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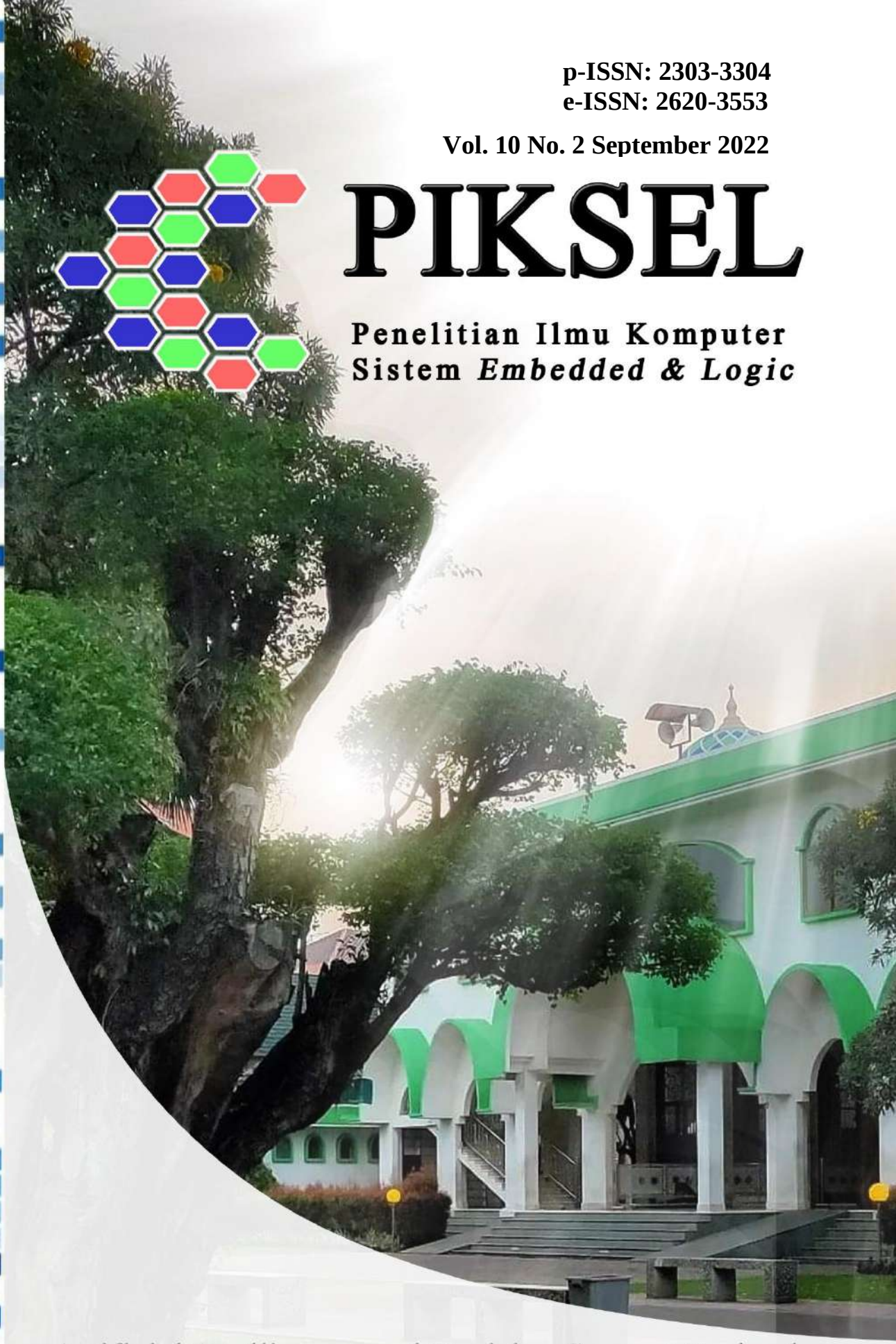

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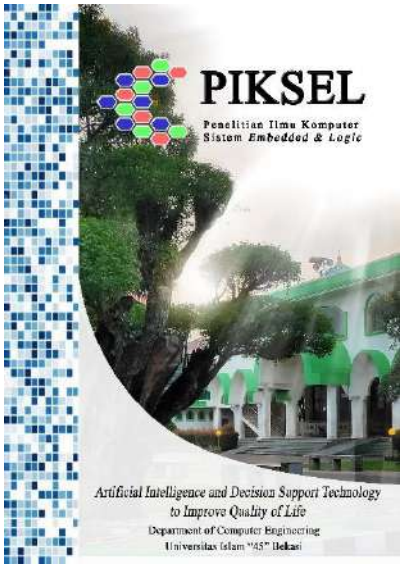

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From Editor-in-Chief

Rahmadya, Ph.D.
Editor-in-Chief

السَّلاَمُ عَلَيْكُمْ وَرَحْمَةُ اللهِ وَبَرَكَاتُهُ

.

Best wishes to all the members of Editorial Board, Reviewers Panel, Authors and Readers of PIKSEL for a very happy, and stay healthy.

The world is facing a new post-pandemic/endemic problem, namely the energy crisis due to war. The quality of life as well as the efficiency and effectiveness of the company still need to be improved through the application of current computer science methods and information systems.

Market analysis, automated inventory systems, export management systems and online booking applications are discussed in this edition. The efficiency of solar panels using a tracking system and the implementation of the Levenshtein algorithm for searching webmail is expected to increase the company's added value. This edition still includes implementation in the health sector, especially the health of toddlers through the application of KNN for nutritional classification.

