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Risk Prediction and Estimation of Corporate Product Claim Reserve Funds in Insurance Companies Using the Extreme Value Theory

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Abstract

Every human action involves risk, and in the insurance industry, customer claims are the biggest risk that companies face. This risk must be managed effectively through claim prediction, especially for corporate products. This research analyzes the risk of claims at insurance companies using the Extreme Value Theory (EVT) method, which can estimate extreme risks. Identification of extreme values in claims data is done through the EVT approach, namely Block-Maxima (BM). Generalized Extreme Value (GEV) distribution parameter estimation is performed, followed by prediction of claim risk using Value at Risk (VaR) and estimation of claim reserve funds. The results show that the GEV approach with a 95% confidence level is most suitable for predicting claim risk. Based on these results, the company requires a claim reserve fund of IDR 100,798,248,000 to deal with potential losses due to extreme claims.

Keywords: Claim risk, Insurance, Extreme Value Theory (EVT), Block-Maxima (BM), Value at Risk (VaR), Estimation of reserve funds

1. Introduction

Every action in human life will not be separated from risk over time. Risk as uncertainty that has the potential to cause losses is the core of business activities, especially in the insurance industry. Salim (2007) defines risk as uncertainty that may lead to a loss event. This definition is in line with Brigham and Houston's (2001) understanding that risk is a condition that is faced with loss or accident.

In the context of insurance, the most significant risk is the claim filed by the customer. Law No. 2 of 1992 on Insurance emphasizes that loss insurance is a business that provides risk coverage services for losses or loss of benefits arising from uncertain events. Therefore, the ability of insurance companies to predict and manage the risk of claims is a key factor in the sustainability of their business.

Insurance claims, especially in corporate products, often show abnormal data characteristics or have heavy tail. This condition indicates the potential for claims with very large values, even though the probability is small. To manage such extreme risks, a specialized statistical approach is required.

Extreme Value Theory (EVT) has proven to be a powerful tool in analyzing and modeling extreme events. Embrechts et al. (2013) highlight the importance of EVT in risk management, especially in the financial industry. EVT methods allow us to identify and quantify risks associated with rare but high-impact events.

In this study, EVT will be used to predict the risk of corporate product claims in an insurance company. The Block-Maxima method, as one of the classical approaches in EVT, will be applied to identify extreme values of the claims data. Thus, the insurance company can obtain a more accurate estimate of the maximum potential loss and can allocate adequate reserve funds. This research is expected to contribute to improving the reliability of claims risk prediction models, so that insurance companies can optimize the allocation of reserve funds and reduce the potential for significant financial losses.

2. Literature Review

2.1. Extreme Value Theory

Extreme Value Theory (EVT) is one of the statistical methods used to study the behavior of the tail of a distribution of data containing extreme values (Dipak K & Dey, 2016). This method explains extreme events or deviant data such as losses that rarely occur but have a very large risk impact (maximum value). This method is used in the insurance field to model and calculate the risk of insurance companies where the risk so that EVT is very suitable for use in modeling risk. There are two kinds of modeling in EVT theory, namely Block Maxima (BM) and Peaks Over-Threshold (POT) (Gilli & Kellezi, 2003). The Block Maxima method is to take the maximum values in a period (monthly or yearly), observing these values as extreme values. The Peaks-Over-Threshold approach is to look at values that exceed a threshold value, values that exceed the limit are considered extreme values.

2.2. Block Maxima

The Block Maxima (BM) method is a method that can be used to identify extreme values based on the highest value of certain observation data that has been grouped from a certain time period. The data is divided into blocks of time periods, such as monthly, quarterly, semester, or yearly. Then each block period is determined based on the highest value, because this data is the extreme value in a certain period that will be included in the sample (Coles, 2001).

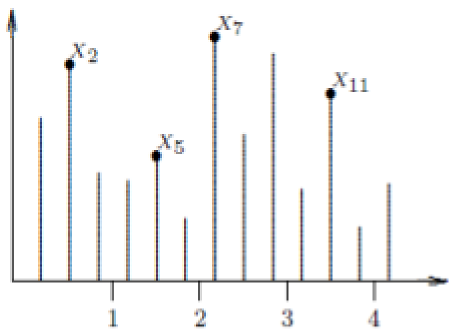

Figure 1. Block Maxima Illustration

Figure 1 shows data grouping using the Block Maxima approach which is divided into 4 blocks based on the month (period). For the first month (first block), the maximum value is X_2 so that the data used as samples for the first month is X_2. For the second month (second block), the maximum value is X_5 so the data used as a sample for the second month is X_5. and for the next month the sampling is done in the same way as the previous month.

