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ANALYSIS OF FUZZY K-NEAREST NEIGHBORS WITH KNN AND FUZZY LOGIC APPROACH ON DUCK BROILER PRODUCTION

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ABSTRACT
Rapid growth and the ability to turn feed into valuable meat are two advantages of broiler ducks. The success of broiler duck production is reflected in measurable performance indicators such as mortality rate, feed consumption, final body weight, feed conversion ratio (FCR). There are still many disadvantages in the cage management pattern, one of the main factors is the high mortality rate. Therefore, based on the results of research on the subject of broiler duck production, researchers tried to analyze production elements using various data processing techniques, including artificial neural network-based clussification and fuzzy classifiers that have been proven to have very good results for classification data. However, in practice there are situations where the distribution of training and testing data is the same but different. From the results of the previous research analysis, the fuzzy k-nearest neighbor algorithm was used to process broiler duck production data. Based on the test results, the accuracy value of the KNN algorithm was 87%, and the accuracy value of fuzzy logic was 98%. Because the data that the researcher prepared had irregular characters which caused the KNN method to experience many errors during data processing. Furthermore, the researcher combined the KNN and Fuzzy Logic methods into fuzzy k-nearest neighbor. which with the FKNN method obtained an accuracy value of 83%. can optimize the KNN method which previously experienced many errors when processing data.

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I. INTRODUCTION

Livestock commodities, especially poultry, have very good market prospects because they are supported by the characteristics of poultry products that are acceptable to the Indonesian people, with easy access and relatively cheap prices. This commodity is the largest contributor to the provision of national meat, and is the main driver of the provision of national animal protein[15]. The large number of requests from the community is not balanced with adequate availability. This is because many meat duck farmers maintain small-scale maintenance, so that the demand for duck meat cannot be met optimally. The rapid growth of hybrid ducks and Peking ducks if properly maintained can meet the needs of duck meat for the Indonesian people[13].

To achieve optimal performance in broiler ducks, the main influencing factors are breed quality, feed, and management practices. The success of broiler duck production is reflected in measurable performance indicators, such as mortality rate, feed consumption, final body weight, feed conversion ratio (FCR). Mortality rate serves as an important benchmark for evaluating broiler duck management results. As a result, low mortality indicates better productivity, leading to more efficient feed utilization and improved overall performance[2].

As a result of this maintenance, another problem was also found, namely that from a total of 10,000 ducks per cage that were brought in each production cycle, the Company experienced losses with a mortality rate ranging from 200 to 500 ducks. The causes of this mortality include disease, bad weather conditions, and weaknesses in cage management practices. Other problems that affect production include uneven feed distribution, inadequate poultry cage sanitation, and less than optimal duck health monitoring. To overcome these challenges, a practical clustering analysis is needed to assess the level of production success. Meat duck production involves various complex variables, including feed type, environmental conditions, duck health, and other factors that can significantly affect production results. In this context, data mining offers a promising solution to uncover hidden patterns and relationships, which provide deeper insights into the dynamics of duck production[5].

Data mining is a method of extracting data to find patterns to produce useful information from large amounts of data, so that it can be applied in real life [19]. There are two methods in data mining: predictive methods and descriptive methods. Predictive methods use classification models. Changing data into groups of the same class or category is known as classification [20]. The success rate of broiler duck is classified into three categories: very good, good, and poor. When selecting farmers, determining the success rate of production is very helpful in decision making. Although the company does not provide training, farmers must. One way to solve this problem is to use a data mining method that uses the FKNN algorithm to classify and identify the features that most affect the success rate of broiler duck production[10].

The K-Nearest Neighbors (KNN) algorithm often struggles with irregular data distributions due to its reliance on majority voting from a fixed number of nearest neighbors, without considering the degree of closeness or data uncertainty. This can lead to misclassification, especially when data is noisy, overlapping, or imbalanced. Fuzzy K-Nearest Neighbors (Fuzzy KNN) addresses these limitations by assigning membership degrees to each class based on the distance of neighbors, allowing a more nuanced classification. Instead of making a hard decision, Fuzzy KNN considers how strongly a data point belongs to each class, making it more robust to irregularities and improving accuracy in complex or uncertain data environments [9].