I hope this issue contribute to support nation after pandemic situation. And once again, thank you to members of Editorial Board, Reviewers Panel, Authors and Readers of PIKSEL (Penelitian Ilmu Komputer, *Sistem Embedded &*

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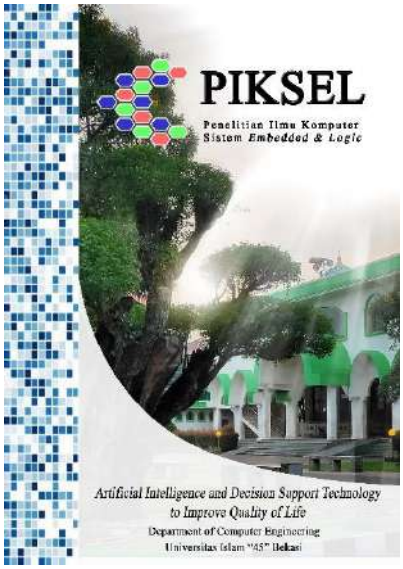

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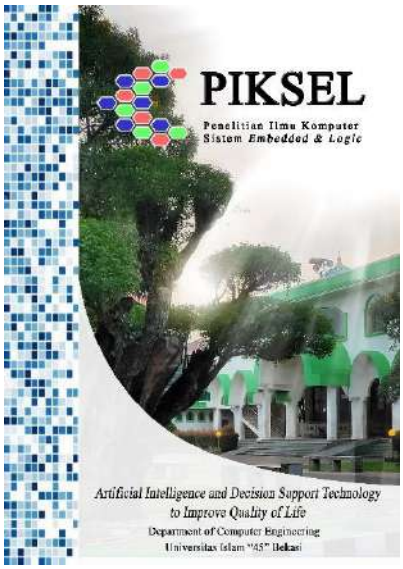

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Nutritional Status Classification of Toddlers Using K-Nearest Neighbor Algorithm

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Abstract

Nutrition is important for the balance of the human body. Knowing the nutritional status is very important to realize the good and the quality human resources. Posyandu Parkit is one of the many Integrated Healthcare Center (posyandu) in Indonesia that provides health services for the community, one of which is monitoring and nutritional development of toddlers. However, the Posyandu Parkit in determining the nutritional status of toddlers is done manually; this method uses measurement parameters based on body weight (BB/U) which are less specific in showing the nutritional status of the toddler by matching manually with a reference standard table available in a healthy card (KMS). The purpose of this research is to produce a website that can determine the nutritional status of toddlers quickly and accurately. The system is designed using the K-Nearest Neighbor method which is a classification method. The K-Nearest Neighbor process is carried out by calculating the distance between the test data and the training data using the Euclidean distance formula, before sorting from the closest distance to the k-th order, then nutritional status is determined. The results of this study are a website that can determine the nutritional status of toddlers by applying the K-Nearest Neighbor algorithm with BB/U, TB/U, and BB/TB accuracies were 93.75%, 87.5%, and 93.75 %, respectively.

Keywords: *euclidean distance, k-nearest neighbor, nutritional status, posyandu*

1. Introduction

Nutrition is essential to the human body's balance. Having a healthy nutritional status is a prerequisite for good and qualified human resources. Nutritional problems can occur in anyone, from the womb, to the elderly (Herawati, 2020).

In Indonesia there are still many problems about undernourishment, especially in the age of toddler's. The status of undernourishment is, of course, influenced by many factors, such as parental ignorance of the proper nutritional value of children, socioeconomic status, and low birth weight. In other sources

the mention of poor nutrition is influenced by knowledge, attitude, practice, and upbringing in the care and feeding of toddler's (Razak et al., 2009).

Children who experience nutritional problems at an early age will have problem of growth and development. Because early age is a period of rapid growth and development in children, if at that time there is a nutritional disorder, it will become permanent until the next phase, even though nutritional needs in the next period are met. Therefore, knowing the nutritional status of toddlers is very important for parents.

Nutrition status may be determined through a laboratory or through a body measurement known as anthropometrics. Measurements through a toddler's body (anthropometri) is found in many types, of the gender (JK), age (U), weight (BB), height (TB), and head circumference (LK) (Devi, 2010).

In Parkit Integrated Healthcare Center (posyandu), general measurement parameters used in determining a toddlers nutritional status based only on weight according to age (BB/U) on the healthy card (KMS) that was then filed manually on a toddler's nutritional status monitoring form and was matched according to standard reference tables WHO in KMS. Although weight according to age (BB/U) does not specifically indicate whether the child is fat, thin, tall, or short. In addition, healthy toddlers get older also increasing gain weight and height. Neither kader nor parent knows for sure whether the toddler's is healthy, normal, or unhealthy.

To minimize the deficiencies in determining nutrition status in toddlers, a new toddler's nutritional status classification system may be needed that can help kader posyandu and parents to find out the toddler's nutritional status based on the anthropometrics index that affects the nutritional status of toddlers.

Classifying is a functioning process of data analysis that helps define a label class from sample data that wants to be grouped or classified. Classification is the process for discovering or specifying a model or function that explains or distinguishes a data class with the purpose of estimating an unknown class from an object (Fitrianingsih et al., 2021).