2.3. Insurance Claim

According to Sidelnyk et al. (2021), claim expense is the compensation paid or the obligation of the insurer or insurance company to the insured, related to the losses incurred. Meanwhile, the Big Indonesian Dictionary explains that an insurance claim is a demand from the insured party in accordance with the contract agreement between the insured and the insurer, where the insurer will compensate for losses when the insurance premium has been paid by the insured.

An insurance claim is an official request to an insurance company for payment based on a predetermined agreement. The claim will be evaluated by the insurance company to ensure its validity before it is approved and payment is made to the insured. The size of the claim and the frequency of claims in a certain period affect the total number of claims, which can be analyzed using statistical approaches (Reiss & Thomas, 2007).

2.4. Insurance Company

In general, in accordance with the Company's Articles of Association, the purpose of PT Asuransi is to support the implementation of government policies and programs in the field of economic and national development, especially in the general insurance sector, in accordance with applicable regulations, by applying the principles of a Limited Liability Company.

PT Asuransi focuses on providing general insurance services by offering insurance products for corporations and retailers, such as Transportation Insurance, Fire Insurance, Aviation Insurance, Engineering Insurance, Marine Hull

Insurance, Motor Vehicle Insurance, Miscellaneous Insurance, Financial Insurance, and Oil and Gas Insurance. However, the products marketed by PT Asuransi only include corporate products, among others:

a). Freight Insurance:Covers financial losses incurred by the owner of the goods in the process of transportation by land, sea, or air.
b). Fire Insurance: Covers property loss due to fire and business interruption caused by fire.
c). Aviation Insurance: Covers aspects of the aviation industry, including airframe insurance, third party legal liability, personal accident for passengers and crew, and satellite launches and orbits.
d). Engineering Insurance: Covers engineering activities during construction, machinery installation, and operations.
e). Marine Hull Insurance: Covers losses to marine vessel frames, including machinery and equipment, as well as during the ship building process.
f). Financial Insurance: Provides guarantees for various financial protections, including bid guarantees, execution guarantees, advance payment guarantees, maintenance guarantees, custom bonds, bank guarantee contracts, import L/C guarantees, and credit insurance.
g). Oil & Gas Insurance: Covers all activities related to the oil and gas industry, both in the upstream and downstream sectors.
h). Miscellaneous Insurance: Provides guarantees for third parties, such as public liability, product liability, fidelity guarantees, as well as guarantees for directors and officers liability, and others.

3. Materials and Methods

3.1. Materials

The data used in this study is secondary data on insurance policy claims that have been paid by product insurance companies from 2019 to 2023. The claim data that has been paid to the insured companies from all Class of Business products includes fire insurance product claim data, motor vehicle insurance, marine hull insurance, engineering insurance, accident insurance, and marine cargo insurance.

3.1.1. Tables

Table 1: Fire COB Data

No.	Insured company	Claim size *(j)* (IDR)	Year
1	PT. Asuransi Dayin Mitra	4,503,574	2019
2	PT. Asuransi Bintang	32,900,759	2019
3	PT. Asuransi Jasindo	942,578,000	2019
4	PT. Asuransi Ramayana	12,910,325,148	2019
5	PT. Asuransi Tugu Pratama	375,190,498	2019
...	...	...	...
21	PT. Asuransi Dayin Mitra	20,037,707	2023
22	PT. Asuransi Bintang	28,841,590	2023
23	PT. Asuransi Jasindo	493.172,000	2023
24	PT. Asuransi Ramayana	3,256,067,214	2023
25	PT. Asuransi Tugu Pratama	646,628,062	2023

