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APPLICATION OF THE EQUIVALENCE PRINCIPLE TO THE CALCULATION OF EDUCATION INSURANCE PREMIUMS FOR VILLAGE-OWNED ENTERPRISES (BUMDes)

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ABSTRACT

Program Education plays a vital role in improving human resources. But on the other hand, education costs are not cheap. For this reason, people need to prepare education funds from an early age. One way is to take part in an education insurance program. This is a business opportunity that a village-owned enterprise (BUMDes) can run by offering education insurance services to the public. This research aims to develop and use programming software to calculate education insurance premiums offered by BUMDes. The method used is The Equivalence Principle method. Based on the case study, the premium price calculated using software that has been developed is very competitive – below market price, depending on the interest rate and fees charged.

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1. INTRODUCTION

Public welfare can be improved through poverty reduction efforts. BPS-Statistics Indonesia notes that the poor live more in rural areas than in cities [1]. To alleviate poverty, various programs have been offered by the government. One of them is the Village-Owned Enterprise Program (BUMDes). The government hopes that BUMDes can stimulate and drive the economy in rural areas. Ultimately, through BUMDes, the welfare of the community can be improved.

Education is a vehicle for community welfare. But the cost of education is not cheap. For this reason, the community needs to prepare for this education fund early on. One of the efforts that can be made by the community to prepare for the cost of education from an early age is to become a participant in education insurance. Education insurance is one of the right solutions to handle financial problems in education [2]. Education insurance is an agreement between two parties, namely the insurance service provider and the community who are the participants in this insurance. Participants of this insurance are obliged to pay dues/contributions/premiums [3], [4]. Meanwhile, the service provider provides a certain amount of funds to participants. It should be noted that according to data from the Financial Services Authority (OJK), the level of insurance ownership by the Indonesian people is still low. In 2019, the level of insurance ownership only reached 2.81%. This figure increased to 2.92 % in 2020 and 3.11% in June 2021 [5].

Socialization to the public about the benefits of life insurance and other types of insurance is very important [6] because it can be a practical solution to uncertainty that can worsen economic conditions in the future [7]. Given the low level of insurance ownership by the community, especially education insurance, and considering that education costs are not cheap [8], [9]. So BUMdes, which in 2018 reached 547 BUMDes spread almost throughout Bali [10], are expected to capture this business opportunity by offering insurance services to the community. Insurance services that can be offered are education insurance. Before being able to offer insurance products to the community, BUMDes needs to provide software that is easy to use by BUMDes staff. Previous research has designed Python programming language applications to calculate the reserves of endowment insurance [11], [12], as well as pension fund contributions [13]. Therefore, this research uses programming software to determine the premium value to be paid by education insurance participants.

2. RESEARCH METHODS

This research uses data sourced from Bringin Life Insurance products, Bringin Danasiswa. Python programming language is used to simulate the calculation of monthly and annual premiums with interest rates of 5%, 6%, and 7%, for insurance costs of $\boldsymbol{z} = \mathbf{5}\%$, and $\boldsymbol{z} = \mathbf{8}\%$.

2.1 The Future Lifetime Random Variable

Suppose (x) denotes a person who is x years old. The death of (x) can occur at any time. The remaining age of (x) is denoted by T_x which is a continuous random variable. $F(x)$ denotes the distribution function of T_x

$$F_x(t) = \Pr[T_x \leq t] \tag{1}$$

The discrete random variable associated with the future lifetime of a person aged x years will be developed in the form of an actuarial model. The random variable is expressed by K_x which has the following probability function

$$Pr[K_x = i] = Pr[i < T_x \leq i + 1] = {}_ip_x\, q_{x+i} = {}_{i|}q_x, \qquad i = 0,1,2, \dots \tag{2}$$

$K_x = i$ can be interpreted as (x) will die between the ages $x + i$ and $x + i + 1$ [14].