Application of k-nearest neighbor (KNN) methods can help to classify a toddler's nutritional status according to the condition of the toddler. K-nearest neighbor is an upright algorithm that results from a newly classified query supervised by the majority of the class label on a few of his closest neighbors (Liu, 2007).

Previous study discussed predicting the nutritional status of toddlers using the K-Nearest Neighbor method by classifying the nutritional status of toddlers into 2 (two) i.e., good nutrition and poor nutrition. It showed the KNN algorithm can predict the nutritional status of toddlers well (Sutoyo, 2018).

Another study discussed the classification of the nutritional status of villages in Malaka district that experience malnutrition to determine the value of the level of toddlers with body weight below the red line into three target classes, namely low, medium, high, using the classification method to build a decision-making assistance system, with the K-Nearest Neighbor method and the K-Means method as a clustering process before entering the classification process. The result of this research is that the KNN method is able to classify the nutritional status of the village well with a system percentage of 93.10% (Fahik et al., 2018).

Likewise, research using the KNN algorithm with various other problems. As in research that uses the KNN algorithm to predict student graduation on time. The results of this study that using the KNN algorithm can predict students' timely graduation based on IP up to 4th semester is 80% (Banjarsari et al., 2015).

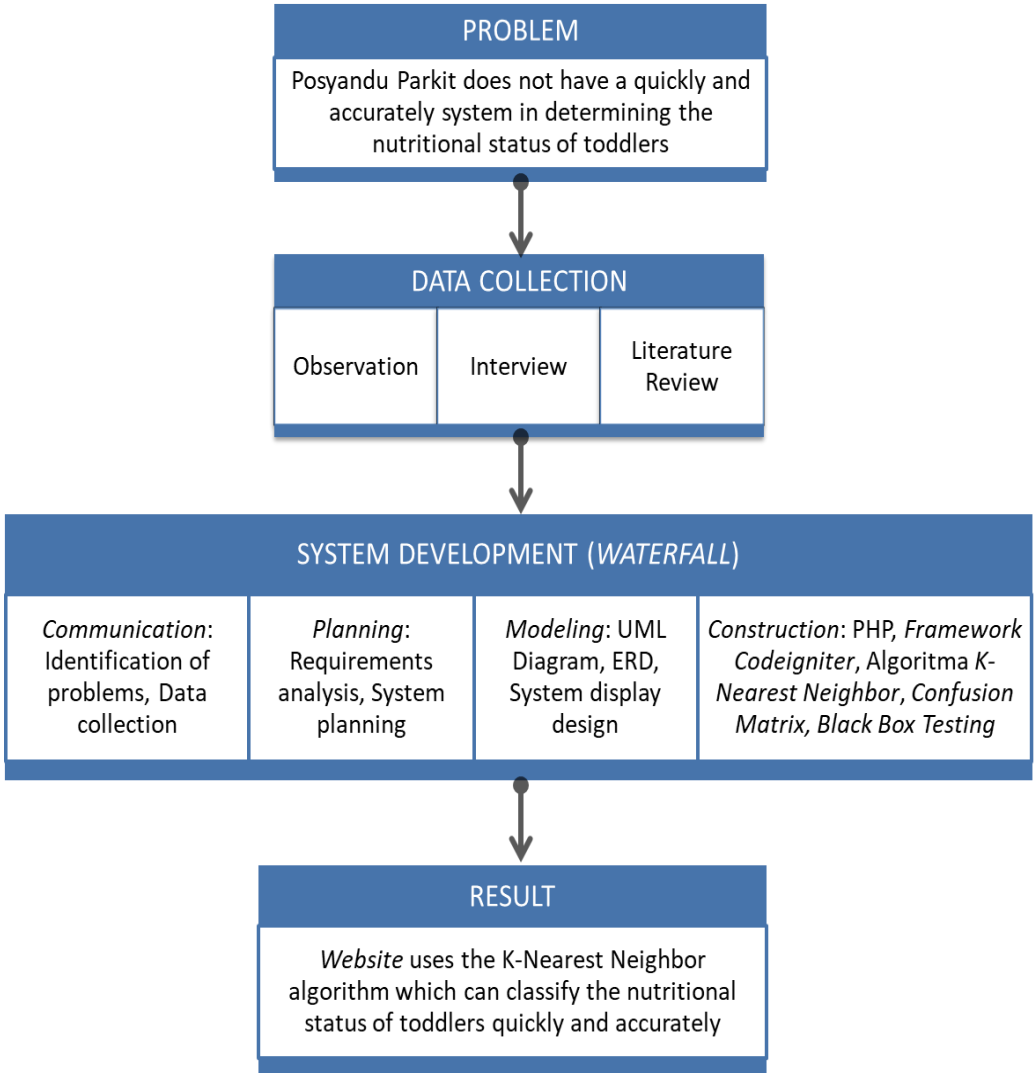
Based on the above description, to help provide a toddler's nutritional status information to staff and parents quickly and precisely, this study proposes a system that gives a toddler's nutritional status in parkit posyandu based on the anthropometri index by k-nearest neighbor (KNN).

2. Research Method

2.1. Research Framework

The research framework of this study is set forth as a guide in the performance of the study to avoid deviating from predetermined purposes.

Below is a toddler's nutritional classification system reaserch framework. Reaserch framework can be seen in figure 1.



