



Calculation of Motor Vehicle Insurance Premiums Through Evaluation of Claim Frequency and Amount Data

Elizabeth Irene Bagariang^{1*}, Amalia Raharjanti²

^{1,2}*Undergrad Program in Mathematics, Faculty of Mathematics and Sciences, Universitas Padjajaran, Sumedang, Jawa Barat, Indonesia*

*Corresponding author email: elizabeth20002@mail.unpad.ac.id

Abstract

Insurance, as a risk control strategy by transferring the burden of risk from one party to another, consists of two main forms: life insurance, which covers financial losses from the risk of death of the policyholder, and general insurance, which involves the transfer of risk against property losses. Motor vehicle insurance has become a common product reflecting the high value and benefits of motor vehicles, which has resulted in an increase in vehicle ownership. Although the increase in the number of vehicles contributes to the increase in road accidents, many owners who suffer losses do not receive the compensation they deserve. In this context, the premium becomes a key factor, where the policyholder pays a certain amount of money to get protection. This research aims to apply risk premium calculation based on claim frequency and claim size data, as conducted by Ozgurel in 2005, especially for each vehicle category and region in XYZ insurance company. The main problem is to optimize the premium calculation to reflect the actual risk, providing a more accurate understanding of the influence of vehicle and regional characteristics in determining a fair and appropriate premium.

Keywords: Vehicle Insurance, Claim, Risk

1. Introduction

Insurance is a widely used method to manage risk, considered as a tool through which individuals can transfer their risk to another party, the insurance company. In this case, the insurance company, as the insurer, collects funds from the insured individuals to meet the financial needs associated with any losses that may occur. Such a concept involves two key aspects, namely risk transfer and loss sharing. In this context, insurance claims are an important aspect. A claim refers to a claim filed by the insured party to the insurance company when an event occurs that covers the guaranteed risk (Lind & Kulik, 2009). Claim payments are made by insurance companies in response to losses or events covered by the policy.

When discussing claims, motor vehicle insurance appears as a specific example. According to Quijano & Garrido, (2015) motor vehicle insurance provides protection against the risk of accident, damage, or loss of motor vehicles. The amount of motor vehicle insurance premiums is often determined by unique factors such as vehicle type, coverage value, and policyholder claims history. By combining the calculation of premiums, claims, and motor vehicle insurance, insurance companies can assess and manage risks more effectively, while ensuring policyholders get the protection that suits their needs.

According to Lesmana et al. 2018 in stated that currently the total vehicles in Indonesia reached 143,340,128 units or more than half of the population. From these data, it is known that 60% or 86,126,221 units are on the island of Java (Shi et al., 2015). While the second highest number of vehicles is in Sumatra with 29,269,502 units or 20.42%. Followed by Kalimantan with 10,210,890 units or 7.12%. Although West Java has a large percentage of the population, the number of motorized vehicles only ranks fourth at 17,268,094 units. These figures indicate how useful motorized vehicles are in Indonesia because they are easy to carry everywhere, thus making an increase every year. In line with this, road accidents are also increasing and many of them suffer losses from motor vehicle accidents and do not get the compensation that is the right of the vehicle owner.

Motor vehicle insurance premium rates in Indonesia are regulated by the Financial Services Authority (OJK) and are based on several factors, including the type of coverage, regional division, and vehicle type. Policyholders have the responsibility to pay premiums to insurance companies, which are determined based on vehicle conditions such as physical condition, type, age, location of use, function, loss event experience, and the type of coverage selected. The

survival of the insurance company depends on the alignment between the total claims to be paid and the total net funds available. Total net funds include initial funds, premiums received, and other sources minus expenses. If claims exceed the total net funds, the insurance company may suffer losses and risk bankruptcy.

The premium is the amount of money that the policyholder has to submit to the insurance company at certain intervals of time. Premiums charged to policyholders involve risk premiums along with administrative costs, acquisition costs, and company profit margins. According to an insurance policy is an official contract between an insurance company and a policyholder (Maylawati et al., 2022; Abraham, 1996; Abraham, 2012). On the other hand, claims are claims for payment rights submitted by policyholders.

Referring to the context that has been described, it can be concluded that insurance has a role in managing risk, where the payment of a sum of money is required to obtain control over the risk, which is referred to as a premium or protection cost. The formulation of this research problem is "How to calculate the risk premium of motor vehicle insurance based on claim frequency and claim size data collected by Ozgurel (2005) for each vehicle category and region in XYZ Insurance Company?" The purpose of this research is to apply risk premium calculation based on claim frequency data and claim size analyzed by Ozgurel (2005) for each vehicle category and region in XYZ Insurance Company.