2.2 Life Tables

Mortality tables contain basic functions l_x, q_x and p_x where l_x represents the number of people aged x years. q_x can be interpreted as the probability that (x) will die before reaching the age $x+1$. p_x can be interpreted as the probability that (x) will reach the age of $x+1$ years. Furthermore, the probability of a person aged (x) years dying before reaching the age of $x+n$ years is denoted by ${}_nq_x$ and is formulated as [14]:

$$ {}_nq_x = 1 - {}_np_x \tag{3} $$

$$ {}_nq_x = 1 - \frac{l_{x+n}}{l_x} = \frac{l_x - l_{x+n}}{l_x} \tag{4} $$

A joint life mortality table for two persons is a table of the combined mortality rates of persons aged x and y years. Suppose it is assumed that the death of (x) will not affect the death of (y). Then the probability that (x) and (y) will reach the ages $x+n$ and $y+n$ is

$$ {}_np_{xy} = {}_np_x \cdot {}_np_y = \frac{l_{x+n}}{l_x}\frac{l_{y+n}}{l_y} = \frac{l_{xy+n}}{l_{xy}} \tag{5} $$

And the probability of one of x and y dying within n years is denoted by ${}_nq_{xy}$ and is formulated as follows:

$$ {}_nq_{xy} = 1 - {}_np_{xy} = 1 - \left(\frac{l_{x+n\,y+n}}{l_{xy}}\right) = \frac{l_{xy} - l_{x+n\,y+n}}{l_{xy}} \tag{6} $$

2.3 Insurance Benefits

Whole life insurance for (x) with the benefit of 1 unit, paid at the end of the year of death is an agreement to pay a benefit of 1 at the end of the year of death if (x) dies. For this whole life insurance is obtained [15]:

$$ A_x = \sum_{k=0}^{\infty} v^{k+1}\, {}_kp_x\, q_{x+k} \tag{7} $$

Life insurance with a coverage period of n years for (x) is insurance with the benefit of 1 unit paid at the end of the year of death provided that death occurs within a period of n years [15]:

$$ A^1_{x:\overline{n|}} = \sum_{k=0}^{n-1} v^{k+1}\, {}_kp_x\, q_{x+k} \tag{8} $$

2.4 Life Annuities

Suppose a person aged x years makes a series of payments of 1 unit as long as the person is still alive. If the payments are made at the beginning of each year, the annuity is called the initial lifetime annuity and the expectation of the cash value of the annuity is denoted by [15]:

$$ \ddot{a}_x = \sum_{k=0}^{\infty} v^k\, {}_kp_x \tag{9} $$

Suppose the payments are made over n years. Then the cash value of the payment is denoted by

$$ \ddot{a}_{x:\overline{n|}} = \sum_{k=0}^{n-1} v^k\, {}_kp_x \tag{10} $$

In the previous section, we talked about annual life annuities. But in practice, premiums or pension benefits are usually paid monthly. For this reason, we will discuss annuities with m payments per year. Suppose $m = 12$ then this means that the annuity is made 12 times a year or once every month. An initial lifetime annuity for (x) with a payment of 1 unit and payments made m times a year is a series of payments of 1 unit over a lifetime, with payments in equal installments m times. The first payment amount, $1/m$, is made at the same time (when the policy is issued). The cash value of this annuity is as follows,

$$\ddot{a}_x^{(m)} = \frac{1}{m}\sum_{k=0}^{\infty} v^{\frac{k}{m}}\ {}_{\frac{k}{m}}p_x \tag{11}$$

Furthermore, an initial life annuity of n years for (x) with a payment of 1 unit, payment is made in installments m times a year, is an agreement to make payments of 1 rupiah by making installments of the same amount, $1/m$, m times a year, for n years and (x) is still alive. The expected cash value of this annuity is symbolized by

$$\ddot{a}_{x:n}^{(m)} = \frac{1}{m}\sum_{k=0}^{nm-1} v^{\frac{k}{m}}\ {}_{\frac{k}{m}}p_x \tag{12}$$

2.5 Premium

Determining the premium price of an insurance product is crucial for insurance companies. Factors that need to be taken into account to determine the premium price include the age of the participant, the period of coverage, and the amount of benefits that will be paid or issued by the insurance company [16]. The person who works on this premium calculation is called an actuary. Premiums paid by participants will form several funds. The funds collected are used by the insurance company to pay the sum insured, administrative costs, operational costs, and others. One of the principles that can be used to calculate premiums is the equivalence principle which has the equation [15] :

$$E[L] = 0 \tag{13}$$

with the amount of the insurer's loss $(\boldsymbol{L})$ as the random variable of the cash value of the benefit plus expenses minus the random annuity variable of the premium paid by the policyholder. That is

Cash value of benefit outgo + Cash value of expenses – Cash value premium income = **0**

Under this method, the premium is set such that the expected value of future loss is zero.