Source: Research Result (2022)

Figure 1. Research Framework

2.2. Data Collection

This research conducted several methods of data collection, including direct observation or observation of posyandu parkit for on-site data, and conducted an interview or a debrief with the chief of posyandu parkit to obtain research related data, as well as a library study or a collection of pre-existing concepts and theories to support research data, And search for library material relating to research in reference books, journal articles, notes and Internet access.

2.3. K-Nearest Neighbors (KNN) Algorithm

K-nearest neighbor is a method used in solving the classification problem by grouping or classifying an unlabelled data (testing) based on the new data range to a few neighbors.

The nearest neighbor was an object of training which has the greatest resemblance or the smallest irregularities of the old data. Closest number of neighbors stated by k. The k value selection is an important thing, because it would affect the work performance of a k-nearest neighbor algorithm (Prasetyowati, 2017). A simple approach to the k value selection, as follows:

$$k = \sqrt{n} \tag{1}$$

K-nearest neighbor's algorithm works by the shortest distance from query instance to training data to define k. How to calculate distance or distance a neighbor usually using methods euclidean distance (Suntoro, 2019).
Equation 2 shows euclidean distance formula:

$$d(x, y) = \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2} \tag{2}$$

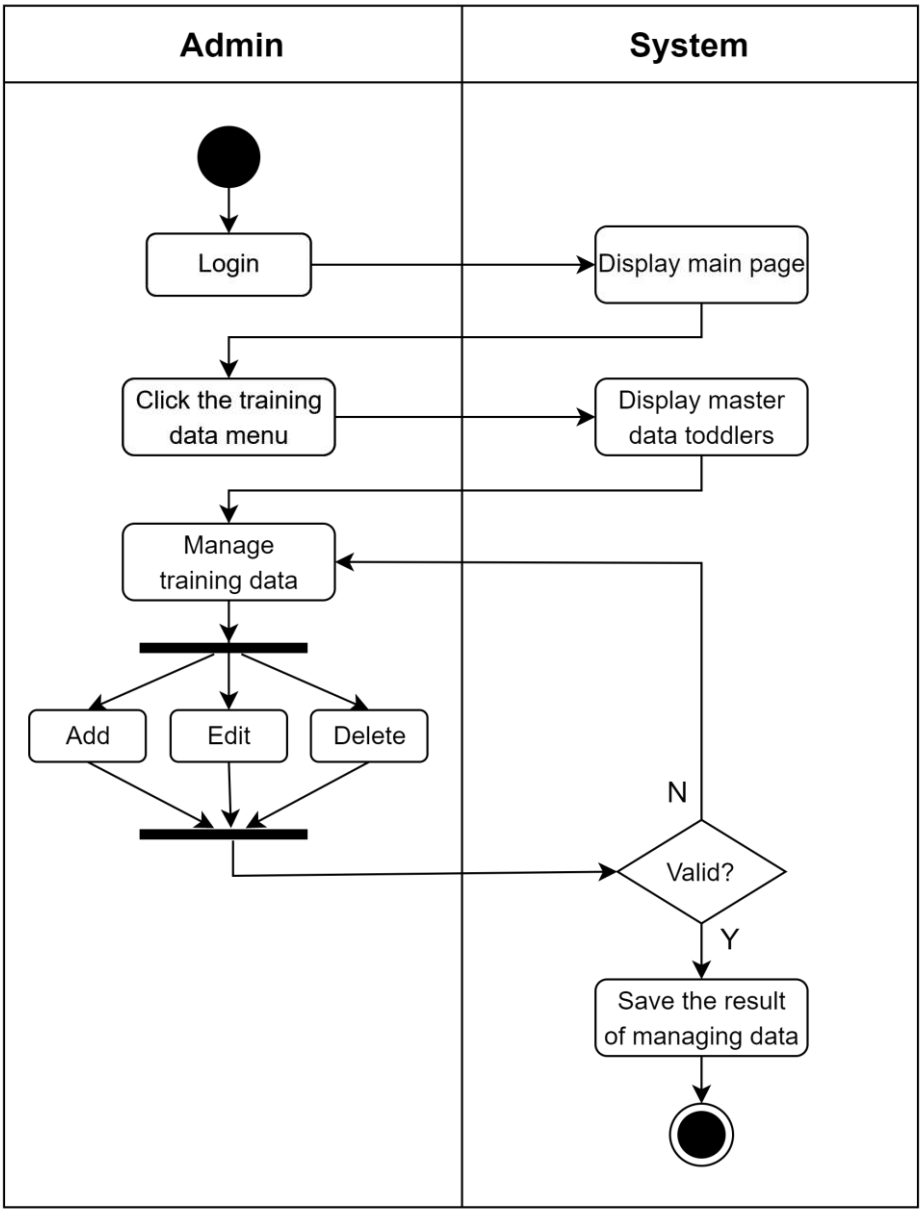
Where:
d (x,y) is the distance between x data and y data
xi is testing data to-i
yi is training data to-i

3. Results and Analysis

According to the problem statement that need to build a system that is expected to be able to assist the posyandu staff and parents to quickly and correctly determine the nutritional status of the toddler. The following are the results and the discussion of the application Classification of the Nutritional Status of Toddlers Using the K-Nearest Neighbor Algorithm at the Posyandu Parkit in Bekasi.

3.1. System Design

At this stage, there is the modeling design stage of the waterfall method. Below is the design of the activity diagram of a toddler's nutritional status system, such as figure 2 to train data and figure 3 to test data and data testing processes.

