Multiple Linear Regression Modeling of Brachen Water Quality Parameters for Vannamei Shrimp Cultivation

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Abstract: In succeeding the government plans to increase shrimp exports by 250% in 2024, the Ministry of Maritime Affairs and Fisheries has formed a Strategic Plan, which includes One of them is the Revitalization of Ponds in Shrimp and Milkfish Production Centre Areas, one of the goals is to increase shrimp export growth by 8% annually. Intensive pond management in shrimp cultivation has several parameters that need to be considered including pH, dissolved oxygen, temperature, and salinity. Based on the normality test in this research shows the P-Value values for temperature, salinity, pH, and DO data.[a] Each is 0.035; 0.188; 0.083; 0.2. If the P-Value is more than 0.05 means that the salinity, pH, and DO variables are normally distributed. Based on the simultaneous test, it can be seen that the value of Fcount is 596,646 and Ftable with degrees of freedom (df), for df1 = 4 and df2 = 53. Thus, Fcount > Ftable so that H0 is rejected, meaning that the variables temperature, salinity, pH, and DO have a jointly significant effect on the shrimp age variable.

1 INTRODUCTION

In succeeding the National Development Agenda, in which the government plans to increase shrimp exports by 250% in 2024, the Ministry of Maritime Affairs and Fisheries has formed a Strategic Plan for the Ministry of Maritime Affairs and Fisheries, which includes Major Projects. One of them is the Revitalization of Ponds in Shrimp and Milkfish Production Centre Areas, one of the goals is to increase shrimp export growth by 8% annually. Total shrimp production in 2019 was 517,397 tons a year, while the expected increase in shrimp production in 2024 was 772,608 tons (Kementrian Koordinator Bidang Maritim dan Investasi Deputi Bidang Koordinasi Sumber Daya Maritim, 2020).

In shrimp cultivation, choosing the type of shrimp is very important to get more efficient pond results. According to Dermawan (2004) and Riani, et al (2012) vannamei shrimp have advantages over other types of shrimp, including being able to produce larger production of up to 10-20 tons per hectare, vannamei shrimp can be harvested faster (<120 days), vannamei shrimp are more resistant to disease, and vannamei can live in more open spaces. In addition to the type of shrimp, pond management methods also greatly affect the production of ponds, and shrimp pond management methods are carried out conventionally or intensively.

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In intensive pond management, there are several parameters that need to be considered to maintain water quality, good water quality will greatly affect pond production, and parameters that must be maintained include pH, dissolved oxygen, temperature, and salinity. This data was measured using a dissolved oxygen meter to measure dissolved oxygen levels, a thermometer to measure water temperature, a refractometer to measure water salinity, and a pH meter to measure the pH value in ponds. These parameters are used as primary data to be analyzed using multiple linear regression.

2 MATERIALS AND METHODS

2.1 Vannamei Shrimp Habitat

Shrimp is a type of animal that lives in waters, especially rivers, seas, or lakes. Shrimp can be found in almost all large "puddles" of water, both freshwater, brackish water, and saltwater at varying depths (0.5-1.5 meters), from near the surface to several thousand meters below the surface (1, 1-1.5 meters). Shrimp is usually used as seafood (seafood) (Dermawan A. & Herman, 2004). Water as a medium in which aquatic organisms live needs to be maintained in terms of quality and quantity because it affects the lives of these organisms. Water quality includes the physics and chemistry of water, including ammonia, temperature, pH, and dissolved oxygen (DO), all of which are related to fish production. A bad environment or sudden changes trigger fish to experience stress so that they are susceptible to parasitic and non-parasitic diseases, even death is possible. Several parameters of water quality in a pond expanse in the form of living elements, both flora, fauna, and humans, form a biological environment (biotic). While non-living elements (physics-chemical components) are non-living (abiotic) environments, attention must be paid to support the life of the organisms in them, including natural shrimp, including Physical Environmental Parameters (Tides, Water Temperature, Salinity, Brightness). Water Chemical Parameters (Dissolved Oxygen, Acidity, Nitrates, Phosphates) and Biological Parameters (Plankton). A good environment for cultivation is when these factors affect each other in balance and at optimal concentration conditions (Raharjo, 2003).

