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EXPERIENCE STUDY: EFFECT OF UNDERWRITING METHODS ON MORTALITY RATE FOR LIFE INSURANCE PRODUCT AT PT. ABC (2015-2020 PERIOD)

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Abstract. *In creating complex mortality tables, some insurance companies do not have enough data to build credible tables based on their experiences. Therefore, insurance companies usually carry out their analysis by comparing the company's actual mortality rate with the expected mortality rate based on industry tables, which is the "A/E ratio". This study aims to determine the best estimates for the mortality rate in PT ABC's underwriting method and its effect on the mortality rate and gross premium. The method used is the actual to expected analysis (A/E Ratio) method. The results of the research and analysis conclude that the more complex the underwriting process assigned to a product, the lower the mortality rate and gross premium.*

Keywords: *experience study, mortality rate, premium, underwriting.*

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1. INTRODUCTION

Human beings are faced with various types of uncertain and unexpected risks such as premature death, loss of properties due to fire, theft, accident, etc., which cause the financial losses. Risk cannot be eliminated but can be shared, managed, and significantly reduced with the help of insurance [1]. There are two parties involved in insurance, namely the insured and the insurer. The insured will share, reduce, or minimize the existing risk by providing a number of material compensation due to the risk suffered by the insured. Insurance means sharing some of the risk with the insurer and in this case the insurance company [2], [3].

The first thing to consider in understanding insurance is to understand the concept of risk well. Underwriting is also known as risk selection. Whether or not a contract is implemented is highly dependent on the underwriting process. Understanding a good underwriting concept is essential to be able to identify good, precise and accurate risks, considering that the main responsibility of the underwriter is to ensure that there are no risks that could cause big problems that burden the company in the future [4]. Therefore, underwriting is the process of forecasting the prospective insured or the assets to be covered, to determine the eligibility of the insured candidate to get protection and adjust the appropriate risk class for the insured [5].

One form of insurance, is life insurance. Life insurance is a protection program in the form of transferring the economic risk of the death or life of the insured person. In doing their business, life insurance companies need a mortality table in order to get a better valuation value [6]. The Indonesian Mortality Table, also known as the industry table, is the result of a study of the experiences of many insurance companies. Experience studies are conducted across the insurance industry to produce industry standard tables [7].

For complex tables of rates such as select and ultimate mortality rates or disability income incidence and termination rates, few companies have sufficient data to construct credible tables based on their own experience. For studies of such complex rates, most companies direct their experiential studies to study their experience in relation to one or more industry tables. Study results are then expressed as percentages of the industry tables, which is often referred to as the "A/E ratios" (actual to expected ratios), where the industry table provides the expected rates [7].

By applying their A/E ratios to industry tables, companies can generate a smooth set of expected rates that match their overall experience [7]. When examined more closely, mortality studies can reveal more than just the overall experience of death. Companies can analyze experiences by grouping data into meaningful segments in hopes of revealing interesting trends [8]. Companies often label these adjusted industry rates as "best estimate" rates and are used to project the prevailing populations for valuation, risk management and financial planning purposes. Companies also use the best estimate rates to project the expected business results for the coming years [7].

The credibility given to a mortality study has nothing to do with quality of underwriting going into the underlying business. The overall mortality rate is correlated with the distribution of risk factors including underwriting class, age, gender, and even product type. However, it is the number of deaths in the experiential study that determines the level of confidence placed in the overall study results. The mortality rate from that one sample is considered to be the best representation ("best guess") of the actual mortality arising from the population. Credibility provides a quantitative measure of how good our guess is [9].

At PT. ABC, there are 3 choices of underwriting methods that can be assigned to a life insurance product, namely full underwriting, simplified underwriting, and guaranteed issue offer. The grouping aims to see the effect of the underwriting method on the mortality rate in life insurance products. Based on the previous explanation, the problem that can be identified in this research are how many assumptions are best estimates for the mortality rate for each underwriting method and how they affect the mortality rate and gross premium. In addition, this study is expected to provide additional literature on the experience study of the effect of the underwriting method on mortality rates.