Table 2: Motor vehicles COB Data

No.	Insured company	Claim size *(j)* (IDR)	Year
1	PT. Asuransi Dayin Mitra	5,348,540	2019
2	PT. Asuransi Bintang	44,343,875	2019
3	PT. Asuransi Jasindo	305,114,000	2019
4	PT. Asuransi Ramayana	348,487,708,500	2019
5	PT. Asuransi Tugu Pratama	31,859,853	2019
...	...	...	...
21	PT. Asuransi Dayin Mitra	9,238,400	2023
22	PT. Asuransi Bintang	19,377,962	2023

23	PT. Asuransi Jasindo	73,682,000	2023
24	PT. Asuransi Ramayana	559,710,955,361	2023
25	PT. Asuransi Tugu Pratama	42,978,456	2023

Table 3: Marine Hull COB Data

No.	Insured company	Claim size *(j)* (IDR)	Year
1	PT. Asuransi Dayin Mitra	1,052,711	2019
2	PT. Asuransi Bintang	1,481,573	2019
3	PT. Asuransi Jasindo	58,565,000	2019
4	PT. Asuransi Ramayana	7,073,394,747	2019
5	PT. Asuransi Tugu Pratama	172,133,898	2019
...	...	...	...
21	PT. Asuransi Dayin Mitra	4,702,757	2023
22	PT. Asuransi Bintang	8,521,134	2023
23	PT. Asuransi Jasindo	211,027,000	2023
24	PT. Asuransi Ramayana	21,836,491,166	2023
25	PT. Asuransi Tugu Pratama	148,449,332	2023

Table 4: Engineering COB Data

No.	Insured company	Claim size *(j)* (IDR)	Year
1	PT. Asuransi Dayin Mitra	1,353,186	2019
2	PT. Asuransi Bintang	3,998,895	2019
3	PT. Asuransi Jasindo	111,519,000	2019
4	PT. Asuransi Ramayana	1,395,847,862	2019
5	PT. Asuransi Tugu Pratama	128,556,714	2019
...	...	...	...
21	PT. Asuransi Dayin Mitra	2,897,230	2023
22	PT. Asuransi Bintang	3,655,734	2023
23	PT. Asuransi Jasindo	60,275,000	2023
24	PT. Asuransi Ramayana	7,286,691,076	2023
25	PT. Asuransi Tugu Pratama	177,999,131	2023

Table 5: Accident COB Data

No.	Insured company	Claim size *(j)* (IDR)	Year
1	PT. Asuransi Dayin Mitra	2,665,214	2019
2	PT. Asuransi Bintang	4,282,973	2019
3	PT. Asuransi Jasindo	566,000	2019
4	PT. Asuransi Ramayana	3,019,250	2019
5	PT. Asuransi Tugu Pratama	7,392,838	2019
...	...	...	...
21	PT. Asuransi Dayin Mitra	788,250	2023
22	PT. Asuransi Bintang	3,380,002	2023
23	PT. Asuransi Jasindo	50,260,000	2023
24	PT. Asuransi Ramayana	3,419,021	2023
25	PT. Asuransi Tugu Pratama	10,568,923	2023

Table 6: Marine Cargo COB Data

No.	Insured company	Claim size *(j)* (IDR)	Year
1	PT. Asuransi Dayin Mitra	1,816,465	2019
2	PT. Asuransi Bintang	6,382,885	2019
3	PT. Asuransi Jasindo	26,934,000	2019
4	PT. Asuransi Ramayana	2,068,405,709	2019
5	PT. Asuransi Tugu Pratama	51,750,867	2019
...	...	...	...
21	PT. Asuransi Dayin Mitra	1,885,071	2023
22	PT. Asuransi Bintang	7,845,013	2023
23	PT. Asuransi Jasindo	39,171,000	2023
24	PT. Asuransi Ramayana	7,366,012,175	2023
25	PT. Asuransi Tugu Pratama	115,740,814	2023

3.2. Methods

3.2.1. *Generalized Extreme Value* (GEV)