2. Methods

This study uses the risk premium calculation method introduced by actuary Ozgurel in 2005. Secondary data on motor vehicle insurance was obtained from XYZ Insurance Company for 2011-2014, including the number of policies, total premiums, number of claims, and total claims which are all in the form of Indonesian Rupiah (IDR) for vehicle categories 1-7 with Total Loss Only (TLO) protection types in Region 1 to Region 3.

3. Results and Discussion

Risk Premium Based on Planning Assumptions

Calculating the Average Size of Claims each Year (MCS)

In calculating the average claim size per year (MCS) of each policyholder in XYZ company with TLO protection type for category 1 region 2 vehicles during 2011-2014, data on the number of claims per year (C_i) and the total claim size per year (TCS_i) are required which can be taken from column 4 and column 5 in Table 1.

Table 1: Expenses and Revenues of XYZ Company (Category 1 Region 2) 2011-2014

Year	Polis Amount	Premium Amount Total	Claims Amount	Claims Total
2011	93,971	24,200,741,966	114	8,517,029,779
2012	96,249	22,785,105,216	277	12,016,069,104
2013	100,621	23,208,834,070	93	17,184,335,101
2014	99,137	23,668,062,473	87	5,767,382,992
Total	389,978	93,862,743,725	571	43,484,816,976

From this data, the average size of claims per year (MCS) will be calculated using the following formula, namely by dividing the Total Claims Per Year (IDR) by the Number of Claims Per Year, so that the results are obtained:

$$MCS_{2011} = \frac{TCS_{2011}}{c_{2011}} = \frac{8,517,029,779}{114} = 74,710,787.54$$

The value of $MCS_{2011} = 74,710,787.54$ means that the average claim size of XYZ company policyholders with TLO protection type for category 1 region 2 vehicles in 2011 was IDR 74,710,787.54 every claim. The same calculation is done for the next category, region, and year.

Calculating the Average of each Year (AOP)

To estimate the average annual premium (AOP) received by XYZ Company with the type of TLO protection for category 1 region 2 vehicles, the period 2011-2014 requires data on the total amount of premiums in rupiah per year (TOP_i) and data on the number of policies per year (N_i) presented in Table 1. column 2 and column 3.

In this calculation, the company's average premium per year (AOP) is calculated by dividing the total premium per year (in Rupiah) by the number of policies every year.

$$AOP_{2011} = \frac{TOP_{2011}}{N_{2011}} = \frac{24,200,741,966}{93,971} = 257,534.15$$

The value $AOP_{2011} = 257,534.15$ means that the average premium earned by XYZ company with TLO protection type for category 1 vehicles, region 1 in 2011 is IDR 257,534.15 for each policy. The same calculation is done for the next category, region, and year.

Calculating the Risk Premium for each Year (IDR)

To calculate the annual risk premium for each policyholder (IDR) with the type of TLO protection for category 1 region 2 vehicles, the period 2011-2014 requires data on the total number of claims each year in rupiah (TCS_i) and data on the number of policies each year (N_i) contained in Table 1. column 2 and column 5.

From these data, the risk premium per year (IDR) will be calculated using the following formula, namely by dividing the Total Claim Size (IDR) per year by the Number of Policies for each year, so that the results are obtained:

$$RP_{2011} = \frac{TCS_{2011}}{N_{2011}} = \frac{8,517,029,779}{93,971} = 90,634.66$$

The value $RP_{2011} = 90,634.66$ means that the risk premium that must be paid by each XYZ company policyholder with the TLO type of protection for category 1 region 2 vehicles for the 2011 period is IDR 90,634.66. The same calculation is done for the next category, region, and year.

Calculating the Ratio of Company Premium to Risk Premium every Year (k)

To calculate the ratio of the company's risk premium to the risk premium every year (k) with the type of TLO protection for category 1 vehicles, region 2, for the period 2011-2014, we need data on the average premium of XYZ company every year in rupiah (AOP_i) and data on the risk premium every year (RP_i) contained in the previous calculation.

From this data, the ratio of the company's premium to the risk premium every year (k) will be calculated using the following formula, namely by dividing the Average Premium of XYZ Insurance Company in rupiah for the i-th year (AOP_i) by the Risk Premium per year, so that the results are obtained:

$$k_{2011} = \frac{AOP_{2011}}{RP_{2011}} = \frac{257,534.15}{90,634.66} = 2.84$$

The value $k_{2011} = 2.84$ means that the premium ratio obtained by XYZ company with TLO protection type to the risk premium for category 1 region 2 in 2011 is 2,84.

Calculating the Average Claim Frequency (m)

To calculate the average frequency of claims (m) the data used is contained in Table 1., taken only the number of claims and the number of policies with the type of TLO protection for category 1 vehicles, region 2, the period 2011-2014 and calculated using the following formula, Based on the data in Table 1, it can be seen that the total number of claims (C_i) is 571, and the total number of policies (N_i) is 389.978. Then the average claim frequency (m) can be calculated as follows:

$$\frac{C_i}{N_i} = \frac{571}{389.978}$$

The average claim frequency of XYZ Company policyholders with vehicle protection type category 1 region 2 is assumed to be constant for 2011-2014 which is 0.001464.