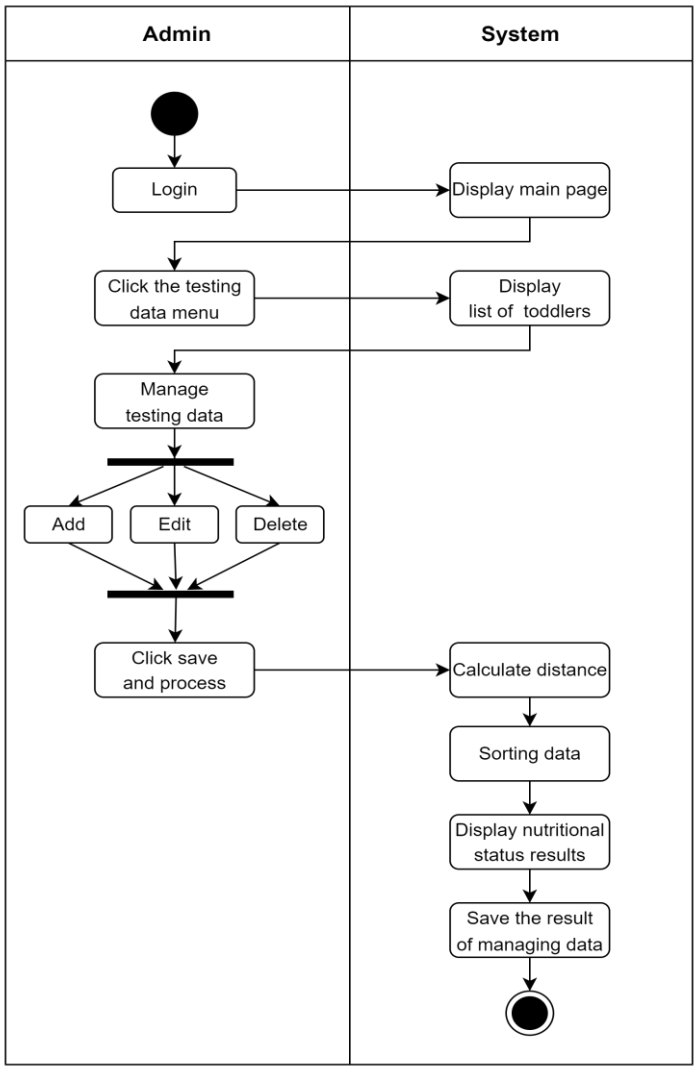


Source: Research Result

Figure 2. Activity Diagram Data Training

Activity diagram of data training can be explained as follows. First, admin logs into the system; second, the system displays the main page; third, admin

selects the training data menu; four, the system displays the toddler master training data; five, admin manages training data (create, read, update, delete); six, the system validates data management, if it is appropriate then the process will be continued, if it is not appropriate then it will return to the data management process; seven, the system stores the results of data management if it is valid.



Source: Research Result

Figure 3. Acitivity Diagram Data Testing and Data Testing Process

Activity diagram of data testing in Figure 3 can be explained as follows: (1) Admin logs into the system; (2) The system displays the main page; (3) Admin selects testing data; (4) The system displays a list of toddlers; (5) Admin

manages testing data (create, update, read, delete); (6) Admin presses the save button and processes after managing data; (7) The system will calculate the distance between the testing data and the training data; (8) The system performs sorting the closest distance data; (8) The system displays the results of the nutritional status of children under five; (10) The system stores the results of data management.

3.2. Application of the K-Nearest Neighbor Method

In this study the K-Nearest Neighbor Algorithm was applied to determine the Nutritional Status of Toddlers at the Parkit Posyandu.

a. Data Training

In this study, data training used toddler data with a total data of 128 toddlers aged 0 to 24 months with details of 54 male toddlers and 74 female toddlers who were in the RW 011 Posyandu Parkit environment whose nutritional status had been calculated manually with the z-score formula is based on the standard table of child anthropometry standards. The data can be seen in table 1.

Table 1. Training Data

No.	Gender	Age (Month)	Weight (Kg)	Height (Cm)	Head Circumference (Cm)	Nutritional Status		
						BB/U	TB/U	BB/TB
1.	L	6	15	65	38	More Nutrition	Normal	Fat
2.	L	14	10	78	36	Good Nutrition	Normal	Normal
3.	L	24	13	85	40	Good Nutrition	Normal	Normal
4.	L	10	7	60	34	Undernutrition	Very short	Normal
5.	L	18	6,5	58	35	Malnutrition	Very short	Normal
...		...	...	...	...	...	...	...
128.	P	6	4	62	38	Malnutrition	Short	Thin

Source: Research Result (2022)

b. Distance Calculation

For instance, we want to know the nutritional status of a toddler named Alvaro Fabian Arsalan, male gender, 7 months old, weight 9 kg, height 70 cm, head circumference 39 cm. The calculation of the distance between

Data Testing and Data Training is calculated using the Euclidean distance formula.

$$d_i = \sqrt{\sum_{i=1}^{n} (p_i - q_i)^2} \quad (3)$$

The following is the result of calculating the distance between Data Testing and Data Training, which can be seen in table 2.