2.2 Parameter

Parameters in measuring the quality of brackish water in vannamei shrimp cultivation are classified into 2, namely physical and chemical parameters, as follows:

2.2.1 Physics Parameters

a) Temperature
According to Haliman and Adijaya (2005), the optimal temperature for shrimp growth is between 26º-32º C. If the temperature is more than the optimum number, the metabolism in the shrimp's body will take place quickly. At temperatures below 25º C, the shrimp's appetite decreases, corrective actions needs to applied, so that their appetite improves and their body's resistance increases.
b) Salinity
Salinity is one aspect that plays an important role because it affects the growth of shrimp. In general, shrimp have a salinity range of 15-25 ppt so that their growth can be optimal (Haliman dan Adijaya, 2005).

2.2.2 Chemical Parameters

a) pH
pH is the degree of acidity of pond water, the ideal pH is between 7.5 - 8.5. Generally, the pH of pond water in the afternoon is higher than in the morning. Conversely, in the morning, CO2 is abundant because of shrimp breathing (Haliman dan Adijaya, 2005). If the pH is too high (more than 8) then the toxicity of ammonia increases. Therefore, it is important to maintain the pH of the water in the recirculating system at around 7.2 in fresh water and 7.8-8.2 in seawater. (Forteath et al .,1993). A good pH value for an intensive system is 6.5-9 (Wedemeyer, 1996). pH values less than 6.0 and more than 9.0 for a long time will interfere with reproduction and growth (Boyd, 1982).
b) Dissolved Oxygen (DO)
Vannamei shrimp can grow and reproduce at an oxygen content of 4-5 ppm. During the day the pond will have DO numbers which tend to be high due to the process of photosynthesis of plankton which produces oxygen. The opposite situation occurs at night (Haliman dan Adijaya, 2005).

2.3 Measuring Instrument Parameter

2.3.1 Dissolved Oxygen Meter D-5519

This tool (fig.1) is a measuring device for oxygen and temperature for the specifications of the tool as follows in table 1 :

Figure 1: Dissolved Oxygen Meter.

Table 1: Oxygen Meter Specifications.

Dissolved Oxygen	0-20 mg/L
Temperature	0 – 50
Accuracy Oxygen	0,4 mg/L

2.3.2 Refractometer Salinity

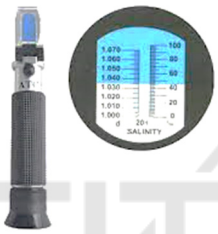

Figure 2: Salinity Refractometer.

A refractometer (fig.2) is a tool for measuring salinity in a pond with the following specifications as shown in table 2 :

Table 2: Salinity Refractometer Specifications.

Measurement Range	0 – 10% ; 1000 -1070 SG
Measurement Accuracy	0,1%

2.3.3 Lutron pH 224

Figure 3: Lutron pH 224.

Lutron pH 224 (fig.3) is a digital pH meter that measures the quality of brackish water in vannamei shrimp ponds with the following specifications:

Table 3: Lutron pH 224 specifications.

Measurement Range	0 – 14 Ph
Resolution	0,01 pH
Accuracy	+- 0,2 pH

2.4 Multiple Linear Regression Method

Multiple linear regression is an algorithm used to explore the relationship pattern between the dependent variable and two or more independent variables (Uyanik & Guler, 2013). The use of multiple linear regression methods has an influence on the quality of brackish water in vannamei shrimp cultivation. Therefore, in this study, multiple linear regression was used to test the correlation between DO and age parameters.

2.5 Variable Identification

Variable identification is the stage of determining the dependent variable and independent variables based on data obtained from vannamei shrimp ponds.

2.6 Data Analysis

At this stage, classical assumption testing and hypothesis testing carried out with SPSS 25 tools.

2.6.1 Classical Assumption Testing

This test consists of a normality test. The requirement to get a good regression model is that the data distribution is normal or close to normal. If the data is not normally distributed, it is necessary to transform the data first.