Although the article presents a comparison of the three methods, it does not explain why K-Nearest Neighbors (KNN) tends to have a higher error rate. KNN is highly sensitive to the structure of the data; it assumes that similar data points are close in distance, which may not hold true in datasets with noise, overlapping class boundaries, or uneven class distributions. These issues can lead to incorrect neighbor selections and thus misclassifications. On the other hand, Fuzzy Logic—particularly in methods like Fuzzy KNN—accounts for uncertainty and gradual transitions between classes by assigning degrees of membership rather than hard labels. This makes fuzzy-based methods more adaptable to ambiguous or imprecise data, contributing to their higher accuracy in such scenarios [8].

Based on the issues outlined above, the author suggests using Classification Analysis of Production Success through data mining techniques such as K-Nearest Neighbors (KNN) and Naive Bayes as an effective tool to classify the success rate of broiler chicken production[17]. With a better understanding of the factors influencing chicken production performance, management can take proactive steps to improve the success rate of production and increase chicken production yields [18]. Therefore, researchers will conduct a trial of clustering analysis of meat duck production using the development of the k-nearest neighbor algorithm, namely Fuzzy K-Nearest Neighbor to cluster meat duck production.

II. RESEARCH METHODOLOGY

The following is previous research that is similar to the classification of poultry production results, including: A think about by Jihao Youa et al, who conducted a later consider connected a arbitrary woodland classification calculation to foresee egg-laying occasions in 202 free-ranging Ross 708 broilers nourished by a accuracy nourishing framework from week 21 to 55, based on a dataset that recorded data from all visits to the station. The crude dataset from the exactness bolstering framework was handled for 6 include classes (34 highlights in add up to) in connection to real-time feathered creature bolstering action and body weight. The handled information was randomized and isolated into 2 subsets: 90% for preparing, and 10% for testing. The generally precision of the demonstrate utilizing the test test was 0.8482, and the out-of-bag score was 0.8510. The accuracy (a degree of virtue in picking) of non-laying and laying, and the review (a degree of completeness in picking) of non-laying and laying were 0.8814, 0.8090, 0.8520 and 0.8453, individually. The Kappa coefficient of the demonstrate was 0.6931, demonstrating significant understanding (significant assention run: 0.61–0.80) [6].

A ponder by Philip J. Hepworth et al. found that the utilize of bolster vector machine learning to recognize highlights related with joint burns in commercial broiler ranches, utilizing routinely collected cultivate administration information. This information can be analyzed utilizing machine learning procedures. Joint burns, a dermatitis of the skin overlying the joints, are an critical marker of broiler wellbeing and welfare. Strikingly, this classifier was able to anticipate the event of tall predominance of joint burns with an precision of 0.78 on concealed information, as measured by the zone beneath the recipient working characteristic bend. We moreover compared the comes about with those gotten with standard multivariable calculated relapse and propose that this strategy gives unused experiences into the information [11].

Somaye Amraei et al. in their research used image processing and Support Vector Regression (SVR) as a non-invasive method. Ellipse fitting algorithm using general Hough transform was performed to localize chickens in the cage and the head and tail of the chicken were removed using the Chan-Vese method. After that, from the

broiler chicken image, six features were extracted, namely area, convex area, perimeter, eccentricity, major axis length, and minor axis length. Based on statistical analysis between SVR weight estimation and manual measurement of chickens up to 42 days, no significant difference was found (P> 0.05). The RMSE (root mean square error), MAPE (mean absolute percentage error) and R2 (correlation coefficient) values of the SVR algorithm were 67.88, 8.63% and 0.98, respectively. This shows that machine vision together with SVR can estimate the live weight of broiler chickens promisingly [14].

