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Milkfish Prediction using Learning Implementation of Data Mining Analysis with Multiple Linear Regression Algorithm

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ABSTRACT: In the context of educational research, the development center has been established to address the challenges posed by the 4.0 era society in the industrial era 5.0. This center is particularly focused on the agricultural community, with a specific emphasis on the provision of side dishes by fishpond farmers in South Sulawesi. The objective is to ensure that the needs of the community are met in a sustainable and effective manner. The Republic of Indonesia has been identified as a consumer society that consumes fish and, in particular, milkfish. The issue that has been identified is a decline in the production of milkfish. The objective of this research is to furnish policymakers with the necessary information and to identify patterns that will facilitate the resolution of the imminent scarcity of milkfish in the coming years. Consequently, a data mining analysis learning technique is required to predict milkfish production and ascertain whether there will be an increase or decrease in production in the future. The objective of this study is to implement a data mining analysis by integrating multiple linear regression methods in the context of milkfish production prediction. The set of variables employed in this study encompasses independent variables, denoted as Xn, comprising feed, fertilizer, and seeds. It is imperative to note that the dependent variable, denoted by Yn, is production. The data presented herein has been obtained through a combination of field observations, library research, and interviews. The research methodology employed in this study involves a systematic data mining analysis of multiple linear regression algorithms. The results indicated that the prediction of milkfish production in 2022 was 5175 tons. The mean absolute percentage error (MAPE) value was determined to be 1.05%. This finding indicates that the prediction value is highly accurate, as evidenced by the coefficient of multiple determination, which is 95.94%. This suggests that the demand for milkfish as a side dish in the coming years is met, underscoring its role as a crucial source of nutrition for the community.

Keywords: Prediction, Milkfish production, Data Mining, Multiple Linear Regression, MAPE.

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1. INTRODUCTION

In the contemporary digital era, characterized by the fourth and fifth industrial revolutions, the evolution of education has undergone significant expansion in alignment with technological advancements. Vocational

education emerges as a prominent alternative, fostering the cultivation of proficiencies in the domain of technology. This encompasses information engineering majors who employ a synthesis of methodologies for addressing diverse transformation challenges or data processing, integrating logical processes. This fundamental notion underscores the imperative for meticulous attention to be accorded to the enhancement of human resources within the domain of agricultural education. This enhancement ought to encompass a range of critical areas, including, but not limited to, agricultural infrastructure, agricultural production systems, food security, and the well-being of farmers. This phenomenon is poised to exert a direct or indirect influence on a substantial proportion of the Indonesian agricultural sector, encompassing the domain of vocational education within the agricultural sector, a field characterized by its intricacy (Rahman et al., 2023). The mastery of data processing media, facilitated by the implementation of data mining analysis techniques—which constitute a subfield of information science—is instrumental in this regard.

The aforementioned concept serves as the foundation for researchers' predictions regarding milkfish production, a pivotal commodity. In the Pangkep district of South Sulawesi Province, the practice of fish pond cultivation has been a long-standing tradition among pond farmers. Pond farmers are defined as individuals engaged in the aquaculture industry, primarily focused on the cultivation of fish and other aquatic organisms. This definition is supported by Fahrudin's (2018) research, which asserts that pond farmers primarily derive their income from fish farming. The practice of fish pond cultivation in Pangkep Regency dates back to the Dutch colonial era, suggesting that the region's fish ponds are among the most long-standing in Indonesia. As stated in the 2016 study by Paena et al., the fish ponds have been in use until the present.

Pangkep Regency is a prominent milkfish production center in South Sulawesi, with a land area in 2020 of 2,344.63 million hectares. In 2021, the production yield of fish ponds was 2,947 tons, representing a decrease of 2.8 percent compared to the 2,228 tons produced in 2020. Rusinta (2022).

The yield of milkfish production is a highly malleable metric, which complicates the estimation of its financial return. The production of milkfish is often characterized by fluctuations in income, with periods of high, low, and even complete absence of revenue. In the context of social life, it is not feasible to ascertain and estimate all variables with the desired degree of accuracy and speed. Consequently, an assessment is required to determine the amount of milkfish production in the future. The factors that affect the production of milkfish include fertilizer, feed, and seeds. Utojo and Ratnawati (2016).

In the research conducted by Rahman et al. (2024) on "Implementation of Clove Production Estimation using Multiple Linear Regression Methods in West Seram Regency," the objective was to address the needs of cloves (Rahman et al.). In the year 2024, the implementation of clove production estimation was initiated, as well as research conducted subsequently by the same researcher with different objects on "Application of Multiple Linear Regression Methods to Predict Seaweed Harvest Yields" (Rahman et al., 2024). Predictions are made on an annual basis, and preparatory steps are taken if there is a decrease in cloves and seaweed. The findings of the empirical investigation employing data mining analysis with the multiple linear regression method demonstrate that prediction using multiple linear regression is feasible because the error rate is comparatively minimal.