Extreme value sample data taken using the Block Maxima (BM) method will follow the Generalized Extreme Value (GEV) distribution (Cooley, Jomelli, & Naveau, 2004). Defined that x is the extreme value in each block, the cumulative distribution function (cdf). ξ is the shape parameter / tail index, σ is the scale parameter, and μ is the location parameter. Generalized Extreme Value can also be divided into three types when viewed from the value of the shape parameter (ξ), namely:

a). Type 1 is Gumbel distributed, when $\xi = 0$, with cumulative distribution function (cdf) is

$$F(x) = exp\left\{-exp\left[-\left(\frac{x-\mu}{\sigma}\right)\right]\right\}, -\infty \leq x < \infty \tag{1}$$

b). Type 2 is Frechet distribution, when $\xi > 0$, with cumulative distribution function (cdf) is

$$F(x) = \begin{cases} exp\left[-\left(\frac{x-\mu}{\sigma}\right)^{-\frac{1}{\xi}}\right], x > \mu \\ 0, x \leq \mu \end{cases} \tag{2}$$

c). Type 3 is Weibull distribution, when $\xi < 0$, with cumulative distribution function (cdf) is

$$F(x) = \begin{cases} exp\left[-\left(-\left(\frac{x-\mu}{\sigma}\right)\right)^{-\frac{1}{\xi}}\right], x < \mu \\ 1, x \geq \mu \end{cases} \tag{3}$$

The value of ξ in the GEV distribution explains that if $\xi < 0$ the extreme value distribution has a certain upper limit, if $\xi > 0$ the extreme value distribution has no upper limit value, while if $\xi = 0$ the extreme value distribution has an unlimited limit (Coles, 2001). The greater the value of ξ, the heavier the tail of the distribution, the greater the chance of extreme values occurring. Therefore, among the three types of GEV distributions, the one with the largest tail is the Frechet distribution.

3.2.2. Parameter Estimation with Maximum Likelihood Estimation (MLE)

The parameter estimator of the Generalized Extreme Value (GEV) method can be estimated using the Maximum Likelihood Estimation (MLE) method by forming a probability density function (pdf) as follows.

$$f(x|\mu, \sigma, \xi) = \tag{4}$$

$$\begin{cases} \frac{1}{\sigma}\left[1+\xi\left(\frac{x-\mu}{\sigma}\right)\right]^{-1-\frac{1}{\xi}} \exp\left(-\left[1-\xi\left(\frac{x-\mu}{\sigma}\right)\right]^{-\frac{1}{\xi}}\right), \xi \neq 0 \\ \frac{1}{\sigma}\exp\left[-\left(\frac{x-\mu}{\sigma}\right)\right] exp\left(-exp\left[-\left(\frac{x-\mu}{\sigma}\right)\right]\right), \xi = 0 \end{cases}$$

Creating a Likehood function

$$\begin{aligned} L(\mu,\sigma,\xi) &= \prod_{i=1}^{n} f(x_i) \\ &= \prod_{i=1}^{n} \frac{1}{\sigma}\left[1+\xi\left(\frac{x_i-\mu}{\sigma}\right)\right]^{-1-\frac{1}{\xi}} exp\left(-\left[1+\xi\left(\frac{x_i-\mu}{\sigma}\right)\right]^{-\frac{1}{\xi}}\right) \\ &= \left(\frac{1}{\sigma}\right)^{n}\left\{\left[1+\xi\left(\frac{x_i-\mu}{\sigma}\right)\right]^{-1-\frac{1}{\xi}}\right\} exp\left(-\sum_{i=1}^{n}\left[1+\xi\left(\frac{x_i-\mu}{\sigma}\right)\right]^{-\frac{1}{\xi}}\right) \end{aligned} \quad (5)$$

$$\begin{aligned} L(\mu,\sigma) &= \prod_{i=1}^{n} f(x_i) \\ &= \prod_{i=1}^{n} \frac{1}{\sigma}\exp\left[-\left(\frac{x_i-\mu}{\sigma}\right)\right] exp\left(-exp\left[-\left(\frac{x_i-\mu}{\sigma}\right)\right]\right) \\ &= \left(\frac{1}{\sigma}\right)^{n} \exp\left[-\sum_{i=1}^{n}\left(\frac{x_i-\mu}{\sigma}\right)\right] exp\left(-\sum_{i=1}^{n} exp\left[-\left(\frac{x_i-\mu}{\sigma}\right)\right]\right) \end{aligned} \quad (6)$$