Research conducted by Christian Cahyaningtyas et al. in their research the success rate of broiler chicken harvest can be seen from the performance index value produced during harvest. Data Mining can be used as an approach method to help classify broiler chicken harvest data. The Data Mining technique used in this study uses the CRISP-DM (Cross Industry Standard Process for Data Mining) method. This study compares 3 classification algorithms to get the best algorithm and compares 3 Feature Selection to get the best method to improve algorithm performance. The results obtained from this study are that the Random Forest algorithm is the best algorithm in classifying harvest data, with an accuracy value of 89.14%. While the best method to improve algorithm performance is to use the Backward Elimination method which can increase accuracy by 7.53%. So that the accuracy value obtained from the Random Forest + Backward Elimination algorithm is 96.67% [3].

Rany Andini et al. this study uses data mining techniques with the clustering method using the Rapidminer application to analyze the pattern of native chicken egg production in South Sumatra province in 2020 to 2022 in order to optimize egg production in each region. This ponder applies a comparison of the K-Means and K-Medoids calculations, the reason of the comparison is to decide which calculation is the most excellent in clustering the generation of local chicken eggs in South Sumatra by comparing the Davies Bouldin Index (DBI) esteem to decide the most excellent K value (number of clusters). The test comes about appear that the K-Means calculation is the leading calculation for clustering local chicken eggs in South Sumatra area with a Davies Bouldin File (DBI) esteem of 0.193 with five clusters compared to K-Medoids of 0.268 with three clusters [12].

Mairead Campbell et al. conducted a proof-of-concept camera observation framework based on programmed location and following of broiler chickens to screen movement bouts utilizing unsupervised 2D direction clustering. To begin with, a convolutional neural network-based finder was prepared and tried on our labeled dataset which yielded accuracy, review and f-score of 0.98, 0.90 and 0.94, separately. Utilizing the detection-based following approach, the proposed framework was able to track chickens over video outlines with a multi-object following exactness of 74.7%. A component-based include saliency Gaussian blend demonstrate (CFSGMM) was at that point built and connected to impartially cluster the directions based on their spatiotemporal data. Nineteen highlights were extricated from the directions, speaking to inactive and energetic characteristics of broiler chicken developments, and three action classes were recognized: 'least active/resting', 'active' and 'highly active'. The proposed strategy was approved on a one-minute monocular video arrangement [9].

According to Emilda Sakina and A. Haidar Mirza stated that facing the challenge of frequent shortages of catfish supply, this study developed a prediction model for catfish production results using three machine learning algorithms: Artificial Neural Network (ANN), Random Forest, and Decision Tree The main objective is to understand the relationship between environmental factors, maintenance practices, and catfish production output. The performance of each algorithm is evaluated using appropriate metrics to determine the best approach. The processing of the ANN method obtained performance results in the form of accuracy with an accuracy level of 81.25%. Prediction of data processing using the Random Forest method after training and testing data obtained performance results in the form of accuracy with an accuracy level of 100%. Prediction of data processing using the Decision Tree method using rapid miner software performance in the form of accuracy with an accuracy level of 25.69% [4].

Research conducted by Beni Basuki et al. guidance from the company is very much needed for farmers because there are farmers who are just starting out or have been established for a long time. Many core companies face difficulties in modeling the level of success in raising broiler chickens because the large volume of data comes from farmers who partner with the company, making it difficult for the company to determine the level of success of broiler chicken production. To manage the increasing amount of data, data mining and the K-Nearest Neighbor (KNN) algorithm are needed in the classification process. This thinks about points to classify the level of victory of broiler chicken generation in Riau and assess the precision of the K-Nearest Neighbor calculation show. A add up to of 927 animal generation information in Riau were utilized, with 80% of the information utilized for preparing and 20% for testing. The comes about of the disarray lattice assessment appeared the most elevated exactness at k = 3 with an exactness level of 86.49%, a exactness of 75.00% and a review of 70.21% [1].

The research conducted by Tukiyat et al. is using a data mining classification approach with the K-Nearest

Neighbors (K-NN) and Naive Bayes algorithms. This study uses the hold-out method with a data division of 60:40 and 70:30 for model training and testing. The production success rate is classified into three categories: good, less good, and very good. The research findings revealed that the K-NN algorithm outperformed with an accuracy of 92.59%, compared to Naive Bayes, which reached 76.67%. Regarding recall, K-NN recorded a value of 96.67%, higher than Naive Bayes at 71.67%. However, Naive Bayes showed slightly better precision (94.29%) than K-NN (93.55%). The results of this study confirm that the K-NN algorithm is more effective in classifying the success rate of broiler chicken production [16].