Table 2. Distance Calculation

No.	Distance Calculation
1.	$d_1 = \sqrt{(7-6)^2 + (9-15)^2 + (70-65)^2 + (39-38)^2} = 7{,}93725393\,32$
2.	$d_2 = \sqrt{(7-14)^2 + (9-10)^2 + (70-78)^2 + (39-36)^2} = 11{,}0905365\,064$
3.	$d_3 = \sqrt{(7-24)^2 + (9-13)^2 + (70-85)^2 + (39-40)^2} = 23{,}0434372\,436$
4.	$d_4 = \sqrt{(7-10)^2 + (9-7)^2 + (70-60)^2 + (39-34)^2} = 11{,}7473401\,245$
5.	$d_5 = \sqrt{(7-18)^2 + (9-6{,}5)^2 + (70-58)^2 + (39-35)^2} = 16{,}9484512\,567$
...	...
54.	$d_{54} = \sqrt{(7-22)^2 + (9-17)^2 + (70-72)^2 + (39-41)^2} = 17{,}2336879\,396$

Source: Research Result (2022)

c. Sorting Data

Sort the distance (in ascending order) and determine the closest distance to the order of k. The value of k is based on the amount of Training Data (n) available, namely k=√n.

The value of k = √54 = 7.34. means the value of k = 7. The following is the result of sorting data can be seen in table 3.

Table 3. Sorting Data

No.	Gender	Age (Month)	Weight (Kg)	Height (Cm)	Head Circumference (Cm)	Nutritional Status			Distance
						BB/U	TB/U	BB/TB	
1.	L	6	10	70	37	Good Nutrition	Normal	Normal	2,4494897428
2.	L	8	12	69	39	More Nutrition	Normal	Fat	3,3166247904
3.	L	10	9	69	40	Good	Short	Normal	3,316624

No.	Gender	Age (Month)	Weight (Kg)	Height (Cm)	Head Circumference (Cm)	Nutritional Status			Distance
						BB/U	TB/U	BB/TB	
4.	L	6	9	67	38	Nutrition Good	Normal	Normal	7904 3,316624
5.	L	9	7	72	38	Nutrition Good	Normal	Thin	7904 3,605551 2755
6.	L	9	10	70	36	Nutrition Good	Normal	Normal	3,741657 3868
7.	L	5	7	70	42	Nutrition Good	Tall	Normal	4,123105 6256

Source: Research Result (2022)

d. Interpretation and Results

Based on Table 3, there is an index anthropometri that produce: (1) BB/U there is 6 Good nutrition, 1 More nutrition; (2) TB/U there is 5 Normal, 1 Short, 1 Tall; (3) BB/TB there is 5 Normal, 1 Thin, 1 Fat.

Then obtained the results of the nutritional status of toddler: (1) BB/U = Good nutrition; (2) TB/U = Normal; (3) BB/TB = Normal.

By Interpretation: (1) Good nutrition = - 2 s/d + 2SD = Normal; (2) Normal = - 2 s/d + 2SD = Normal; (3) Normal = - 2 s/d + 2SD = Normal.

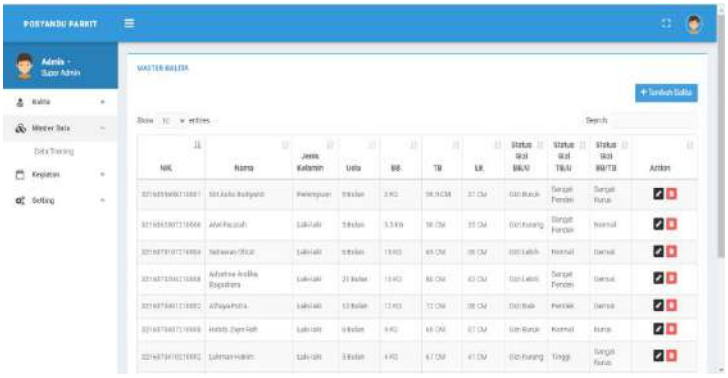
From the above calculations, it can be concluded that the toddler named Alvaro Fabian Arsalan is male, age 7 months, weight 9 kg, height 70 cm, head circumference 39 cm, nutritional status is BB/U = Good, TB/U = Normal, BB/TB = Normal, and the interpretation is Normal.

3.3. System Implementation

After doing the modeling process, then the system design that has been made will be implemented by coding the program. The following is the interface of the Posyandu Parkit Wanajaya application in determining the Nutritional Status of Toddlers.

a. Training Data Display

Figure 4 is a display of the data training menu. In this menu admin can add, edit, or delete training data.

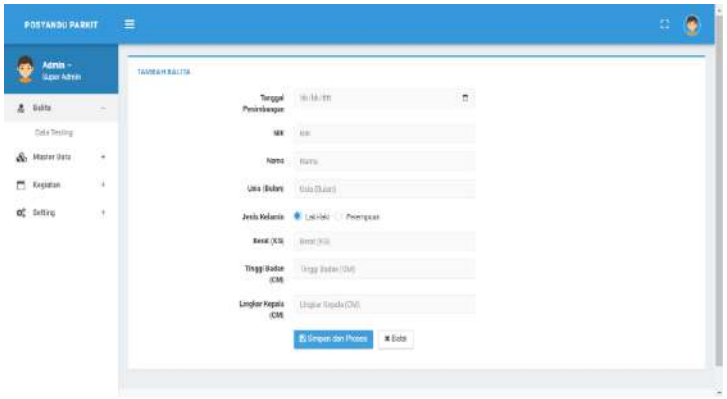


Source: Research Result (2022)

