classification evaluation is based on testing on correct and incorrect objects. To determine the best type of learning scheme used, data validation is used based on training data to train the learning scheme. The confusion matrix contains information about the actual classification results and those predicted by the classification system [14].

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3. RESULT AND DISCUSSION

Application of K-Medoids Algorithm Calculation

1. Data Transformation

In this section, data transformation is carried out to change the original data measurement scale to a certain format or structure, so that it is easier to understand.

Table 1. Data Results After Transformation

No	Toddler Names	Weight (kg)	Height (cm)	BMI
1	Andi Pratama	15	95	16,62
2	Budi Santoso	17	90	20,99
3	Citra Dewi	18	100	18,00
4	Dedi Kurniawan	10	80	15,63
5	Evi Wulandari	13	85	17,99
…	…	…	…	…
30	Endah Lestari	20	97	21,26
	Min	9	73	14,40
	Max	22	105	22,45

Table 1 is the result of data transformation used as input in determining clusters based on the k-medoids algorithm including numeric variables such as weight, height, and BMI. This analysis was conducted using a sample of 30 data taken from the toddler nutritional status dataset at Posyandu.

2. Data Normalization

In this section, data normalization is performed to equalize the range of values in each variable with a certain scale by moving the decimal value of the data in the desired direction using Equation 1. Table 2 is normalization that carried out on each variable with the same formula according to the data in that variable.

Table 2. Data Results After Normalization

No	Toddler Names	Weight (kg)	Height (cm)	BMI
1	Andi Pratama	0,462	0,688	0,276
2	Budi Santoso	0,615	0,531	0,818
3	Citra Dewi	0,692	0,844	0,447
4	Dedi Kurniawan	0,077	0,219	0,152
5	Evi Wulandari	0,308	0,375	0,446
…	…	…	…	…
30	Endah Lestari	0,846	0,750	0,852

3. Perform Iterations

In this study, iteration was carried out twice. Where this iteration is used to optimize the division of data into the most representative clusters. Clustering is divided into 3 clusters, with normal nutritional status, deficiency, obesity in Table 3.

Table 3. Nutritional Status of Toddlers Based on Clusters

Cluster Terms	
Cluster 1	Normal
Cluster 2	Malnutrition
Cluster 3	Obesity

Determine temporary medoids at the 1st iteration where the medoids are chosen randomly, so that they can be used to determine the distance to the medoids (Table 4).

Table 4. Temporary medoids

No	Toddler Names	Weight (kg)	Height (cm)	BMI
01	Andi Pratama	0,462	0,688	0,276
02	Budi Santoso	0,015	0,531	0,818
03	Citra Dewi	0,692	0,844	0,447

Determine the distance between data and medoids using the Euclidean distance formula with the Equation 2 (Table 5).

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Table 5. Results of the 1st Iteration

Cluster 1	Cluster 2	Cluster 3	Proximity	Cluster
0,000000	0,585545	0,327234	0,000000	1
0,585545	0,000000	0,491463	0,000000	2
0,327234	0,491463	0,000000	0,000000	3
0,618848	0,912187	0,925476	0,618848	1
0,387871	0,507633	0,606347	0,387871	1
0,695694	0,319720	0,443104	0,319720	2
Amount Of proximity			9,825654	

Table 6. Number of Clusters in the 1st Iteration

Number of Clusters	
Cluster 1	17
Cluster 2	9
Cluster 3	4

Based on the results of the 1st iteration, the total proximity obtained is 9,825654. The results of this iteration show a fairly stable cluster distribution, with Cluster 1 as the dominant cluster (Table 6). Next, determine the new medoids for the 2nd iteration, by doing the same thing as in the 1st iteration, where the medoids are selected randomly.

Table 7. New Medoids

No	Toddler Names	Weight (kg)	Height (cm)	BMI
028	Cindy Kartika	0,692	0,719	0,637
029	Doni Wahyudin	0,615	0,594	0,706
030	Endah Lestari	0,846	0,750	0,852

In the Table 7, a new medoid is shown to perform the second iteration, the medoid is selected randomly from the normalized data results.

