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Mitigation of The Risk of Failed Harvest Pond Farming Fisheries Using the Calculating of the Premium Through the Approach to the Principle of Expectation Value

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Abstract

Pond cultivation is a promising business to be engaged in at this time, the demand for fish in the market is high, it opens opportunities for entrepreneurship in the field of fish cultivation. It is undeniable that several factors will cause crop failure in fish farming, both from weather factors and in the livestock process. If such an unexpected thing happened, the cultivators would be slightly affected. Therefore, there is a need for special insurance to protect farmers from financial losses due to possible risks, namely Fishery Microinsurance. This study aims to determine a reasonable amount of insurance premiums for small-scale shrimp pond aquaculture cultivators using the expectancy value principle calculation method. The data on the number of events uses the Poisson distribution, while the loss data uses the Exponential distribution in Pandeglang Regency. Next use the Maximum Likelihood Estimation method to calculate the parameter estimate. After that, the results of the parameter estimation are used to search for a collective risk model. Thus, the result of the premium calculation in this study was Rp 25.893.046.

Keywords: Fishery Micro insurance, Premium Calculation, Poisson Distribution, Exponential Distribution, Principle of The Expected Value.

1. Introduction

Indonesia has rich and potential fishery resources, both from marine fisheries, public waters, and aquaculture (Sari, 2020). From the statistical data, it can be seen that the total fishery production in Indonesia is currently around 4.8 million tons per year. Of this amount, around 78% or approximately 3.7 million tons are the result of production from the marine fisheries sector. Of the total production of marine fish and fresh fish of around 4.8 million tons, only 0.6 million tons were exported abroad. In 1997 the fisheries sector was able to collect foreign exchange worth US$ 2.05 billion, an increase from the previous year which only reached US$ 1.9 billion (Dewi Wuryandani, 2011). This shows the high interest of fishery business actors in developing their business, especially in the pond culture fishery sub-sector, one of the areas that has a high interest in harvesting pond aquaculture, namely the Banten region, especially Pandeglang district.

This research on microinsurance was previously conducted by Pratiwi, et al (2013) with the title Calculating of The Size of Risk for The Aggregate Loss Model which explained modeling natural disaster insurance premiums based on aggregate losses so that an appropriate premium is obtained which is to find out the calculation of insurance premiums through the calculation of the principle of expected value, as well as the needs and opportunitiesfor insurance for fishermen in the Caribbean and fishermen's assets that can be guaranteed, as well as Riaman, et al (2013) with the title Analysis of the Collective Risk Model in Credit Life Insurance Using the Aggregated Claims Model.

Based on the explanation above, the purpose of this research is to determine the estimated number of shrimp ponds with crop failure and losses due to crop failure, as well as determine the amount of microinsurance premium for shrimp ponds to be paid using the expectation principal approach. The results of this study can be used by insurance companies as a consideration for determining the amount of insurance premiums for shrimp ponds in Pandeglang district.

2. Literature Review

2.1. Micro Insurance

Micro insurance is an insurance product designed to provide protection against the financial risks faced by people with low incomes (Cohen & Sebstad, 2005).

2.2. Pricing Micro Insurance

Pricing refers to the process of establishing the premium rate for an insurance product. Generally, the premium rate needs to be determined in a way that ensures the total value of all premiums received over the coverage period will be enough to cover future claims expenses (Garand, 2012).

2.3. Risk Management

The focus of risk management is to identify risks and take appropriate action against them, with the aim of continuously creating or increasing maximum value from all activities, including the aquaculture industry (Power, 2009).