In the preceding research by Panggabean et al. (2020), the objective was to utilize the application of data mining to predict tree seedling orders with multiple linear regression. The purpose of this research is to facilitate the prediction of seedling orders by employing SPSS software to assist BPDASHI.

The findings of the study indicate that the multiple linear regression method is the most effective approach for analyzing data, as it exhibits the lowest error rate. A study was conducted by Abd Rahman et al. (2025) on "The Implementation of Climate Change Analysis on Food Crop Production." The objective of the study was to determine the results of predicting the effects of climate change on rice production each year using multiple linear regression methods. The study found a strong correlation between rainfall and rice production.

The impetus for this study stems from the background and achievements of the phenomenon that occurred, as well as the main points of thought in the previous research. The objective of the present study is to conduct research entitled "Milkfish Prediction using Learning Implementation of Data Mining Analysis with Multiple Linear Regression Algorithm."

2. METHOD

The methodology employed in this study involves the implementation of multiple linear regression, a statistical technique that elucidates the interrelationship between the response variable (also designated as the dependent variable) and the factors that exert influence on more than one predictor (also termed the independent variable) (Rahman et al., 2024). This method involves the systematic collection of data and information through a series of stages. These stages include a literature study, interviews, and the analysis of references pertinent to the research. The data is then collected and analyzed to achieve the objective of predicting the effect of changes in the independent variable on the dependent variable in addressing the problem of predicting milkfish using the learning implementation of data mining analysis with a multiple linear regression algorithm.

Data Collection

The data collection process was executed at the Fisheries Service of Pangkep Regency, South Sulawesi Province. The utilization of secondary data is a hallmark of quantitative methods, encompassing numerical data derived from statistical patterns that delineate historical data from a prior period. The focal point of this method is the examination of alterations in patterns and the influence of disturbances, attributable to random factors of natural or human origin.

Data Mining

Data mining is a process that involves the extraction of meaningful information from large data sets. This process is closely related to data analysis and the utilization of specialized software that is designed to identify patterns or similarities within the data. One of the software algorithms employed in this technique is the multiple regression algorithm method. The underlying working principle of data mining software facilitates the extraction of previously unknown or invisible patterns. Data mining is defined as the process of examining data sets to identify unexpected relationships and condensing data in a manner that differs from previous methods and is comprehensible and beneficial to data owners.

Multiple Linear Regression

As posited by Adha and Utami (2022) and Abd Rahman et al. (2025), multiple linear regression is a form of regression analysis that describes the relationship between response variables (Xn/dependent variables) and factors that affect multiple predictors (Yn/independent variables). The objective is to express kelas as a linear combination of attributes, with predetermined weights, according to the following formula:

Y is expressed as a function of X_1 and X_2, with $Y = a + b_1.X_1 + b_2$. The production quantity prediction result, denoted by Y, is expressed as follows:

$Y = X_2 + b_3.X_3 + bn.Xn$

where X_1, X_2, ..., Xn represent the independent variables, and Y is the dependent variable.

The constant a is defined as the value of Y when X_1, X_2, ..., Xn are equal to 0.

The regression coefficient b is defined as the value of the increase or decrease.

X_1 = feed

X_2 = fertilizer

X_3 = seedlings

Multiple correlation (R) and the coefficient of determination (R^2) are to be calculated. The following formula is employed for the calculation of multiple correlation and the coefficient of determination:

Admirani et al. (2020) (Rahman, 2013)

$ry(123) = (b_1 \varepsilon X_1 y + b_2 \varepsilon X_2 y + b_3 \varepsilon X_3 y)/(\varepsilon Y_2)$ (Rahman, 2013)

Accuracy Testing

The precision of a prediction is contingent upon the discrepancy between the forecast data and the actual data. There are multiple methodologies for calculating the error in the accuracy of a forecast or prediction. The mean absolute percentage error (MAPE) is one such method. The formulation of the testing equation using the

maximum absolute percentage error (MAPE) is presented in equation 4 below. Adha, M., & Utami, E. (2022).

$$\text{MAPE} = \frac{|\,Aktual\ t - Prediksi\ t|}{Aktual\ t} \text{x } 100\ \%.$$

The interpretation of the mean absolute percentage error (MAPE) value can be used as a measurement of the ability of a prediction model. It is evident that the magnitude of the MAPE value directly correlates with the extent of the error in prediction results. In essence, a smaller MAPE value indicates a smaller error in prediction results, while a larger MAPE value corresponds to a larger error in prediction results. As illustrated in Table 1.1, these values are evident.