Obtain the maximum value of the likelihood function by forming the first derivative of the ln likelihood against the parameters (μ, σ, ξ). Form the ln likelihood function

$$\ln L(\mu,\sigma) = -n\ln(\sigma) - \sum_{i=1}^{n}\left(\frac{x_i-\mu}{\sigma}\right) - \sum_{i=1}^{n} exp\left[-\left(\frac{x_i-\mu}{\sigma}\right)\right] \quad (7)$$

Furthermore, the ln likelihood equation obtained is then derived from the parameters to be estimated and equated to zero. Based on the equation formed, an equation is obtained as follows.

$$\begin{aligned} \frac{\partial \ln L(\mu,\sigma,\xi)}{\partial \xi} = \frac{1}{\xi^2}\sum_{i=1}^{n} &\left\{ \ln\left[1+\xi\left(\frac{x_i-\mu}{\sigma}\right)\right]\left[1-\xi-\left[1+\xi\left(\frac{x_i-\mu}{\sigma}\right)\right]^{\frac{1}{\xi}}\right] \right. \\ &\left. + \frac{1-\xi-\left[1+\xi\left(\frac{x_i-\mu}{\sigma}\right)\right]^{\frac{1}{\xi}}}{1+\xi\left(\frac{x_i-\mu}{\sigma}\right)}\xi\left(\frac{x_i-\mu}{\sigma}\right) \right\} \end{aligned} \quad (8)$$

From the parameter estimation equations for each type of distribution in GEV, the equations obtained are not closed form to estimate the GEV distribution parameters with the MLE approach. So further numerical analysis is needed by iterating to maximize the ln likelihood function. One of the numerical analysis is by using the Newton Raphson method.

3.2.3. Parameter Estimation with *Probability Weighted Moments* (PWM)

The Probability Weighted Moments (PWM) method is a modification of the conventional method of moments and was first proposed by Hosking et al. (1984). Parameter estimation of the Generalized Extreme Value (GEV) method using the Probability Weighted Moments (PWM) method by forming the cumulative density function (cdf) of the random variable X is as follows.

$$M_{p,r,s} = E\left[x^p \left(F(x)\right)^r \left(1 - F(x)\right)^s\right] = \int_0^1 \left[x\left(F(x)\right)\right]^p \left(F(x)\right)^r \left(1 - F(x)\right)^s dF(x) \quad (9)$$

where p, r, s are real numbers.
According to Hosking, Wallis, and Wood (1985) the weighted probability moments (PWM) of the GEV distribution for $\xi < 1, \xi \neq 0$ are as follows

$$\beta_r = M_{1,r,0} = \frac{1}{r+1}\left\{\mu + \frac{\sigma}{\xi}\left(1 - (r+1)^{-\xi}\Gamma(1+\xi)\right)\right\} \quad (10)$$

3.2.4. Distribution Conformity Testing

Testing the suitability of the distribution is carried out to determine whether the distribution used is in accordance with the theory studied. In this study, the Kolmogorov-Smirnov test was used. The distribution suitability test is carried out by adjusting the empirical distribution function $F_n(x)$ with the theoretical distribution $F_0(x)$. Hypothesis test :

$H_0: F_n(x) = F_0(x)$ (Data follows a certain theoretical distribution $F_0(x)$)
$H_1: F_n(x) \neq F_0(x)$(Data does not follow a particular theoretical distribution $F_0(x)$)

Test Statistics:

$$D_{count} = Sup_x |F_n(x) - F_0(x)| \quad (11)$$

The Kolmogorov-Smirnov test will result in a decision to reject H_0 if $D_{count} > D_\alpha$ in the one-sample Kolmogorov-Smirnov table with a significant level of α. $F_n(x)$a is the cumulative probability value (cumulative distribution function) based on the sample data. $F_0(x)$ is the cumulative probability value (cumulative distribution function) under H_0 (Daniel, 1989).

3.2.5. *Value-at-Risk (VaR)*

Value-at-Risk (VaR) is a statistical method for measuring risk that is used to estimate the maximum possible loss of a portfolio at a given confidence level (Best, 1998). VaR is defined as the maximum expected loss in the value of an asset or stock in a given time period and at a given confidence level (Gilli & Kellezi, 2003).
Misra and Prasad (2007) state that the VaR value for General Extreme Value is as follows:

$$VaR_{GEV} = \hat{\mu} - \frac{\hat{\sigma}}{\hat{\xi}} \quad (12)$$

With ξ being the shape parameter/tail index, σ being the scale parameter. μ is the location parameter and m is the number of observations per block.
The analysis steps used in this study are as follows

A. Analyzing the Characteristics of Claims Data in insurance companies
   1. Collect all claim data.
   2. Calculate the mean, median, mode, standard deviation, etc.
   3. Using histograms and normality plots to detect heavy tail and extreme value data.