Figure 4. Training Data Display

b. Testing Data Display and Nutritional Status Determination Process

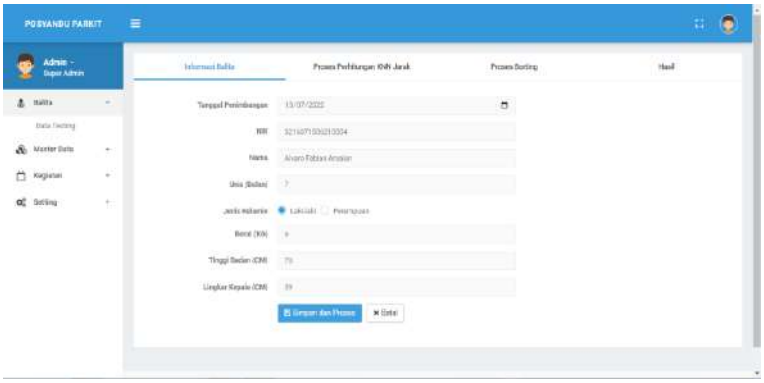
Figure 5 is a Testing Data Input Display. After selecting the data testing menu, the admin presses the add toddler button, and the admin enters the data to be tested, then presses the save and process button.



Source: Research Result (2022)

Figure 5. Display of Toddler Data Input to be Tested

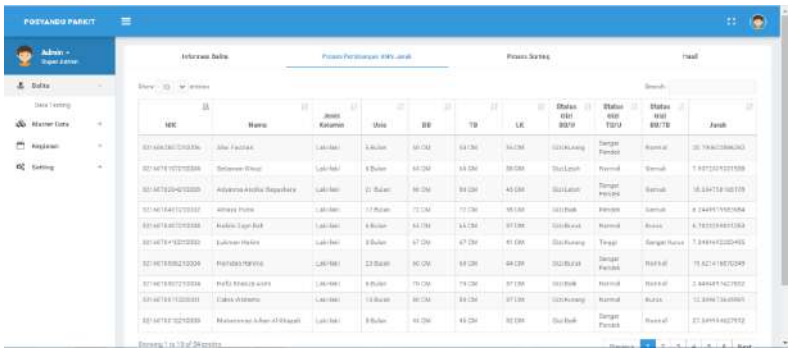
Figure 6 is a display of toddler data information that has been inputted.



Source: Research Result (2022)

Figure 6. Display Testing Data Information that has been Inputted

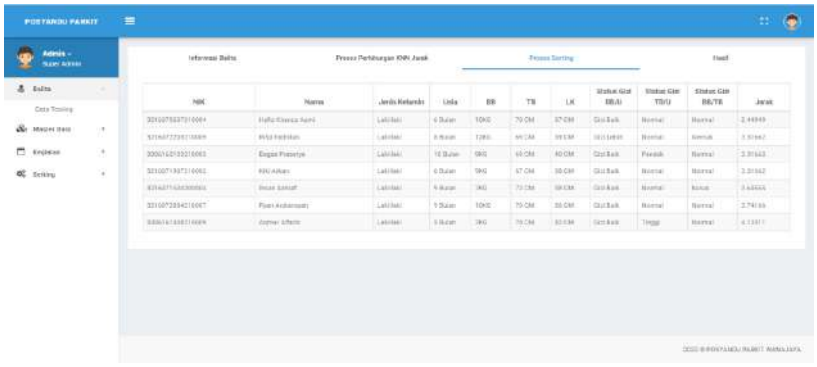
Figure 7 is a display of the distance calculation process between Data Training and Data Testing.



Source: Research Result (2022)

Figure 7. Distance Calculation Process Display

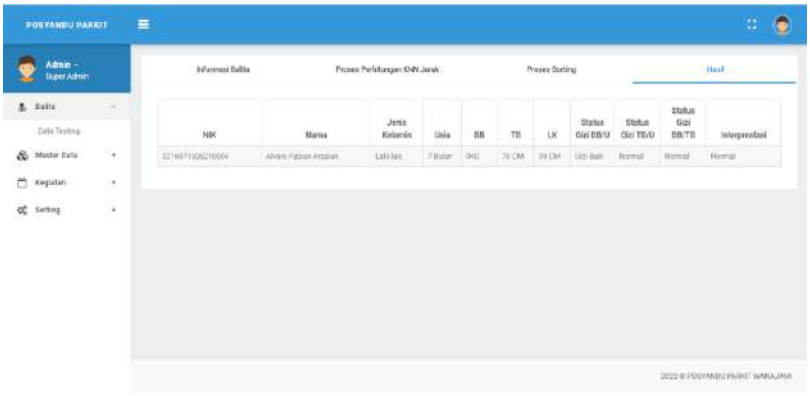
The view of the Data Sorting Process is shown in Figure 8.



Source: Research Result (2022)

Figure 8. Data Sorting Process Display

Figure 9 is a display of the results of data testing that has been processed with the K-Nearest Neighbor Algorithm so as to produce the output of the nutritional status of toddlers along with their interpretation.



Source: Research Result (2022)

Figure 9. Display of Data Test Results

c. Confusion Matrix (Accuracy Testing)

At this stage, the data whose nutritional status has been predicted using the K-Nearest Neighbor algorithm will then be analyzed to find the accuracy value with a confusion matrix. In this study, the authors divide the training data and test data with a ratio of 80%-20% with details of 128 training data and 32 testing data.