Research by Muhammad Rifaldo Al Magribi et al. Where broiler chickens are a prevalent breed that has tall meat efficiency and a brief regenerative cycle, hence empowering the arrangement of organization participation between agriculturists and expansive companies. As a center, the company assesses the victory of ranchers as seen from the execution list or IP esteem. The qualities that influence the IP esteem are exhaustion, normal collect weight, bolster transformation proportion (FCR), and collect age. The reason of this consider was to decide the traits that most impact the victory rate of broiler chicken generation in Riau and to get the exactness esteem of the choice tree show utilizing the C4.5 calculation. This think about utilized 952 agriculturist generation information in Riau which were partitioned by a proportion of 80% preparing information and 20% test information. The test delivered a choice tree where the FCR trait was the root hub with a pick up esteem of 0.45 and got to be the property that most impacted the victory rate of broiler chicken generation in Riau. Assessment employing a disarray lattice created an exactness esteem of 97.11%, a accuracy of 98.89%, and a review of 98.16% [10].

This study proposes a data set and method for clustering broiler duck production, using a system design illustrated in Figure 1. The broiler duck production data set will be normalized in the preprocessing stage. After the data is normalized, it is then processed using the KNN and Fuzzy Logic algorithms, after which it is continued into the FKNN algorithm process, which is a combination of the KNN and Fuzzy Logic algorithms. Furthermore, researchers use the FKNN method to cluster broiler duck production.

A. Method

The research system architecture for clustering broiler duck production at PT. X can be seen in Figure 1 below.

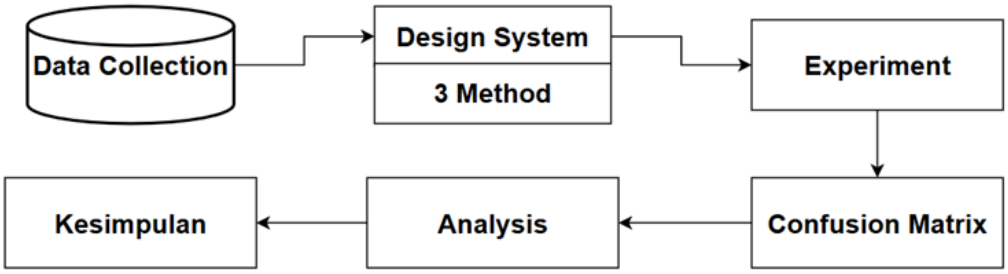

Figure 1. System Architecture

Where in figure 1 it is explained that the first step is collecting data on broiler duck produc-tion. Continued to the next stage by applying three methods, namely KNN, Fuzzy Logic, and FKNN. And continued to the experiment stage, namely by optimizing the FKNN algorithm. Af-ter optimizing FKNN, continued to the confusion matrix stage which will evaluate the three methods. Then analyze the results of the confusion matrix evaluation. And then draw conclu-sions. Below we also display the system design process using three methods to cluster meat duck production data