2. RESEARCH METHODS

The data used in the research are death claim data and inforce policy data provided by the Actuarial Pricing Division of PT ABC. The type of data used in this research is quantitative data. Meanwhile, the method used is the Actual to Expected (A/E) method. The analysis used aims to determine the best estimates on the mortality rate. The following are the calculation steps in the A/E analysis:

1. Set the research period.
2. Classify the underwriting method for each insurance product.

Underwriting is the process of assessing and classifying the level of risk owned by a prospective insured or a group of prospective insured, or making a decision to accept or reject the risk [10]. The underwriting process consists of three important steps, focusing on obtaining the relevant information about the risk, deciding whether and to what extent the risk will be borne by the insurer, and thirdly establishing the appropriate insurance premium to be paid by the insured [11].

At PT ABC, there are three (3) choices of underwriting methods that can be assigned to a life insurance product, namely full underwriting, simplified underwriting, and guaranteed issue offer. The full underwriting method requires the insured candidate to carry out a medical check-up. There are two criteria in determining what laboratory tests need to be applied in the full underwriting method, namely medical underwriting which depends on age and the sum insured, and financial underwriting which depends on the amount of the sum insured. Next, the simplified underwriting or simplified issue does not require the prospective insured to carry out a medical check-up. The insured is only required to complete a health questionnaire or health statement determined by the company. Finally, the guaranteed issue offer, which is a method that does not provide any conditions and accepts all the risks of the insured candidate.

3. Calculate the number of actual claims of death that occurred.
4. Calculate the exposure.
5. Calculate the expected claims from policy data.
6. Calculate the A/E ratio for each year and the total during the study period.
7. Calculate credibility and adjusted A/E ratio for each year and total during the research period.

Application of credibility theory is often necessary to evaluate the suitability of assumptions such as mortality and lapse rates for the company's business blocks. Credibility theory can be used to help companies assess whether the data is fully credible (100% credible) or not, in which case companies can develop assumptions or create tables based on their own data [12]. The more credible our information about the particular lives under review, the less dependent we are on other sources [13]. If the data are not completely credible, then the credibility theory method can be used to combine the company's experience with the appropriate base experience (e.g. industry tables or specified valuation tables) to develop more accurate estimates [12].

When the number of claims observed is less than the number of claims required to be considered credible, a partial credibility method is needed to calculate the mortality rate of this study based on the weighted average of the industrial mortality rate [6], [14].

Credibility value is obtained by: [15]

$$C = [Z * own\ experience] + [(1 - Z) * Industry\ experience] \quad (1)$$

where Z is the credibility factor and can be calculated by

$$Z = min\left(1, \sqrt{\frac{the\ number\ of\ claims\ observed}{the\ number\ of\ claims\ required\ to\ achieve\ full\ credibility}}\right) \quad (2)$$

If $p = 0.9$ and $r = 0.5$, then

$$Z = min\left(1, \sqrt{\frac{the\ number\ of\ claims\ observed}{1082}}\right) \quad (3)$$

After calculating the A/E ratio, this research is continued by simulating the premium calculation. In the simulation, the following are determined: age, coverage period, sum insured, premium payment period, method of payment of premiums (eg annual), actuarial interest, and insurance costs. In insurance companies, the amount of premium received by the policyholder is called the gross premium. This gross premium is

greater than the net premium, the difference between the gross premium and the net premium is called cost. The formula can be described as follows: [2]

$$Gross\ Premium = Net\ Premium + Expenses \quad (4)$$

The net premium is a number of payments with the intention of obtaining a number of benefits if the insured risk occurs to the insured. The net premium can be calculated by: [2], [16]

$$P^n = \frac{(A^1_{x:\bar{n}})}{\ddot{a}_{x:n}} \quad (5)$$

with,

P^n = Net premium,
$A^1_{x:\bar{n}}$ = The actuarial present value of a customer aged x years on an n-year term life insurance,
$\ddot{a}_{x:n}$ = Anuity value.

The formula for term life insurance is as follows: [17]

$$A^1_{x:\bar{n}} = \sum_{k=0}^{n-1} v^{k+1}\ {}_kp_x\ \ q_{x+k} \quad (6)$$

with,

$A^1_{x:\bar{n}}$ = The actuarial present value of a customer aged x years on an n-year term life insurance,
v = Interest rate discount factor,
${}_kp_x$ = The probability that a customer aged x years will survive to the age of (x+k) years,
q_{x+k} = The probability that a customer aged x years will die before reaching (x+k) years.