3. RESULTS AND DISCUSSION

In this section, a model that can be used to calculate education insurance premiums is determined. The data in this study were obtained from Bringin Danasiswa products owned by Bringin Life Insurance company. Bringin Danasiswa is a combination of savings, accidental death protection, critical illness, and total permanent disability. This insurance product protects parents (father or mother) and children, by providing stages of education funds according to the child's education level. The illustration of this insurance design is a 40-year-old mother who participates in an insurance program for her 1-year-old son. The insurance period is 21 years, if one of the mother or son dies within 21 years, the heirs will receive a sum insured. The premium payment period is 10 years with an education fund plan (benefit) of Rp 50,000,000.00. If the premium payment period is 10 years, it means that the premium will continue to be paid if the mother and child are still alive within 10 years. The complete illustration of the Bringin Danasiswa education fund is given in **Table 1.**

Table 1. Illustration of Education Fund

Son's Age	School (Entry)	Percentage	Total
4	Playgroup	5% Benefit	Rp 2,500,000.-
5	Kindergarten	10% Benefit	Rp 5,000,000.-
6	Elementary	15% Benefit	Rp 7,500,000.-
12	Intermediate	20% Benefit	Rp 10,000,000.-
15	High School	25% Benefit	Rp 12,500,000.-

Son's Age	School (Entry)	Percentage	Total
18	Undergraduate	30% Policy Value	Rp 7,327,500.-
19	Undergraduate (Second Year)	35% Policy Value	Rp 6,207,500.-
20	Undergraduate (Third Year)	40% Policy Value	Rp 4,694,000.-
21	Undergraduate (Fourth Year)	50% Policy Value	Rp 3,445,500.-
22	Master Degree	100% Policy Value	Rp 3,003,000.-

***Data source**: (https://www.finansialku.com/asuransi/asuransi-pendidikan-anak-manfaat-dan-biaya/)*

Apart from the benefits listed in **Table 1**, there are additional benefits that will be received if the mother dies, namely: Premium payments are waived, and the Education Fund Stage will still be paid according to the son's education level. This payment will continue until the insurance period ends.

Furthermore, the calculation of premiums is obtained using the equivalence principle, namely the expected cash value of gross premiums is equal to the expected cash value of insurance benefits plus the cash value of expenses. The data in **Table 1**, will be used for the simulation in this section, by expressing the mother's age as a variable x and the child's age as a variable y. The premium will continue to be paid if both are still alive for n years. If one of them dies within m years, a sum insured of B will be paid. If the child lives, an annuity will be paid. Using the equivalence principle, the expected cash value of the net premium is $mP\ddot{a}^{(m)}_{xy::\overline{n|}}$, where P is the amount of premium paid m times a year, for $m = 12$, it means the premium is paid every month.

On the other hand, in return for premium payments, participants will receive benefits if one of their mothers or children dies. In addition, if the child is still alive during the insurance period, at a certain age they will receive an education fund. For this case, the expected cash value of the death benefit is $\frac{i}{\ln(1+i)} MA^{1}_{\overline{xy}:\overline{n|}}$, where M states the amount of benefits if the insured and prospective beneficiaries at ages x and y die and n states the insurance period (years). Furthermore, the expected cash value model of the education fund is given, namely

$$\begin{aligned} nupt[0] = {} & B_1 v^{t_1}{}_{t_1}p_y + B_2 v^{t_2}{}_{t_2}p_y + B_3 v^{t_3}{}_{t_3}p_y + B_4 v^{t_4}{}_{t_4}p_y + B_5 v^{t_5}{}_{t_5}p_y \\ & + B_6 v^{t_6}{}_{t_6}p_y + B_7 v^{t_7}{}_{t_7}p_y + B_8 v^{t_8}{}_{t_8}p_y + B_9 v^{t_9}{}_{t_9}p_y + B_{10} v^{t_{10}}{}_{t_{10}}p_y \end{aligned} \tag{14}$$

Where $B_1, B_2, B_3, \cdots, B_{10}$ are the amount of education funding at certain ages. By using the equivalence principle while the cost of education insurance is set to $z\%$ of the premium, it is obtained a formula to state the amount of education funding at certain ages.

$$mP^B \ddot{a}^{(m)}_{xy::\overline{n|}} = \frac{i}{\ln(1+i)} MA^{1}_{\overline{xy}:\overline{m|}} + nupt[0] + 0.05 \times 12 P^B \ddot{a}^{(m)}_{xy::\overline{n|}} \tag{15}$$

or

$$P^B = \frac{\frac{i}{\ln(1+i)} M(1 - d\ddot{a}_{xy:\overline{m|}} - v^m{}_m p_{xy}) + nupt[0]}{(1 - z\%) \times 12 \ddot{a}^{(m)}_{xy::\overline{n|}}} \tag{16}$$

with

$$nupt[0] = \sum_{i=1}^{10} B_i v^{t_i}{}_{t_i}p_y \tag{17}$$

To calculate the premium value in **Equation (16)**, an application program was developed using the Python programming language. This application requires less time than conventional applications, for example, Ms. Excel Macro. The manufacturing process follows the flowchart in **Figure 1**.