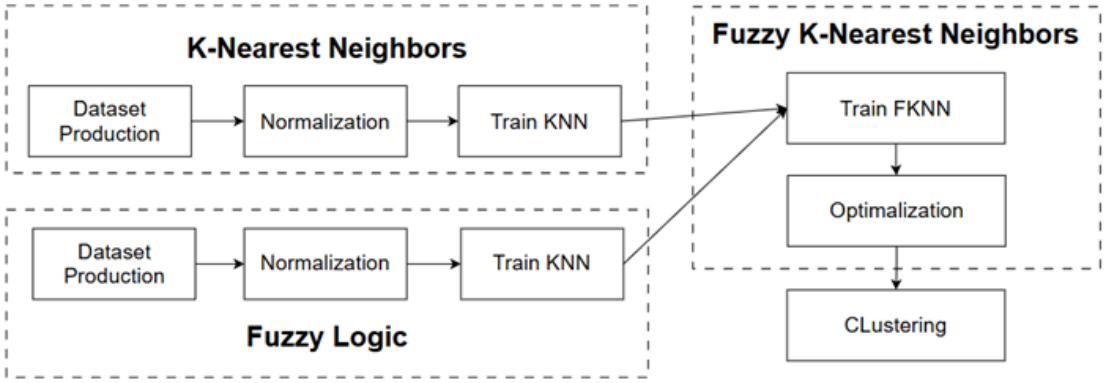

Figure 2. Block Diagram KNN, Fuzzy Logic, & FKNN

In figure 2 it is explained that after collecting the data of meat duck production, it is continued into algorithm

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processing. The first algorithm to be processed is KNN, then try to process the dataset with the fuzzy logic algorithm. after the 2 methods are trained, the next is to enter the fuzzy k-nearest neighbors algorithm which is a combination of the KNN and fuzzy logic algorithms.

B. Dataset

Data collection is the most important stage in this study, therefore several stages are carried out so that the data to be processed is more precise, and several stages are needed to obtain the right data needs to be processed, explained in Figure 1 starting from Data Collection which is an understanding of duck production from the object to be studied, understanding the data to be collected (data understanding) and the readiness of the data to be processed (data preparation). The following types of data used for research obtained from the results of meat duck production by PT. X, the following input variable data that researchers will test are as follows.

TABLE 1
DATASET VARIABLE

No	Attribute	Data Type	Description / Identification
1	Population	Numeric	Number of live ducks
2	Age	Numeric	Daily age of ducks
3	Death	Numeric	Duck death in a day
4	Feed	Numeric	Amount of feed consumption

To produce clustering results, one variable is needed. The variable used is duck mortality as a label for measuring duck production clustering, from all the data to be tested, the researcher divided the data into 2 parts, the first is Training Data and the second is Test Data with a ratio of 75:25 percent. The following is daily duck production data as follows.

TABLE 2
ITEM AND DATASET PRODUCTION BROILER DUCK

No	Population	Age	Death	Feed
1	9982	1	24	250
2	9958	2	20	250
3	9958	3	20	250
4	9920	4	15	250
5	9905	5	15	250
...	...	...	...	...
302	9767	30	10	1700
303	9757	31	9	1850
304	9748	32	10	1750
305	9738	33	14	1750
306	9724	34	0	1750

The data used is the duck harvest results with a daily record of 306 daily data that we obtained from 3 cages (13, 17, and 20) consisting of 3 harvest cycles. And each cage carried out duck in as many as 10,000 ducks.

C. Evaluation

In this evaluation stage, the author uses the Confusion Matrix method to obtain the level of accuracy of each algorithm and can be seen in terms of precision and recall. Where in each algorithm can be drawn conclusions about the comparison of each algorithm.

Before entering the equation, the method first normalizes the dataset, where at this stage min-max normalization is used, namely by changing the data to 0 and 1 [8]. This method maintains the relationship with the original data and can be done by using a predetermined formula. As follows.

$$normalized(x) = \frac{minRange + (x - minValue)(maxRange - minRange)}{maxValue - minValue} \quad (1)$$

D. Equation KNN

The following is the calculation procedure using the k-nearest neighbors algorithm as follows.

a) In the initial stage, the value of k is determined
b) Calculate the euclidean separate between the test information and the preparing information
c) Bunch the information based on the calculation of the euclidean separate
d) Cluster the nearest neighbors by arranging the data based on the smallest distance
e) Select the most frequently occurring class among the *K* neighbors and use it as a prediction

To calculate the euclidean value, the following equation is used:

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$$d(X_1.X_2) = \sqrt{\sum_r^n (a_r(X_1) - a_r(X_{12}))^2} \quad (2)$$

X1 and x2 are two data sets with a total of n attributes, use the distance calculation x1 and x2 to find the distance between attribute values in the data sets x1 and x2. To determine the data classification, the euclidean distance is searched and the K value is selected from the euclidean results that have the lowest value and are closest to the data prediction. The largest class is taken as the final decision on da-ta classification.