2.6.2 Hypothesis Test

From testing the classical assumptions on the normality test, the next step is to find out whether the proposed hypothesis is accepted or not, namely by conducting a simultaneous test (F test). The F test carried out to find out whether the independent variable has a significant effect on the dependent variable or not.

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2.7 Multiple Linear Regression Determination

The next step is to determine the coefficients or regression parameters with multiple linear regression methods.

Multiple linear regression, forecasting the dependent variable Y is obtained by forming an equation that relates more than one variable M. Bayu Nirwana (2021), namely X1, X2, ..., Xn. In general, the multiple regression equation formulated by (Y. A. Ryan, 2022):

$$Y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_n x_n + e \quad (1)$$

Calculations were carried out with the help of SPSS 25 tools. If the calculation results are close to 1, it means that the influence of the independent variable on the dependent variable is large Farizal (2020), Ahmad M. A. Zamil (2021), Yasaman Ensafi (2022), Zhi-Ping Fan (2017). Therefore, the model used is good for explaining the influence of these variables.

3 RESULT AND DISCUSSION

3.1 Variable Identification

The data used is monthly data, which totals 58 data. The dependent variable in this study is the age of the vannamei shrimp while the independent variables are pH, salinity, DO, and temperature.

3.2 Data Analysis

Data analysis used in this study is Classical Assumptions Test.

3.2.1 Normality Test

The normality test uses the Kolmogorov-Smirnov (K-S) test with the help of SPSS 25 tools. The normality test results for temperature data shows in the following figure :

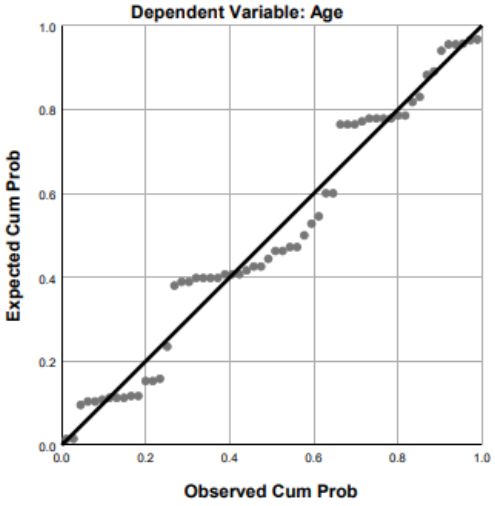

Figure 4: The temperature normality test.

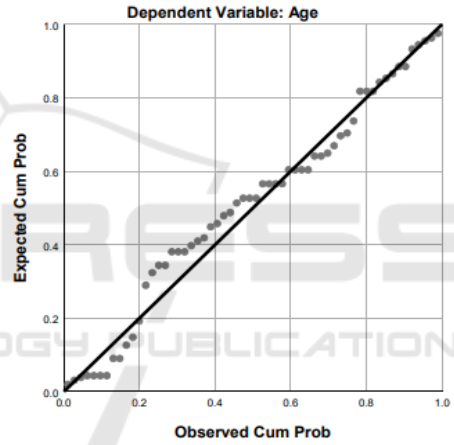

Figure 5: The Salinity normality test.

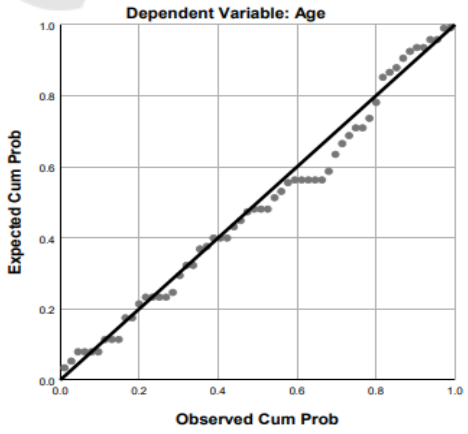

Figure 6: The pH normality test.

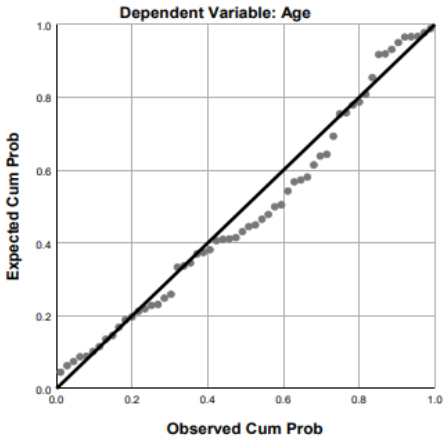

Figure 7: The DO normality test.