B. Extreme Value Identification with Block Maxima
   1. Split the data into monthly and quarterly blocks.
   2. Using MLE to estimate the parameters μ, σ, and ξ.
   3. Performing Kolmogorov-Smirnov test

C. Risk Prediction with Value-at-Risk (VaR)
   1. Using the Generalized Extreme Value (GEV) distribution to model extreme claims data (maximum value in each block).
   2. Calculating Value-at-Risk (VaR) with a 95% confidence level (α = 5%). This VaR will provide a loss threshold value that will not be exceeded in 95% of cases.

4. Results and Discussion

4.1. Descriptive Claim Data

An overview of claim size data on fire insurance products, motor vehicle insurance, marine hull insurance, engineering insurance, accident insurance, and marine cargo insurance to identify the descriptive characteristics of the data and identify the presence of heavy tail or extreme value.

Table 7: Descriptive Claim Data

Variable	Mean	Stdev	Max
Fire	2,863,542,935	5,920,237,200	22,043,403,146
Motor vehicles	98,433,906,96	205,296,747,395	585,868,320,561
Marine Hull	2,095,373,908	5,203,633,339	21,836,491,166
Engineering	911,383,974	2,011,802,174	7,286,691,076
Accident	7,481,244	11,761,082	50,260,000
Marine Cargo	671,114,814	1,642,743,983	7,366,012,175

Table 7 shows that motor vehicle insurance claims have the largest average value of claim payments than the average of other claims, which is IDR 98.433 billion. Then the largest data sample diversity shown from the standard deviation value is also owned by motor vehicle insurance claims with a value of IDR 205.296 billion. Likewise, the maximum value of claims ever paid by the largest insurance company is in motor vehicle insurance claims, which is IDR 585.868 billion.

4.2. Maxima Extreme Value Extraction with Block Maxima

After obtaining extreme data on each COB, then the parameter estimation value for the generalized Extreme Value (GEV) distribution is calculated. The calculation of parameter estimates used in this GEV distribution analysis uses the Probability Weighted Moments (PWM) method. This is because the extreme data generated cannot be estimated using the Maximum Likelihood Estimation (MLE) method. The results of the parameter estimation value of each COB using the GEV distribution are as follows.

Table 8: Parameter Estimation of GEV Distribution Block Year

COB	Block Year		
	μ	σ	ξ
Fire	2863542934.8	5800624118.88531	1.1
Motor vehicles	98433906961.2	201148910788.7993	1.1
Marine Hull	2095373907.72	5098498595.504182	1.099999999
Engineering	911383973.64	1971155515.5559626	1.1
Accident	7481243.56000074	11523459.644684501	1.09999999999972
Marine Cargo	671114813.64	1609553814.1626997	1.1

Based on the results of the calculation of the GEV distribution parameter estimation with the probability weighted moment approach using the quarter block in table 8. The result of the location parameter estimation (location) μ states the location of the data centering point in each block has the smallest estimation value on the Accident Insurance COB. The result of the parameter estimation value on COB Accident Insurance is for the location parameter of 7481243.56000074. The results of the scale parameter estimation (scale) σ which states the amount of data diversity with the smallest estimated value is in COB Fire with a scale parameter value of 5800624118.88531. As for the shape parameter ξ, the smallest is owned by COB Fire, COB Motor Vehicle, COB Engineering and COB Marine Cargo with a cost of only 1.1, where this value states the maximum tail behavior in the data.

After calculating the parameter estimates and obtaining the cumulative distribution function (CDF) for each COB, the next step is to check the suitability of the distribution using the Kolmogorov Smirnov test. This test aims to ascertain whether the extreme data used has followed the Generalized Extreme Value (GEV) distribution, with a significance level (α) of 5%. The results of the GEV distribution suitability test are then displayed in Table 9.