Calculating the Growth Rate in Average Claim Size (r)

To calculate the growth rate in the average size of claims (r) with the type of TLO protection for category 1 region 2 vehicles, the period 2011-2014, the MCS value for 2011-2014 is needed, then the average growth rate of large claims can be calculated and assuming geometric growth.

$$MCS_{i+1} = (i + r)^i MCS_i$$

The average size of MCS claims in 2011 was IDR 74,710,787.54 and 3 years later it was IDR 66,291,758.53. Thus, r can be calculated from:

$$66,291,758.53 = (1 + r)^3 74,710,787.54$$

The number IDR 66,291,758.53 indicates the average claim size for 2014 for category 1 region 2 vehicles, the number 3 indicates the time period, and the number IDR 74,710,787.54 indicates the average claim size for 2011, thus obtained:

$$\begin{aligned}
 66,291,758.53 &= (1 + r)^3 74,710,787.54 \\
 \frac{66,291,758.53}{74,710,787.54} &= (1 + r)^3 \\
 (0.887311735)^{\frac{1}{3}} &= (1 + r)^{\wedge 3 \cdot \frac{1}{3}} \\
 0.960930715 &= (1 + r) \\
 r &= 0.960930715 - 1 \\
 r &= -0.039069285 \\
 r &= -0.039069285 \times 100\% = -3.906928541\%
 \end{aligned}$$

It can be seen that the results obtained by the value of $r = -3.90\%$, this figure shows that the average growth rate of large claims for XYZ Company for the period 2011-2014 for category 1 region 2 vehicles for the period 2011-2014 is -3.90% . This figure shows that the growth rate is according to because the value is minus.

Relationship between Consecutive Number of Policies

The relationship between the number of consecutive policies for category 1 region 2 vehicles, period 2011-2014 can be calculated in the following way, calculated by trial and error as previously done by Ozgurel (2005).

The value of n_2 is calculated by dividing the number of policies in year 2, namely 2012 with year 1, namely 2011, so that $\frac{96,249}{93,971} = 1.024241521 \approx 1.0242$. So that it can be obtained $n_2 = 1.0242 n_1$. Next, find the value of x using the following equation:

$$\begin{aligned}
 n_3 &= (1.0242 + x)n_2 \\
 n_3 &= (1.0242 + x) \cdot 96.249 \\
 100,621 &= (1.0242 + x) \cdot 96,249 \\
 100,621 &= 98582.22219 + 96,249x \\
 96,249x &= 2038.777814 \\
 x &= 0.021182327 \approx 0.0212
 \end{aligned}$$

Then we get $n_3 = (1.0242 - 0.0212) n_2$. Henceforth, we can use the general formula $n_{i+1} = (1.0242 - (i - 1) \times 0.0212) n_i$.

For further calculations, we need to follow the following assumptions: (1) In 2011, 93,971 policyholders will be booked; (2) The average claim size in 2011 is IDR 74,710,787.54; (3) The claim frequency rate (m) over the next 4 years is constant at 0.001464 or about 0.15%; (4) The average claim size decreases at a constant rate of decline or equal to -3.90% ; (5) The number of policyholders experiences a one-time increase and then decreases in relation:

$$n_{i+1} = (1.0242 - (i - 1) \times 0.0212) n_i.$$

By referring to the assumptions above, it can be calculated the amount of claims, the number of claims and the total amount of claims paid each year with the type of TLO protection for category 1 region 2 vehicles, the period 2011-2014. The calculation results are presented in Table 2.

Table 2: Number of Claims and Total Amount of Claims Category 1 Region 2 in 2011-2014

i	Year	Big Claim Average (IDR)	Polis Amount	Claims Amount	Big Claim Total
1	2011	74,710,788	93,971	138	8,148,216,788
2	2012	43,379,311	96,249	141	16,085,076,088
3	2013	184,777,797	100,621	147	18,453,612,316
4	2014	66,291,759	99,137	145	4,806,152,493
Total		369,159,654	389,978	571	47,493,057,685

Risk Premium Calculation Result

Based on the values in Table 2, the risk premium will be calculated based on planning assumptions with TLO protection type for category 1 region 2 vehicles, period 2011-2014. The risk premium is calculated using the following, namely by dividing the Total Claims based on planning assumptions by the Number of Policies,

$$RP_{2011} = \frac{TCS_{2011}}{N_{2011}} = 86.710$$

The value of $RP_{2011} = 86.710$ means that the risk premium based on planning assumptions that must be paid by each policyholder of XYZ Company with the type of TLO protection for category 1 region 2 vehicles for the 2011 period is IDR 86,710.