Many insurance companies use commutation tables in calculating premiums. The values in the commutation table were obtained based on the mortality table [18]. Some commutation symbols used by life insurance companies are $D_x, N_x, C_x,$ dan M_x [19]. Using commutation table,

$$A^1_{x:\bar{n}} = \frac{(M_x - M_{x+n})}{D_x} \quad (7)$$

where, $D_x = l_x v^x, M_x$ represents the sum of C_{x+i} with $i \geq 0$, $C_x = d_x v^{x+1}$, l_x represents the number of people who live at the age x years, and d_x represents the number of people who die at the age of x years [19].

3. RESULTS AND DISCUSSION

3.1. Calculation of A/E Ratio

1. Set the research period

   The period specified in this research is 6 years, from January 1, 2015 to December 31, 2020.

2. Classify the underwriting method for each insurance product

   Generally, the distribution of the underwriting method for each product at PT. ABC is as follows:

Table 1. Underwriting Methods in PT. ABC

No	Underwriting Method	Type of Insurance Product
1	Full Underwriting	Unit-Linked and Non-Linked Individual Insurance and Standalone Term
2	Simplified Underwriting	Health Insurance with a death benefit
3	Guaranteed Issue Offer	Health Insurance without death benefit

However, in certain products, there are exceptions. For example, the x-link product, which is a unit-linked insurance product, applies the guaranteed issue offer method, which is a method that does not apply any conditions to the insured.

3. Calculate the number of actual claims of death that occurred

   After classifying insurance products according to the underwriting method used, the next step is to calculate the actual claims. This actual claim is calculated based on the number of death claims with the following conditions:

a. Years of observation: 2015, 2016, 2017, 2018, 2019, and 2020.
b. Actual claims are calculated in each year of observation.
c. Actual claims are calculated per policy.
d. Claim status is paid.
e. The date of policy status is December 31 in the year of observation.
f. Date of death ≥ January 1, in the year of observation.
g. Date of death ≤ December 31, in the year of observation.
h. In unit-linked products, the actual claim is obtained from the total claim paid minus the investment return.

The number of actual claims by count and actual claims by amount each year can be seen in Table 2 and Table 3.

Table 2. Actual Claim (by Count) PT. ABC

Year	Underwriting Methods		
	Full Underwriting	Simplified Underwriting	Guaranteed Issue Offer
2015	257	34	0
2016	289	33	1
2017	263	26	1
2018	301	30	1
2019	275	34	1
2020	274	35	0
Total	**1659**	**192**	**4**

Table 3. Actual Claim (by Amount) PT. ABC

Year	Underwriting Methods (IDR)		
	Full Underwriting	Simplified Underwriting	Guaranteed Issue Offer
2015	36,214,468,852	211,228,234	-
2016	44,349,084,750	197,500,000	100,000,000
2017	45,660,594,110	132,840,947	100,000,000
2018	46,583,112,986	195,696,856	18,750,000
2019	53,370,426,054	180,149,648	18,750,000
2020	31,599,030,703	224,376,693	-
Total	**257,776,717,455**	**1,141,792,379**	**237,500,000**

4. Calculate the exposure

In calculating exposure, there are several provisions:

a. Years of observation: 2015, 2016, 2017, 2018, 2019, and 2020.
b. Valuation Date: December 31 of each year of observation.
c. Exposure is calculated per policy in each year of observation.
d. Exposure is calculated annually, namely the number of days the policy is active in the year of observation divided by the total days in a year, which is 365 days.
e. Payment due year ≥ year of observation, this indicates that the policy is active in the year of observation.
f. Initial date of coverage ≤ valuation date.
g. In a policy with an inactive status due to death, the contribution for exposure is 1 (one) in the year of death because the policy benefits are paid in full at the end of the year.
h. For policies with Paid-Up status, namely in force policies whose premium payment period has been completed, have an exposure value of 1 (one), except for exposure before the policy was issued.
i. Policies with canceled and cool off status are excluded from observation because they are considered to have never been issued.