E. Equation Fuzzy Logic

Before entering the fuzzy equation, we first determine the dataset variable with a crisp value which will later be converted into a fuzzy value (degree of membership) based on the membership function that has been determined. There are two membership functions on the input and one membership function on the output. Low, medium, and high membership functions are membership functions for the input. While for the output, the membership function is the mortality rate. The following is the fuzzification equation for each set:

$$\mu_{rendah}(X) = \begin{cases} 1, & jika\ x \leq a \\ \dfrac{a-x}{a}, & jika\ x > a \end{cases} \quad (3)$$

$$\mu_{sedang}(X) = \begin{cases} 0, & jika\ x < a\ atau\ x > b + (b-a) \\ \dfrac{x-a}{b-a}, & jika\ x \geq a\ dan\ x \leq b \\ \dfrac{(b+(b-a)) - x}{b-a}, & jika\ x > b\ dan\ x \leq b + (b-a) \end{cases} \quad (4)$$

$$\mu_{tinggi}(X) = \begin{cases} 1, & jika\ x \geq b \\ \dfrac{x-b}{b}, & jika\ x < b \end{cases} \quad (5)$$

After performing the formation of the fuzzy rule base, the next step is to change the results of the infer-ence (linguistic value) back into a crisp value (numerical value). By using the centroid method, at this stage it will calculate the weighted average of all crisp values based on their degree of membership. The following is the output equation as follows:

$$Output = \frac{\mu_{rendah}.45 + \mu_{sedang}.16 + \mu_{tinggi}.8}{\mu_{rendah} + \mu_{sedang} + \mu_{tinggi}} \quad (6)$$

After entering the calculation of the KNN equation and the Fuzzy equation, proceed to the next stage, namely combining the KNN and Fuzzy equations to optimize the Fuzzy K-Nearest Neighbors method

III. RESULT AND DISCUSSION

To run the comes about of this ponder, the creator employments a framework called Google Collab as the proper choice, since Google Collab is python-based, web-based without having to be introduced on a PC/Laptop and is simple to show with application back and information collected and stored on Google Drive to form it less demanding when calling the da-taset to the Google Collab framework. To create a duck passing forecast, one of the reference properties is required. The trait utilized is the real time as a name and the sum of preparing and testing information is decided by a proportion of 75:25, with the trust that the more preparing information, the higher the comes about will be gotten, particularly to make strides its exactness.

Before running scenarios 1 & 2, first separate the data that will be used for the output parameters. Namely population data, age, and feed usage will be used to predict duck deaths. continued with the results of extracting the duck death dataset using the death rate parameters, namely: a. Low with the provision of a death rate of 0-15, b. Medium with the provision of a death rate of 16-25, c. High with the provision of a death rate of 26-40, d. Very High with a mortality rate of 41 - ∞ animals.

A. Scenarios 1

The following are the results of testing the KNN algorithm, the results obtained are as follows:

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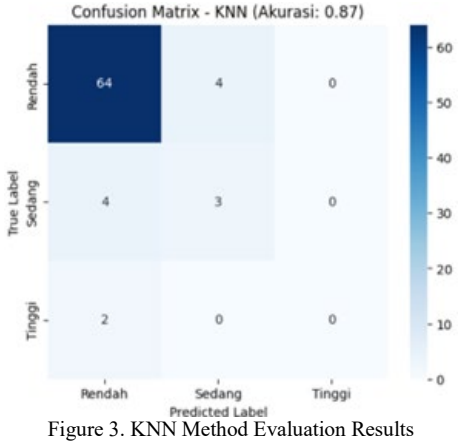

Figure 3. KNN Method Evaluation Results

B. *Scenarios 2*

Below we show the results of experiments using the fuzzy logic algorithm, the results obtained are as follows:

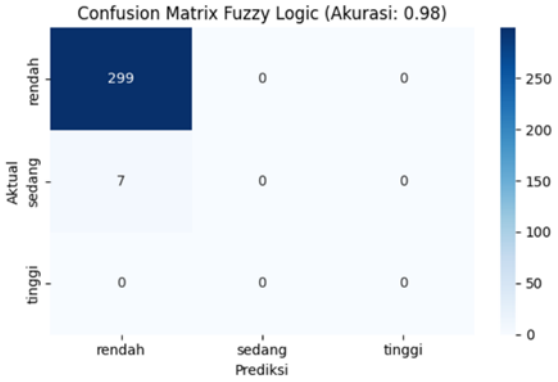

Figure 4. Fuzzy Logic Method Evaluation Results

C. *Scenarios 3*

Here we show the results of experiments using the fuzzy k-nearest neighbors algorithm after combining the knn and fuzzy algorithms. The following results were obtained:

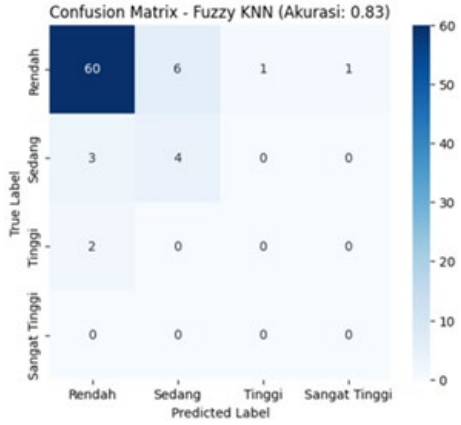

Figure 5. Fuzzy KNN Method Evaluation Results

The following are the results of the evaluation reading of the three methods that researchers have applied, and the results of the evaluation reading of the confusion matrix obtained.

TABLE 3
COMPARISON RESULTS OF THREE ALORITHM METHODS

Algorithm	Accuracy	Precision	Recall	F1-score
KNN	87%	91%	94%	93%
Fuzzy Logic	98%	98%	100%	99%
FKNN	83%	92%	88%	90%

Based on table 3, it is found that the fuzzy method has a superior level of accuracy among others, so that the KNN method can be optimized with the Fuzzy method. so that the FKNN method is more precise in data processing.

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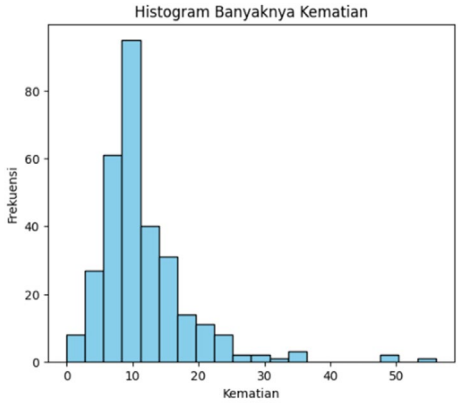

Figure 6. FKNN Algorithm Reading Prediction Results

The results of the production data analysis stated that the average death rate of meat ducks was 8 to 15 per day, and the highest death rate of ducks was in the age range of 1 to 10 days, which could reach 30 to 50 per day.

IV. CONCLUSION

A conclusion section Based on research similar to the fuzzy k-nearest neighbors algorithm clustering process to optimize the performance of meat duck production, the following conclusions can be drawn:

a) In general, taken from all test scenarios, fuzzy logic outperforms FKNN with the evaluation results obtaining an accuracy level of 98%.
b) The KNN algorithm was not successfully implemented because it achieved a high error value for reading data. This is due to the very irregularity of the processed dataset, which results in a low level of accuracy.
c) K-Nearest Neighbor is easy to implement so it is very sensitive to data distribution, if the data distribution does not match the probability assumptions used, KNN performance can decrease. In contrast to Fuzzy k-Nearest Neighbor, it is more resistant to data noise and is very suitable for data that has ambiguity or labels that are not completely clear so that it is handled better.
d) The FKNN method in the results of this study has a fairly good level of accuracy for clustering the level of broiler duck production. In addition, in this system, variations in the value of k, variations in the amount of training data and variations in the composition of training data affect the level of system accuracy

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