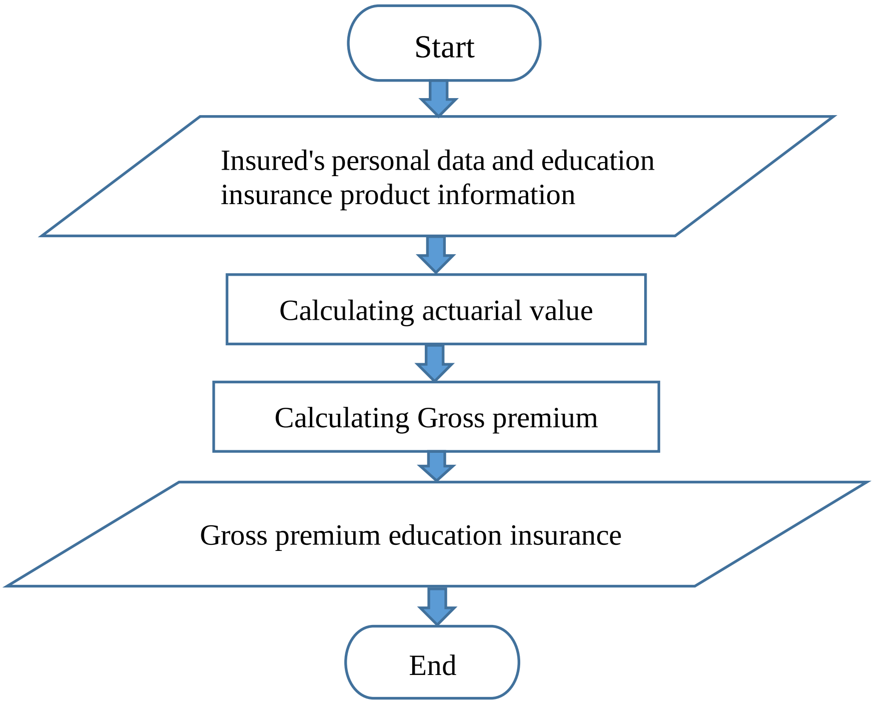

Figure 1. Flowchart

The input of this program is shown in **Figure 2**

```
Insured's Age: 40
Child's Age: 1
Premium Payment Term: 10
Number of Premium Payments in a Year: 12
Interest: 0.05
Death Benefit: 50000000
```

Figure 2. Python Programming Input

The output is shown in **Figure 3**

```
Number of Premium Payments: 12  Times a Year
Gross Premium =  404145.0
```

Figure 3. Gross Premium

By using **Equation (16)**, the programming software that has been created for the insurance costs of $z = 5\%$ and 8% of the premium, and interest rates $i = 5\%$, 6%, and 7% the calculation results made by the software are listed in **Table 2**.

Table 2. Premium Value Paid for Interest Rates 5%, 6%, and 7%

Interest	Annual Premium		Monthly Premium	
	Expenses			
	5%	8%	5%	8%
5%	$Rp4{,}745{,}348.-$	$Rp4{,}900{,}088.-$	$Rp404{,}145.-$	$Rp417{,}323.-$
6%	$Rp4{,}434{,}429.-$	$Rp4{,}579{,}030.-$	$Rp379{,}237.-$	$Rp391{,}604.-$
7%	$Rp4{,}156{,}208.-$	$Rp4{,}291{,}737.-$	$Rp356{,}902.-$	$Rp368{,}540.-$

From **Table 2** it can be seen that the annual premium is more than 4 million rupiahs but less than 5 million rupiahs. Furthermore, the higher the interest rate used, the cheaper the premium price. On the other hand, the greater the fee charged, the more expensive the premium price that education insurance program participants must pay It is important to note that the market price premium for this case is 5 million rupiahs.

4. CONCLUSIONS

Based on the case study, the annual premium price calculated using software that has been developed is very competitive or below market price, which is more than 4 million rupiahs but less than 5 million rupiahs. The market price for this product is 5 million rupiahs.

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