2.4. The Poisson Distribution

1) The random variable N has a Poisson distribution with λ as a parameter, the probability function:
$$P(N=x)=e^{-\lambda}\frac{\lambda^x}{x!} \tag{1}$$
2) For the moment generating function:
$$M_N(t)=\exp\{\lambda(e^t-1)\} \tag{2}$$
3) The expectation is the first derivative of the moment generating function with $t=0$
$$E(N)=\lambda \tag{3}$$
4) For the variance equation:
$$Var(N)=\lambda \tag{4}$$

2.5. The Exponential Distribution

1) The random variable X has a Poisson distribution with μ as a parameter. The probability function:
$$f(x)=\frac{1}{\mu}\,e^{\left(-\frac{x}{\mu}\right)} \tag{5}$$
2) The moment generating function:
$$M_x(t)=\frac{1}{1-\mu t} \tag{6}$$
3) For the expectation equation:
$$E(X)=\mu \tag{7}$$
4) For the variance equation:
$$Var(X)=\mu^2 \tag{8}$$

2.6. Kolmogorov-Smirnov Distribution Conformity Test

The Kolmogorov-Smirnov test measures the greatest absolute disparity between the cumulative distribution function $F_0\,(x)$ of a population and the empirical distribution function $F_n\,(x)$ of a sample which is the empirical distribution function of the sample:
$$D=\max\{|F_k(x)-F_0(x)|\} \tag{9}$$
The hypothesis:
H_0 : data has the same distribution as theoretical distribution
H_1 : the data is not distributed the same as the theoretical distribution

The decision criterion is that if $D<D_{table}$ then H_0 is accepted, which means that the observed sample distribution has the same distribution as the theoretical distribution (Antoneli, 2018).

2.7. Maximum Likelihood Estimation

Each distribution uses the MLE method to estimate its parameters. From this process, the results obtained are (Myung, I. J. 2003):

1) Poisson distribution parameters

$$\hat{\lambda}_{MLE} = \frac{\sum x_i}{n} \quad (10)$$

2) Exponential distribution parameters

$$\hat{\mu}_{MLE} = \bar{x} \quad (11)$$

2.8. Collective Risk Model

The sum of individual claims up to time is defined $S(t)$

$$S(t) = \sum_{i=1}^{N} X_i \quad (12)$$

Where N is a random variable that states the number of events that cause losses, and X which states the amount of losses received (Cossette, 2019). Expectations and variances of aggregate losses can be calculated by the following equation:

$$E(S) = E(N)E(X) \quad (13)$$

$$Var(S) = E(N)Var(X) + Var(N)\big(E(X)\big)^2 \quad (14)$$

2.9. Premium Calculation Model

The premium calculation is based on the expected value principle based on the pure premium multiplied by the loading factor. Mathematically formulated mathematically formulated as in the equation (Galeotti,. 2013):

$$p(t) = (1 + \alpha)E(S) \quad (15)$$

With $0 < \alpha < 1$.

3. Materials and Methods

3.1. Materials

The research object used in this study is to determine the microinsurance premium for shrimp ponds in Pandeglang Regency using the expected value principle approach. The data used is primary data in the form of loss of income for shrimp ponds if there is a crop failure in Pandeglang Regency from 1 January 2017 to 1 January 2021. Data collection was obtained through a survey, namely by distributing questionnaires to shrimp ponds in Pandeglang Regency.

3.2. Methods

The initial step taken in this study was to collect data in the form of the number of shrimp ponds experiencing crop failure and the magnitude of the loss of pond income if there is a crop failure that occurs in Pandeglang Regency.

Based on the data obtained from the survey results that have been conducted, then data analysis is carried out in the form of a premium calculation model through the expected value principle approach which forms the basis of the method used to calculate microinsurance premiums for shrimp ponds in Pandeglang Regency. Starting with testing the suitability of the existing distribution using the Kolmogorov Smirnov test for data that is continuously and discretely distributed, then proceed with estimating the parameters of the distribution of data with the Maximum Likelihood function, to get a large premium. Easy fit software and Microsoft Excel are used to speed up and simplify the calculation process. The following is the data on the average number of incidents and the number of losses in shrimp ponds due to crop failure per year used in Table 1:

Table 1: Average Number of Incidents and Shrimp Farm Losses in case of crop failure Per year

No	Year	Average Number of Events	Average Loss Amount
1	2017	1.94	11,683,462.01
2	2018	2.06	12,348,628.13
3	2019	2.06	11,853,204.00
4	2020	2.1	12,980,280.10
5	2021	2.04	12,434,251.88