Table 8. Results of the 2nd Iteration

Cluster 1	Cluster 2	Cluster 3	Proximity	Cluster
0,430329	0,466885	0,695694	0,430329	1
0,271768	0,128444	0,319720	0,128444	2
0,227740	0,368256	0,443104	0,227740	1
0,929807	0,859082	1,167934	0,859082	2
0,550147	0,458441	0,771457	0,458441	2
0,265775	0,314434	0,000000	0,000000	3
Amount of proximity			13,074997	

Table 9. Number of Clusters in the 2nd Iteration

Number Of Clusters	
Cluster 1	10
Cluster 2	15
Cluster 3	5

Based on the results of the 2nd iteration (Table 8) and number of cluster (Table 9), the total proximity value achieved is 13,074997. Where this result is the accumulation of the distance between each object and its respective cluster medoids. This second iteration is less optimal compared to the first iteration because it has a higher proximity.

Table 10. Difference between 2nd Iteration and 1st Iteration

Proximity Difference
3,249343

Based on the optimization rules, the results of the difference between the 2nd iteration and the 1st iteration > 0 (Table 10), then the iteration stops. Where the cluster is in the 1st iteration is selected as the optimal final solution. The calculation of the confusion matrix can be seen in the Table 11.

Table 11. Confusion Matrix from Clustering Results

Confussion Matrix K-Medoids			
	Cluster 1	Cluster 2	Cluster 3
Cluster 1	17	0	0
Cluster2	0	9	0
Cluster 3	0	0	4
Accuracy	**Precision (P)**	**Recall(R)**	

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100%	P (Cluster 1)	100%	R (Cluster 1)	100%
	P (Cluster 2)	100%	R (Cluster 2)	100%
	P (Cluster 3)	100%	R (Cluster 3)	100%

Based on Table 11, the results of the confusion matrix used for clustering performance evaluation include accuracy, precision, and recall. Where the evaluation shows the performance of the k-medoids algorithm is perfect 100% for all clusters. So that k-medoids is able to divide data into clusters without error.

UI/X Implementation

The following is the design result of the website with the application of the K-Medoids Method for Classification of Toddler Nutritional Status.

1. Login Page

On this login page, the user must first enter their username and password, as shown in Figure 1. In addition, this page has a "sign up" button on the navbar, for users to register an account on Clustora, as can be seen in Figure 2.

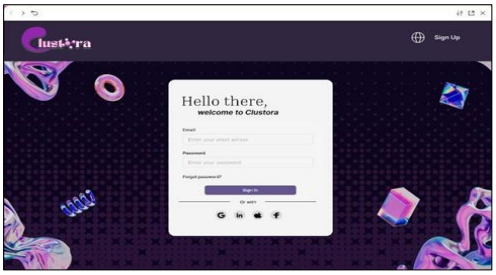

Figure 1. Login Page

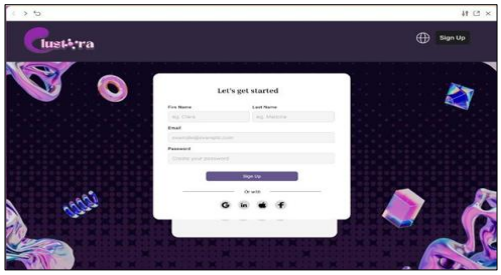

Figure 2. Sign Up Page

2. Dashboard Page

The dashboard page is the main page for displaying important information, after the user has successfully logged in. Based on Figure 3, the dashboard page displays the option to upload files manually or via the drag-and-drop method. Where, the status of files that have been successfully uploaded and files that are still in the upload process is also displayed.

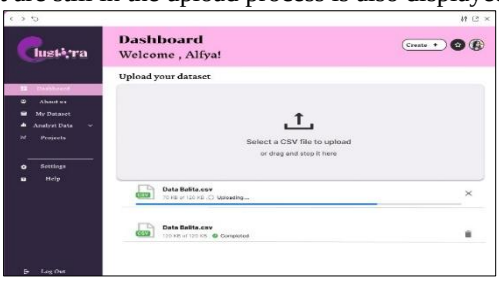

Figure 3. Dashboard Page

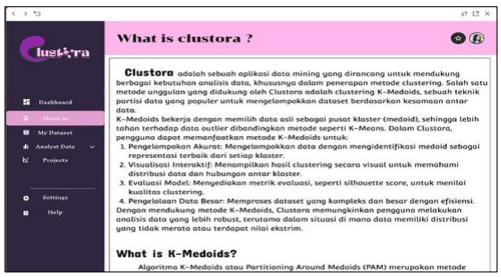

Figure 4. About Us Page

4. About Us Page

The about us page is a page that displays a brief explanation regarding information about the Clustora application (Figure 4).