Table 1. MAPE Value for Prediction Evaluation

MAPE Value	Prediction Accuracy
<10%	Excellent prediction
10-20%	Good prediction
20-50%	Feasible Prediction
>50%	Bad predictions

3. RESULTS AND DISCUSSION

Definition of Forcasting

Forecasting is defined as the estimation of future events. The ability to predict is an essential component of effective decision-making. The function of a prediction will be evident when making a decision. A "good" decision is one that is based on what will happen when the decision is implemented. In the event that the prediction results are found to be inaccurate, the prediction period is also a period that must be faced. (Sucipto & Syaharuddin, 2018).

Predictions, by their very nature, are generally based on past data that has been analyzed using specific methods. The collection, study, and analysis of historical data is a process that seeks to establish correlations between past events and future outcomes. While the precision of predictions may not match that of a perfect estimate, they offer the ability to foresee a range of future circumstances. Fauziah et al. (2019).

Definition of Milkfish

Suradi et al. (2017) posit that milkfish is among the most popular fish in Indonesia. In Indonesia, the fish is referred to by another name. In the Bugis and Makassar languages, it is referred to as "ikan bolu." Milkfish are piscivorous fish that typically forage for food on the surface of bodies of water. Their diet consists of sea grass, plankton, and other small organisms such as worms.

Sciaenidae, more commonly referred to as milkfish, is a fish species that possesses the remarkable capacity to inhabit a variety of habitats, including both freshwater and brackish waters during its developmental stage. The milkfish (Chanos chanos) is characterized by a long, slender body shape, a flat and dense texture, and a torpedo-like shape that facilitates rapid movement. Milkfish exhibit a tendency to forage for sustenance on the surface of the ground or the walls of the layers. The diet of these fish is comprised of oceanic sources, including plankton, shrimp, microorganisms, and aquatic plants (Vatria, 2013; Asriadi, A., et al., 2024).

Data Findings

The following data, which was obtained from the Pangkep Regency fisheries department, is indicative of the actual data found in the department:

Table 2. Data Aktual Ikan Bandeng

Period		Fertilizer (Ton)	Feed (Ton)	Seeding (Ton)	Production (Ton)
Moon	**Year**	**X1**	**X2**	**X3**	**Y**
January	2020	180	270	1712	184
February	2020	181	273	1727	185
March	2020	182	274	1733	186
April	2020	182	274	1737	186
May	2020	181	273	1727	185
June	2020	180	271	1713	184
July	2020	180	271	1715	184
August	2020	180	271	1718	184
September	2020	182	274	1733	186
October	2020	183	275	1741	187
November	2020	184	277	1751	188
December	2020	185	279	1765	189
January	2021	163	246	3787	234
February	2021	158	238	3672	227
March	2021	147	221	3408	210
April	2021	177	267	4116	254
May	2021	159	239	3681	228
June	2021	174	262	4030	249
July	2021	209	314	4840	299
August	2021	187	282	4347	269
September	2021	184	276	4258	263
October	2021	159	239	3688	228
November	2021	182	274	4218	242
December	2021	158	237	3655	244

Result

The term "results" is used to denote the various stages that comprise the design process or system testing. The ensuing findings were derived from the empirical investigation reported herein.

Multiple Linear Regression Calculations

In this regression calculation, production data from 2020 to 2021 was utilized, yielding a total milkfish production of 5,175 tons.

During the data processing stage, data selection is implemented with the objective of ensuring that the data corresponds to the anticipated type. The methodology employed in this study is the initial multiple linear regression approach. The parameter data (test data/actual data) is displayed in Table 2 above. Subsequently, the data is modeled and the data record is calculated by listing the data based on each column. The findings of the training data summarization calculation are presented in Table 3 below.

Table 3. Data Training

Data	Value
N	24
Y	4237
X_1	6377
X_2	68472
X_3	5175
$X_1.Y$	914232
$X_2.Y$	1375914
$X_3.Y$	15670341
$X_1.X_2$	1131774
$X_1.X_3$	12026815
$X_2.X_3$	18099125
X_1^2	751967
X_2^2	1703421
X_3^2	227335174
Y^2	1143597

Subsequently, the constant value and the coefficient of the determinant of matrices A, A1, A2, and A3 must be calculated. This calculation is the result of the following analysis.