Based on Fig. 4, 5, 6, 7 P-Value values for temperature, salinity, pH, and DO data. Each is 0.035; 0.188; 0.083; 0.2. If the P-Value is more than 0.05. This means that the variables of salinity, pH, and DO have a normal distribution, while the temperature variable is not normally distributed.

3.2.2 Hypothesis Testing

Simultaneous Test (F test); the results of processing the data for the F test with the SPSS 25 tools presented in the following table:

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2386.585	4	596.646	18.856	.000[b]
	Residual	1677.040	53	31.642		
	Total	4063.625	57			

Figure 8: Simultaneous Test (f test).

The initial hypothesis and the alternative hypothesis on the F test are:

H0: the variables of temperature, salinity, pH, and DO not have a significant effect on productivity variables together.

H1: the variables temperature, salinity, pH, and DO have a significant effect on the variable age together.

Based on Fig. 8, it can be seen that the value of mean square is 596,646 and Ftable with degrees of freedom (df), for df1 = 4 and df2 = 53. Thus, Fcount > Ftable so that H0 is rejected, meaning that the variables temperature, salinity, pH, and DO have jointly significant effect on the age variable.

3.2.3 Regression Modelling

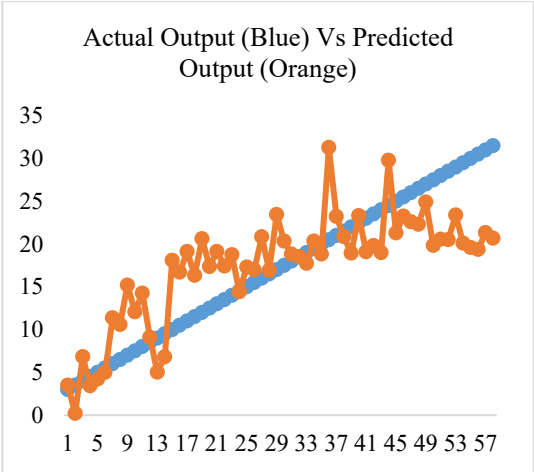

Figure 9: Regression Modelling.

Regression modeling of brackish water quality on the growth of vannamei shrimp culture with the equation:

$$Y = 152.172 + 0.682X_1 + 0.622X_2 - 10.479X_3 - 11.003X_4 \quad (2)$$

The equation is obtained from the results of multiple linear regression tests with X_1: temperature, X_2: Salinity, X_3: pH and X_4: Dissolved Oxygen. Of the four water quality parameters that are positively correlated with shrimp age are temperature and salinity, while negatively correlated are pH and Dissolved oxygen. From the modeling results, the dominant influence of brackish water quality parameters is pH and Dissolved Oxygen. The modeling results in Fig. 9 describe the dependent variable, namely age as a parameter of shrimp growth which is obtained from the regression equation formula between actual Y and predicted Y with an RMSE value of 5.37. From the RMSE value obtained, it means that the prediction results are still not far from the actual results for the age of vannamei shrimp growth.

4 CONCLUSION

Based on the tests and analyzes that have been carried out, the following conclusions are obtained:

1. The data from the P-Value test for the salinity variable is 0.188, while the pH variable = 0.083, and DO = 0.2, which means that the values for these variables are normally distributed. Meanwhile, the P-Value for the temperature

variable is 0.035, which means that the temperature variable is not normally distributed.

2. Multiple linear equations can be formulated by $Y = 152.172 + 0.682X_1 + 0.622X_2 - 10.479X_3 - 11.003X_4$. So that the X_4variable, namely DO, has the greatest influence on the age of the shrimp, and salinity has the least effect on the age of the shrimp.
3. Multiple linear regression modeling has RMSE value at 5.37. From the RMSE value obtained, it means that the prediction results are still not far from the actual results on the age of vannamei shrimp growth.

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