The results of the exposure calculation for each year are based on each underwriting method which are set out as follows:

Table 4. Exposure PT. ABC

Year	Underwriting Methods		
	Full Underwriting	Simplified Underwriting	Guaranteed Issue Offer
2015	109,671	20,326	687
2016	107,608	25,004	138
2017	103,251	24,631	90
2018	94,994	19,432	138
2019	87,330	18,097	286
2020	79,205	17,210	372
Total	**582,058**	**124,700**	**1,710**

5. Calculate the expected claims for policy data

The number of expected claims (by count) is obtained from the probability of the insured dying multiplied by the exposure for the death claim. The amount of the expected claim (by amount) is obtained from the probability of death of the insured multiplied by the sum insured and the exposure for the death claim. In this case, the age of the insured at the time of observation uses the age last birthday approach. The mortality table used as a reference in this research is the Indonesian Mortality Table III (TMI III) in 2011. The results of calculating the expected claims by count and by amount for each year can be seen in Table 5 and Table 6.

Table 5. Expected Claim (by Count) PT. ABC

Year	Underwriting Methods		
	Full Underwriting	Simplified Underwriting	Guaranteed Issue Offer
2015	328	43	3
2016	324	53	1
2017	348	57	1
2018	340	51	1
2019	338	53	2
2020	334	55	3
Total	**2030**	**312**	**10**

Table 6. Expected Claim (by Amount) PT. ABC

Year	Underwriting Methods (IDR)		
	Full Underwriting	Simplified Underwriting	Guaranteed Issue Offer
2015	62,541,979,555	252,842,646	145,512,001
2016	67,313,230,216	343,201,271	57,007,700
2017	74,154,465,994	376,351,056	41,131,723
2018	83,005,061,025	332,534,223	47,014,874
2019	89,275,360,411	341,856,373	80,788,124
2020	97,479,931,579	356,317,049	95,181,306
Total	**473,770,028,780**	**2,003,102,619**	**466,635,728**

6. Calculate the A/E Ratio for each year and the total during the study period

The annual A/E Ratio is obtained from the comparison between the actual claims and the expected claims in 2015, 2016, 2017, 2018, 2019 and 2020. Then, the A/E Ratio during the study period is obtained from the total actual claims in 2015-2020 divided by the total Expected claims in 2015-2020. The results of the calculation of the A/E Ratio for each product classification that applies the full underwriting, simplified underwriting and guaranteed issue offer methods each year and the total during the study period can be seen in Table 7, Table 8, and Table 9.

7. Calculate credibility and adjusted A/E ratio for each year and total during the research period

Based on the Poisson distribution, assuming p = 0.9 and r = 0.05, it takes 1082 death claims data to achieve full credibility [3]. The adjusted A/E Ratio was calculated based on the weighted average of industry

mortality rates (TMI III 2011). The results of the calculation of credibility and the blended A/E Ratio for each product classification that applies the full underwriting, simplified underwriting and guaranteed issue offer methods each year and the total during the study period, can be seen in Table 10, Table 11, and Table 12.

Table 7. A/E Ratio with Full Underwriting method

Year	A/E Ratio (by Count)	A/E Ratio (by Amount)
2015	78%	58%
2016	85%	66%
2017	76%	62%
2018	88%	82%
2019	81%	60%
2020	82%	32%
Total	**82%**	**54%**

Table 8. A/E Ratio with Simplified Underwriting method

Year	A/E Ratio (by Count)	A/E Ratio (by Amount)
2015	79%	84%
2016	62%	58%
2017	46%	35%
2018	58%	59%
2019	64%	53%
2020	64%	63%
Total	**62%**	**57%**

Table 9. A/E Ratio with Guaranteed Issue Offer method

Year	A/E Ratio (by Count)	A/E Ratio (by Amount)
2015	-	-
2016	137%	175%
2017	196%	243%
2018	109%	40%
2019	41%	23%
2020	-	-
Total	**38%**	**51%**

Table 10. Credibility factor and blended A/E Ratio with Full Underwriting

Year	Credibility Factor	Blended A/E Ratio (by Count)	Blended A/E Ratio (by Amount)
2015	49%	89%	79%
2016	52%	92%	82%
2017	49%	88%	81%
2018	53%	94%	91%
2019	50%	91%	80%
2020	50%	91%	66%
Total	**100%**	**82%**	**54%**

Table 11. Credibility factor and blended A/E Ratio with Simplified Underwriting

Year	Credibility Factor	Blended A/E Ratio (by Count)	Blended A/E Ratio (by Amount)
2015	18%	96%	97%
2016	17%	93%	93%
2017	16%	92%	90%
2018	17%	93%	93%
2019	18%	94%	92%
2020	18%	93%	93%
Total	**42%**	**84%**	**82%**