4. Results and Discussion

For data the number of events is assumed to have a Poisson distribution, and the data for the magnitude of losses is assumed to have an exponential distribution. This assumption is proven by modeling the data with histogram graphs using Easy fit software as Figure 1 and Figure 2:

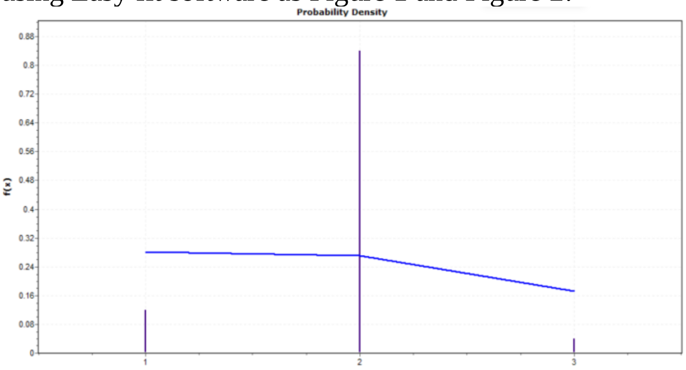

Figure 1: Data on The Number of Events

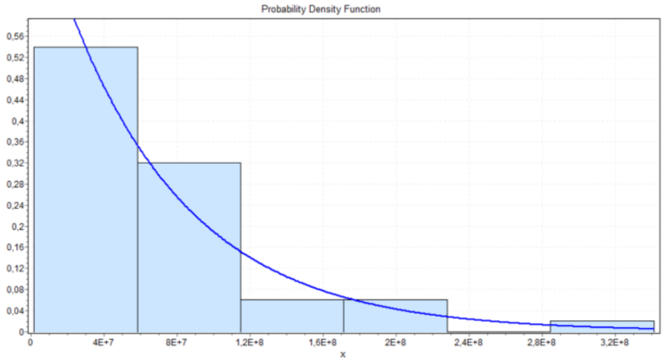

Figure 2: Data Loss Amount

The subsequent stage involves determining the parameters for every data distribution. The process of parameter estimation was performed utilizing the Maximum Likelihood Estimation (MLE) technique. The parameter λ is employed for estimating numerous events resulting in losses, while the parameter μ is utilized for estimating the magnitude of the losses incurred.

$$\hat{\mu}_{MLE} = \frac{\sum_{i=1}^{49} x_i}{49} \tag{16}$$

$$\hat{\mu}_{MLE} = \bar{x} \tag{17}$$

Based on the data that given in Table 1, the values of each parameter that calculated by using equations (16) and (17) is:

$$\lambda = 1.92$$

$$\mu = 12,,259,965$$

After that, the calculation of the amount of individual losses is carried out by estimating the expected value and variance of the data on the amount of loss. For data contained many event that cause losses, $E(N) = \lambda$ and $Var(N) = \lambda$. For data contained the amount of losses received, $E(X) = \mu$ and $Var(X) = E(X^2) - \left(E(X)\right)^2$. The result is:

$$E(N) = 1.92$$
$$Var(N) = 1.92$$
$$E(X) = 12,259,965$$
$$Var(X) = 150,306,741,801,225$$

So, the values of the collective risk model that calculated by using equations (13) and (14) are:

$$E(S) = 23,359,133$$
$$Var(S) = 288,588,967,797,484$$

After obtaining an estimate of the collective loss risk value from the loss data, it is then used to determine the amount of premium that must be paid by the shrimp pond. Calculations using the principle of expected value based on equation (15) the result is:

$$p(t) = 23,893,046$$

5. Conclussion

Parameter estimates are used to determine the expectations and variances of individual risk models. After that, the results of the individual risk model are used to find the value of the collective risk model and calculate the premium. The premium calculation results are used as a reference for insurance companies in determining the amount of microinsurance premiums that must be paid by shrimp ponds. The premium value generated is IDR 153,861,958.00 annually.

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