Table 9: Kolmogorov-Smirnov GEV Test

Variable	D count	D table	P-Value	Decision
Fire	0.72	0.272	0.5909	Fail to reject H0
Motor vehicles	0.6	0.272	0.1625	Fail to reject H0
Marine Hull	0.56	0.272	0.5909	Fail to reject H0
Engineering	0.68	0.272	0.8494	Fail to reject H0
Accident	0.48	0.272	0.5614	Fail to reject H0
Marine Cargo	0.56	0.272	0.8494	Fail to reject H0

The results of checking the suitability of the distribution using the Kolmogorov-Smirnov test for all COBs with the Block Maxima approach are shown in Table 9. All variables produce a value of $D_{count} < D_{table}$ and the resulting p-value is greater than α = 5%, so the accepted decision is Failure to Reject H_0. So it can be concluded that the extreme sample data on COB fire, motor vehicle, marine hull, engineering, accident, and marine cargo follow the generalized extreme value distribution.

4.3. Claims Risk Prediction

After obtaining parameter estimates with the Generalized Extreme Value (GEV) approach, the prediction of claim risk using Value-at-Risk can be determined.

Table 10: VaR Value with GEV Approach (in ,000)

COB	VaR GEV (IDR)
Fire	7,935,859
Motor vehicles	274,327,213
Marine Hull	6,553,721
Engineering	2,635,047
Accident	17,557,854
Marine Cargo	2,078,578
TOTAL	311,088,272

Table 10 provides an overview of the maximum potential loss (VaR) that may be experienced by PT ABC Insurance for each type of insurance claim. The highest VaR value is found in motor vehicle claims, indicating that this type of claim has the greatest risk of loss. The use of the GEV approach in calculating VaR allows companies to take into account extreme events that may occur.

4.4. Estimated Claims Reserves

After calculating the largest potential loss (VaR) of insurance claims using the Block Maxima method, we can estimate how much money insurance company should set aside as a reserve to pay claims from its corporate insurance products. The amount of this reserve is calculated based on the amount of VaR and the proportion of the number of claims from each type of insurance product. The results of this calculation show how much reserve funds are needed, both taking into account additional costs and without these costs.

Table 11: Estimated Claims Reserve with GEV Approach (in ,000)

COB	VaR GEV (IDR)
Fire	2,583,892
Motor vehicles	87,360,692
Marine Hull	1,864,490
Engineering	816,655
Accident	7,077,037
Marine Cargo	595,482
TOTAL	100,798,248

Table 11 provides an overview of the estimated maximum loss (Value at Risk or VaR) that may be experienced by insurance company for each type of insurance claim. The VaR values listed in the table are calculated using the

Generalized Extreme Value (GEV) approach, which is a statistical method commonly used to model extreme events such as large losses in insurance.

5. Conclussion

Based on the observations that have been made, the following conclusions are obtained.

a). Descriptive characteristics of claim data at insurance company show COB motor vehicles with the largest average value of claim payments than the average of other claims, which is IDR 98.433 billion. Then the largest data sample diversity shown from the standard deviation value is also owned by motor vehicle insurance claims with a value of IDR 205.296 billion. Likewise, the maximum value of claims ever paid by the largest insurance company is in motor vehicle insurance claims, which is IDR 585.868 billion. All COBs in insurance company for 5 years have heavy tail and extreme value, so the VaR analysis can be continued with EVT.

b). The results of the analysis using the Block Maxima approach show that the extreme sample data on COB Fire, Motor Vehicle, Marine Hull, Engineering, Accident, and Marine Cargo in the annual block follows the Generalized Extreme Value distribution. Furthermore, when viewed based on the value of the shape parameter generated in each COB shows a value greater than 0 ($\xi > 0$).

c). The risk prediction results of annual claims follow the Generalized Extreme Value (GEV) distribution of annual blocks with risk estimates, namely fire risk estimates of IDR 7.395 billion, motor vehicles of IDR 274.24 billion, marine hulls of IDR 6.55 billion, engineering of IDR 2.635 billion, accidents of IDR 17.5 billion, and marine cargo of IDR 2.078 billion.

d). Based on the risk value of the resulting claim, the calculation of the estimated claim reserve fund required by insurance company as a whole is IDR 100.798 billion for the claim reserve fund.

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