Table 3: Risk Premium Based on Planning Assumptions Category 1 Region 2 Year 2011-2014

i	Year	Claim Amount	Polis Amount	Claim Total (IDR)	Risk Premium (IDR)
1	2011	138	93,971	8,148,216,788	86,710
2	2012	141	96,249	16,085,076,088	167,119
3	2013	147	100,621	18,453,612,316	183,397
4	2014	145	99,137	4,806,152,493	48,480
Total		571	389,978	47,493,057,685	

The total row of Table 3 contains the values that are important in this analysis. The result of the analysis of the number of policies ordered in 4 years is 389,978 or about 390 thousand policies ordered for vehicles of category 1 region 2, for the period 2011-2014. The number of claims in this period was 571, and the total amount of claims paid by the company in this period was IDR 47,493,057,685.

Calculation Result of Net Premium Amount

From the risk premium obtained and if the value will be applied during 2011-2014, the original number of policies (data in Table 1) will result in the collection of the total amount of net premium for category 1 region 2 vehicles, period 2011-2014. The total net premium is calculated by multiplying the original number of policies by the planned risk premium or based on assumptions made earlier, resulting in the results in Table 4.

Table 4: Total Net Premium Category 1 Region 2 Year 2011-2014

i	Year	Polis Amount	Risk Premium Planned	Net Premium Total
1	2011	93,971	86,710	8,148,216,788
2	2012	96,249	167,119	16,085,076,088
3	2013	100,621	183,397	18,453,612,316
4	2014	99,137	48,480	4,806,152,493
Total		389,978		47,493,057,685

The total row in Table 4, shows that 389,978 policies were ordered in 4 years, the number of claims in that period was 571 (Table 2). And the total amount of net risk premium that would be collected if following the planned assumptions is IDR 47,493,057,685. The same calculation is done for the following years based on the category, type of vehicle and region for which the risk premium will be sought.

4. Conclusion

Based on the discussion in this study, the researcher concluded that the results of the calculation of risk premiums based on planning assumptions for category 1 motor vehicle insurance (passenger vehicles that cost \leq IDR 125,000,000), region 2, obtained results for 2011 = IDR 93,971, 2012 = IDR 96,249, 2013 = IDR 100,621 and 2014 = IDR 99,137.

The risk premium results can be used to estimate the total net premium obtained based on the assumptions that have been planned. Because the total net premium is calculated by multiplying the risk premium results based on assumptions with the original number of policies. The result of the total net premium with the type of TLO protection

for category 1 and region 2 vehicles for the period 2011-2014 is IDR 47,493,057,685. In research conducted by Ozgurel (2005), the total claim is smaller than the total net premium so it can be said that the company does not suffer losses. The total claim value for category 1 and region 2 vehicles for the period 2011-2014 was IDR 47,493,057,685. This value is the same as the total net premium, so it can be said that the XYZ Insurance Company has stability.

The original value of the total four-year number of claims and the number of policies for category 1 and region 2 is very close to the value obtained from the planning assumptions. For the original number of claims is 571 as well as the number of claims based on planning assumptions, while for the total number of policies, the original value is 571.

References

Abraham, K. S. (1996). A theory of insurance policy interpretation. *Mich. L. Rev.*, 95, 531.

Abraham, K. S. (2012). Four conceptions of insurance. *U. Pa. L. Rev.*, 161, 653.

Lesmana, E., Wulandari, R., Napitupulu, H., & Supian, S. (2018). Model estimation of claim risk and premium for motor vehicle insurance by using Bayesian method. In *IOP Conference Series: Materials Science and Engineering* (Vol. 300, No. 1, p. 012027). IOP Publishing.

Lind, E. A., & Kulik, C. T. (2009). *Hear me out: Voice and justice* (Doctoral dissertation, Emerald Group).

Maylawati, D. S. A., Khosyi'ah, S., & Kholid, A. (2022). Society's perspectives on contemporary islamic law in Indonesia through social media analysis technology: a preliminary study. *International Journal of Islamic Khazanah (IJK)*, 12(1), 14-31.

Ozgurel, H. G., & Vipulanandan, C. (2005). Effect of grain size and distribution on permeability and mechanical behavior of acrylamide grouted sand. *Journal of geotechnical and geoenvironmental engineering*, 131(12), 1457-1465.

Quijano Xacur, O. A., & Garrido, J. (2015). Generalised linear models for aggregate claims: to Tweedie or not?. *European Actuarial Journal*, 5(1), 181-202.

Shi, P., Feng, X., & Ivantsova, A. (2015). Dependent frequency-severity modeling of insurance claims. *Insurance: Mathematics and Economics*, 64, 417-428.