5. My Dataset Page

The My dataset page is a page that displays a list of dataset files that have been uploaded by the user.

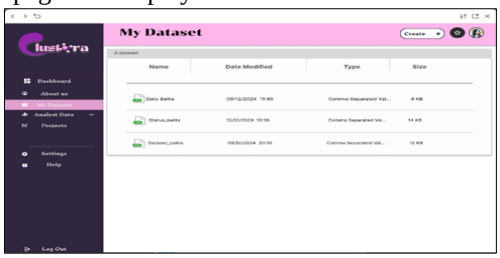

Figure 5. My Dataset Page

As can be seen in Figure 5, this page display has a "create+" button feature used to create a dataset manually. When the "create+" button is clicked (Figure 6), user will be asked to create a name for the dataset to be created, and there are options used for the column structure to be used. Then there is a submit

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button that will bring the input variable display into the specified column structure as seen in Figure 7. Meanwhile, the next display when the "go" button is clicked, user will be asked to create a dataset manually.

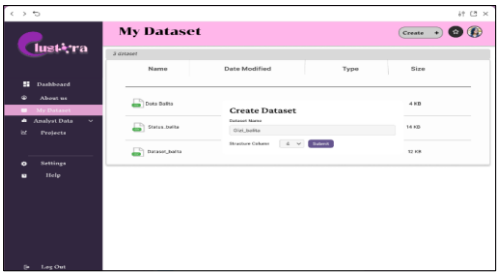

Figure 6. Manual Dataset Name Input

Figure 7. Column Structure Input View

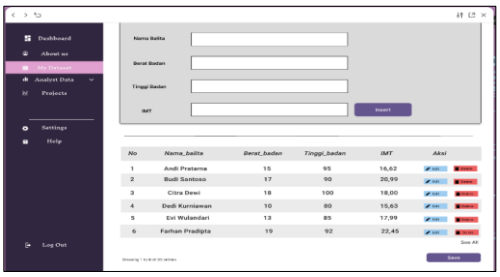

Figure 8. Input Dataset View

Based on Figure 8, it can be seen that there is a form to enter new data with columns such as Toddler Name, Weight, Height, and BMI, as well as an "insert" button to add data. Below it, there is a table that displays a list of toddler data with columns No, Toddler_Name, Weight, Height, BMI, and Action. The action column provides options to update or delete data, and a "save" button to save the dataset.

6. Data Analyst Page

This page contains two Data Analyst categories, namely K-Medoids Clustering and Visualization.

a) Analyst Data K-Medoids Clustering

This section is a feature of k-medoid clustering data analysis.

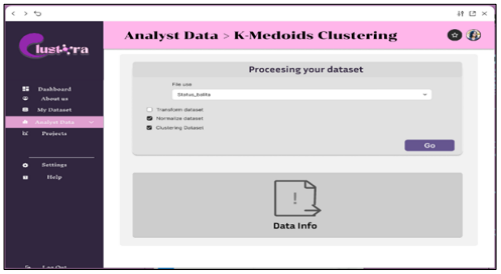

Figure 9. K-Medoids Clustering Page

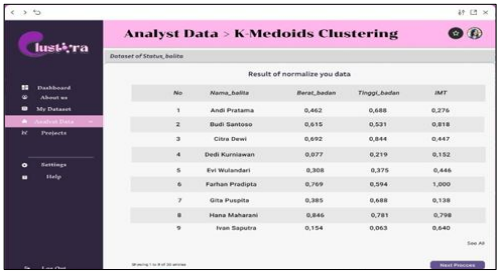

Figure 10. Normalization Process Results

It can be seen in Figure 9, where on this page the user can process the dataset with several options such as "Transform Dataset", "Normalize Dataset", or "Clustering Dataset". There is a dropdown menu to select the dataset file to be used, and a "go" button to start the process. In addition, there is a "data info" button that will display the toddler nutritional status dataset including, dataset name, size, features, meta and missing data.

Figure 11. Temporary Medoids Input View

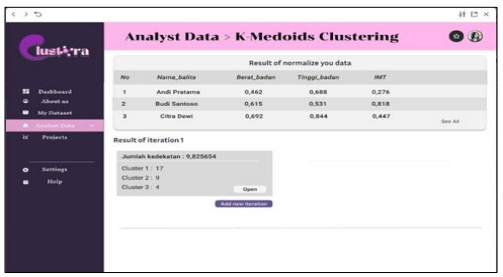

Figure 12. Results of the First Clustering Process

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Figure 10 shows the results of dataset normalization, which will then continue to the clustering process where the user will determine the number of clusters to be used. In addition, there is a “Create” button to continue to the display as in Figure 11.