In finding the accuracy value with the confusion matrix using the result data, the actual is the data before being tested, while the prediction is the data that has been tested (testing) with the k-nearest neighbor algorithm. In this test, the prediction results of all the data that have been tested have been obtained. The data can be seen in tables 4, 5, and 6 confusion matrix with the following equation:

Table 4. Confusion Matrix BB/U

		Actual			
	Class	**Malnutrition**	**Undernutrition**	**Good Nutrition**	**More Nutrition**
Prediction	**Malnutrition**	1	0	0	0
	Undernutrition	0	3	0	0
	Good Nutrition	0	2	21	0
	More Nutrition	0	0	0	5

Source: Research Result (2022)

Accuracy value of Weight by Age (BB/U):

$$accuracy = \frac{1+3+21+5}{32} x100 = 93{,}75\%$$

Table 5. Confusion Matrix TB/U

		Actual			
	Class	**Very short**	**Short**	**Normal**	**Tall**
Prediction	**Very short**	5	1	0	0
	Short	0	0	0	0
	Normal	1	2	20	0
	Tall	0	0	0	3

Source: Research Result

Accuracy value of Weight by Age (TB/U):

$$accuracy = \frac{5+20+3}{32} x100 = 87{,}5\%$$

Table 6. Confusion Matrix BB/TB

		Actual			
	Class	**Very Thin**	**Thin**	**Normal**	**Fat**
Prediction	**Very Thin**	0	0	0	0
	Thin	0	1	0	0
	Normal	1	1	25	0
	Fat	0	0	0	4

Source: Research Result (2022)

Accuracy value of Weight by Age (BB/TB):

$$accuracy = \frac{1+25+4}{32} x100 = 93{,}75\%$$

4. Conclusion

Based on the results, it can be concluded that the K-Nearest Neighbor (KNN) Algorithm can be used to determine the nutritional status of toddlers by using anthropometri input data variables such as age, weight, height, and head circumference with an accuracy result of BB/U of 93,75%, accuracy TB/U is 87,5%, and accuracy BB/TB is 93,75%. And the system built can provide information on the nutritional status of children under five to kader posyandu and parents quickly and accurately.

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Author Contributions

Nur Amanda Pratiwi proposed the topic; Nur Amanda Pratiwi, Prima Dina Atika and Herlawati conceived models and designed the experiments; Prima Dina Atika and Herlawati conceived the algorithms. Prima Dina Atika and Herlawati conceived analysed the result.

Conflicts of Interest

The author declare no conflict of interest.

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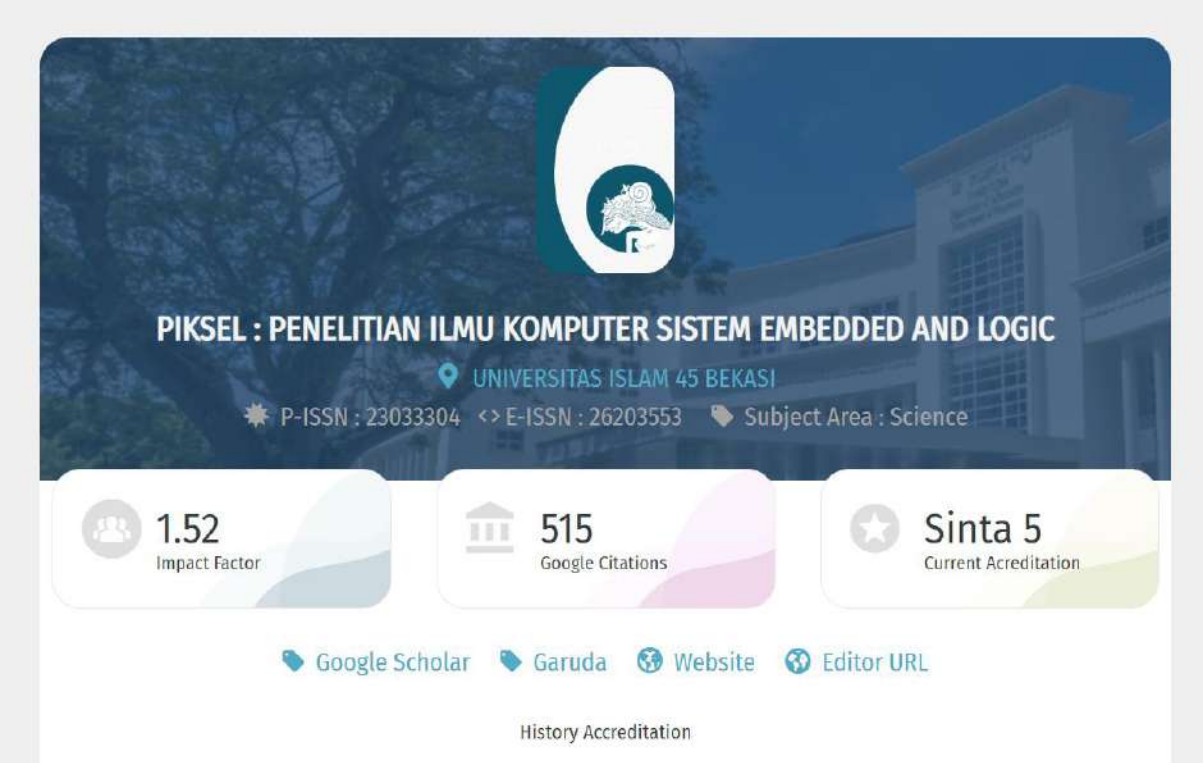

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