Table 12. Credibility factor and blended A/E Ratio with Guaranteed Issue Offer

Year	Credibility Factor	Blended A/E Ratio (by Count)	Blended A/E Ratio (by Amount)
2015	0%	100%	100%
2016	3%	101%	102%
2017	3%	103%	104%
2018	3%	100%	98%
2019	3%	98%	98%
2020	0%	100%	100%
Total	**6%**	**96%**	**97%**

Based on the Table 10, Table 11, and Table 12, it can be seen that based on this study the A/E Ratio by amount for insurance products that apply the full underwriting, simplified underwriting, and guaranteed issue offer methods, respectively are 54%, 82%, and 97%. This means that the mortality rate of products that apply the full underwriting, simplified underwriting, and guaranteed issue offer methods, respectively, is 54%, 82%, and 97% from the TMI III 2011 table. Thus, it can be said that the full underwriting method has a mortality rate. the lowest compared to other underwriting methods. This shows that the claims experience is better with the underwriting process. The higher mortality rate in the simplified underwriting method compared to the full underwriting method is due to the simplified underwriting method not requiring the prospective insured to carry out a medical check-up. The insured is only required to complete a health questionnaire or health statement determined by the company.

The guaranteed issue offer method has the highest mortality rate compared to other methods because this method does not provide any conditions and accepts all the risks of the insured candidate. It can be seen that fewer questions asked and less evidence collected by the company can magnify important but undetected risks during the insurance application process. Based on this, it can be said that the underwriting process has an important role in the experience of the occurrence of claims. Therefore, the effect of the underwriting method on the mortality rate is that the more complex an underwriting process is assigned to a product, the lower the mortality rate will be.

This can also be seen in the credibility factor. The Full Underwriting method produces a 100% credibility factor, meaning that the company's own experience data is 100% credible. However, other underwriting methods are not 100% credible (partial credibility), even the guaranteed issue offer method is only 6% credible. Therefore, the two underwriting methods have to use and combine other sources such as tables of other companies.

3.2. Premium Calculation Simulation

Mr. Budi who is 30 years old, purchased a term insurance product with the following conditions:

1. Coverage Period: 25 Years.
2. Sum Insured: IDR 5,000,000,000.
3. Premium Payment Period: 25 Years.
4. How to Pay Premium: Annual.
5. Actuarial Interest: 5.25%
6. Insurance Costs can be seen in Table 13.

Table 13. Insurance cost assumption

Cost	1st Year		2nd Year to 25th	
	Per Policy (IDR)	Per Premium (%)	Per Policy (IDR)	Per Premium (%)
Acquisition	5,047,500	47	5,047,500	47
Maintenance	520,000	4	520,000	4
Commission	-	20	-	6

In this simulation, the gross premium will be calculated assuming the same benefits and costs for each assumption of the underwriting method applied. The results of calculating the gross premium for each underwriting method can be seen in Table 14.

Table 14. Underwriting methods in PT.ABC.

No	Underwriting Method	Mortality Rate (Best Estimate Rate)	Gross Premium (IDR)
1	Full Underwriting	54% TMI III 2011	27,241,972
2	Simplified Underwriting	82% TMI III 2011	34,416,961
3	Guaranteed Issue Offer	97% TMI III 2011	38,239,639

Based on Table 14, if this product stipulates the full underwriting method with a mortality rate of 54% from TMI III 2011, it will have the lowest gross premium than other methods. Therefore, it can be seen that the effect of changing the complexity of an underwriting method on gross premiums is inversely proportional to the calculation of annual gross premiums for individual term insurance.

4. CONCLUSIONS

Based on the analysis of best estimates assumptions, it can be said that the mortality rate of insurance products that apply the full underwriting method is the lowest compared to the simple underwriting and guaranteed issue offer methods, which is 54% from TMI III 2011 while the simple underwriting method is 82% from TMI III 2011 and 97% guaranteed issue offer from TMI III 2011. Moreover, it can be seen that the effect of the underwriting method on the mortality rate is that the more complex an underwriting process is assigned to a product, the lower the mortality rate will be. It also can be seen with credibility factor. Furthermore, it can be seen that the effect of changes in the complexity of an underwriting method on gross premiums is inversely proportional to the calculation of annual gross premiums on individual term insurance, which means that the more complex an underwriting process is determined, the lower the premium value, and conversely.

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