In Figure 11, where this display shows a table that allows users to select temporary data or medoids to perform iteration. In this display will also continue to a display like Figure 12, where the results of the first iteration will be automatically saved along with the previous normalization results. In this display, the processing dataset or clustering results will be saved, where at the bottom of the first iteration result label there is a “new add new iteration” button to add a new iteration. After the 2nd iteration is done, process can be stopped by clicking the “stop iteration button” as shown in Figure 13.

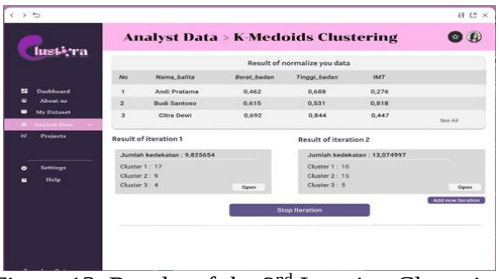

Figure 13. Results of the 2nd Iteration Clustering Process

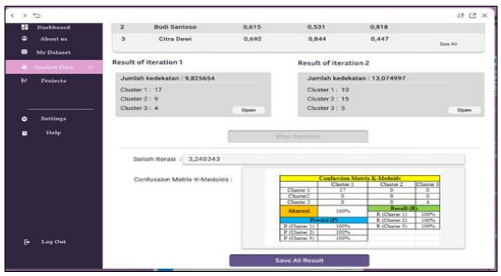

Figure 14. Final Result Display of Clustering Process

Based on the display in Figure 13, the user will be taken to this display after performing an iteration, and the iteration results are automatically saved on this page. In Figure 14, this display is shown after all iterations have been carried out, then the iteration difference process is carried out and the display of the number of iterations after the difference and also the confusion matrix table will appear.

b). Analyst Data Visualization

This section is the data visualization analysis feature.

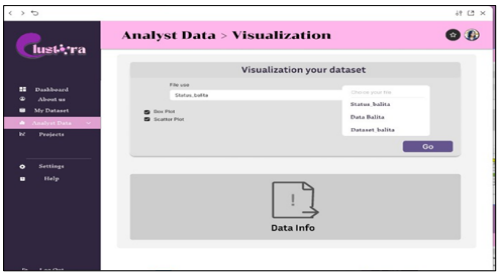

Figure 15. Analyst Data Visualization Page

Figure 16. Dataset Visualization Results Display

Based on Figure 15, on the "Analyst Data > Visualization" page, users can select a dataset file to visualize through a dropdown menu, such as "Status_balita." Users can also select the type of visualization, namely Box Plot or Scatter Plot, by checking the appropriate option and there is a "go" button to start the visualization process. In Figure 16, it can be seen that this display shows the results of the dataset visualization process. Where, at the top there is a Box Plot that displays the distribution of data based on certain clusters. At the bottom, a Scatter Plot is displayed that illustrates the relationship between two variables in the dataset that helps users understand patterns and relationships data.

4. CONCLUSION AND SUGGESTIONS

Based on the discussion of the implementation of the K-Medoids algorithm in grouping toddler nutritional status data, it can be concluded that the clustering process is carried out in two iterations. In the first iteration, the total proximity produced is more optimal with a value of 9,825654, while in the second iteration, the total proximity increases to 13,074997, indicating that the second iteration is less than optimal. Therefore, the first iteration is chosen as the best solution. Evaluation of the performance of the K-Medoids algorithm using a confusion matrix shows very good results, with accuracy, precision, and recall levels reaching 100%. Thus, the k-medoids algorithm is able to divide toddler data into clusters very precisely.

There are several suggestions that can be considered by repeating the Clustering Process, although the first iteration gives more optimal results, it is recommended to repeat the clustering process with different parameter variations or number of clusters. This can help find a good solution to ensure that the results obtained do not depend on one iteration. Further analysis, namely gaining a deep understanding of the data,

can conduct analysis of the clusters formed. For example, looking at the characteristics of each cluster to identify factors that influence toddler nutritional status and develop effective intervention strategies. Grouping toddler nutritional status data applied to other datasets, such as health or education data that can help in exploring the potential in algorithms in various fields.

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