Tabel 4 . Results of Matrix Determinant Calculation

Description	Result
Det (A)	15231188210148
Det (A1)	346297278747184
Det (A2)	76809121724877
Det (A3)	-44771486702985
Det (A4)	446573581230

Subsequently, the values of a, b_1, b_2, and b_3 are obtained from the calculation of the determinant matrix above.:

$$a = \frac{346297278747184}{15231188210148} = 22{,}736$$

$$b_1 = \frac{76809121724877}{15231188210148} = 5{,}043$$

$$b_2 = \frac{-44771486702985}{15231188210148} = -2{,}939$$

$$b_3 = \frac{446573581230}{15231188210148} = 0{,}029$$

Subsequent to the acquisition of the determinant values of a, b_1, b_2, and b_3, the multiple linear regression equation is derived as follows::

$Y_1 = a + b_1.1 + b_2.2 + b_3.3$

Y = 22,736 + 5,043 * 4237 + -2,939 * 6377 + 0,029 * 68472.

Predictive Results Testing and MAPE

In order to predict the results of milkfish production, it is necessary to test these results. The prediction results are displayed in the following table.

Table 5. Milkfish Prediction Results

Period		Fertilizer (Ton)	Feed (Ton)	Seeding (Ton)	Production (Ton)
Moon	**Year**	**X1**	**X2**	**X3**	**Y**
January	2020	180	270	1712	184
February	2020	181	273	1727	185
March	2020	182	274	1733	186
April	2020	182	274	1737	186
May	2020	181	273	1727	185
June	2020	180	271	1713	184
July	2020	180	271	1715	184
August	2020	180	271	1718	184
September	2020	182	274	1733	186
October	2020	183	275	1741	187
November	2020	184	277	1751	188
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January	2021	163	246	3787	234
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August	2021	187	282	4347	269
September	2021	184	276	4258	263
October	2021	159	239	3688	228
November	2021	182	274	4218	242
December	2021	158	237	3655	244

Table 6. Milkfish Prediction Results

Period	Original Data	Predictions	Error	MAPE
	A_t	F_t	A_t-F_t	I (A_t-F_t)/At*100
January	184	187	-3	2
February	185	184	1	1
March	186	186	0	0
April	186	186	0	0
May	185	184	1	1
June	184	184	0	0
Juli	184	184	0	0
August	184	184	0	0
September	186	186	0	0
October	187	188	-1	1
November	188	188	0	0
December	189	187	2	1
January	234	233	1	0
February	227	228	-1	0
March	210	214	-4	2

Period	Original Data	Predictions	Error	MAPE
	A_t	F_t	A_t-F_t	I (A_t-F_t)/At*100
April	254	251	3	1
May	228	230	-2	0
June	249	248	1	0
July	299	296	3	1
August	269	264	5	2
September	263	264	-1	0
October	228	230	-2	1
November	242	259	-17	7
December	244	230	14	6
Average value				**MAPE 1,5 %**

Correlation Values

The following formula will be used to calculate the value of the correlation between variables X_1, X_2, and X_3 on the production variable (Y):

where Y is the production variable, X_1, X_2, and X_3 are the independent variables, and β is the coefficient of determination.

The following formula can be used to calculate the correlation value::

ry(123) = (b_1 ε X_1 y+b_2 ε X_2 y+ b_3 ε X_3 y)/(ε Y_2)

ry(123)((5,043*628,8750)+(-2,939*873,3750)+(0,029*906066))/(27737,62500)

ry(123) = 0,97952

Coefficient of determination (R2) =(0,97952)2 *100= 95,94665

The findings of the correlation calculation can be elucidated as follows. In order to ascertain the extent to which the variables of fertilizer (X_1), feed (X_2), and seedlings (X_3) exert an influence on production (Y), it is necessary to examine the double correlation coefficient R and the coefficient of determination (r^2). The obtained value of ry (123) is 0.97952. This indicates the presence of a robust correlation coefficient, with a value ranging from 0.80 to 1.0, as indicated by the conclusion of the correlation analysis. The value of the coefficient of multiple determination is obtained at 95.9466%..

4. CONCLUSIONS AND SUGGESTIONS

Following the collection of relevant data and its subsequent processing, the prediction of milkfish production volume can be made. This analysis will describe the extent to which the increase or decrease in milkfish production volume in Pangkep Regency, which is one of the primary fish production areas in central Indonesia, is predicted to change in 2022. The predicted amount of milkfish production in 2022 is 5175 tons. The mean absolute percentage error (MAPE) value is 1.05%, indicating that the prediction value is highly accurate. The double coefficient of determination is 95.9466%, suggesting a strong correlation between the model's predictions and the observed data.

Tabel for Reviewer 1st and 2nd

Given/First Name *)	:
Middle Name	:
Family/Last Name *)	:
Degree	:

Research Specialties :

Institution :

Department :

E-mail *) :

Reason :

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