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MULTI-STATE MODEL FOR CALCULATION OF LONG-TERM CARE INSURANCE PRODUCT PREMIUM IN INDONESIA

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Abstract. *Long Term Care (LTC) insurance is a type of health insurance. One of the LTC products is Annuity as A Rider Benefit. This insurance provides benefits for medical care costs during the term and death benefits if the insured dies. This insurance product can be modeled with a multi-state model. The multi-state model is a stochastic process in which the subject can switch states at a specified number of states. This paper discusses the calculation of LTC insurance premiums with the Annuity as A Rider Benefit product using a multi-state model for critically ill patients in Indonesia. The state used consisted of eight states, namely healthy, cancer, heart disease, stroke, died from the illness from each disease, and died from others. The premium calculation also utilized Markov chain transition probabilities. The data used were data on Indonesia's population in 2018, data on the prevalence of cancer, heart disease, stroke, and Indonesia's 2019 mortality table. The stages of this study were calculating the net single premium value, benefit annuity value, and insurance premium value. The case study was conducted on a 25 years old male in good health following LTC insurance with a coverage period of 5 years. It was known that the compensation value for someone who dies was IDR 100,000,000 and the interest rate used was 5%. The calculation results obtained an annual premium of IDR 5,308,915 which was then varied based on gender and varied interest. Insurance premiums for men were more expensive than for women since men had a greater chance of dying. Then, the higher the interest rate taken; the lower premium paid. This was because the interest rate is a discount variable.*

Keywords: *Markov Chain, Rider Benefit*

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1. INTRODUCTION

Health insurance is an insurance that covers medical expenses incurred due to an illness. The costs covered can be in the form of hospitalization costs, drug costs, or doctor's consultation fees. Calculation of health insurance must be done accurately and optimally, requiring statistical data for a disease. However, the availability of statistical data for a disease tends to be limited in developing countries [1]. The same thing also happened in Indonesia, which has limited statistical data on the disease. Meanwhile, disease statistics are very useful in modeling health insurance products [2].

Various studies have been conducted related to the calculation of health insurance premiums, one of which was modeled using a multi-state model. A multi-state model involves a stochastic process that can occupy one of a number of possible states, which may for instance represent different stages of a chronic disease [3]. Change in the states occupied by a person is called a transition or event. The complexity of a model greatly depends on the number of states and also on the possible transitions [4]. Several health insurance companies use this model to model insurance products, one of which is the Long-Term Care (LTC) insurance product. The LTC involves a range of support and services for people with chronic illness and disabilities who cannot perform activities of daily living independently [5].

The LTC insurance is the necessary care insurance for critical illness. The benefits provided are in the form of cash coverage that can be used by policyholders for medical expenses for chronic illnesses suffered [2]. The LTC insurance began to develop along with the increasing incidence of critical illness in the community. Critical illness is a disease that requires long-term health care and is difficult to return to normal [1]. Critical diseases that often occur in the community are heart disease, cancer, stroke, and kidney failure, classified as non-communicable diseases. Critical diseases that are the dominant causes of death in Indonesia are cancer, heart disease, and stroke [6]. Statistical data in 2018 show that the death rate from cancer is 234,511 deaths, followed by deaths from heart disease 400,905 deaths, and deaths from stroke 449,361 deaths [7].

This study aims to determine the premium for LTC insurance products with a multi-state model, then determine the Markov Chain transition matrix to create a state that can move to another state. Therefore, the amount of premium on the LTC insurance product, Annuity as A Rider Benefit, can be determined. Accurate premium calculations are needed for insurance companies to guarantee payment of claims and compensation without experiencing losses. The data used in this study were data on the population of Indonesia in 2018, data on the prevalence of cancer, heart disease, and stroke, as well as Indonesia's 2019 mortality table. The premium calculation began by calculating the population of each age using linear interpolation. Data on the population of each age obtained were used to determine the prevalence of each disease. The mortality table was used to determine the probability of death for each disease at each age. Furthermore, a multi-state model was formed by compiling a transition matrix accompanied by determining the age of the insured, the time of coverage, the amount of compensation to be given, and the interest rate. This study found that the annual premium value of the LTC insurance can be used as a reference for paying insurance premiums.

2. RESEARCH METHODS

2.1 Linear Interpolation

Interpolation is the process of finding or calculating the value of a function where the graph passes through a known set of points[8]. These points are experimental results in an experiment or can be obtained from a known function. Linear interpolation is a way of determining the value between two known values based on a linear (straight line) equation [9].

Figure 1 visualizes a linear interpolation equation that passes through 2 points, namely $P_1(x_1, y_1)$ and $P_2(x_2, y_2)$:

$$y = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1) + y_1 \tag{1}$$

The ratio of distance $(y - y_1)$ to distance $(y_2 - y_1)$ is the same as the ratio of distance $(x - x_1)$ to distance $(x_2 - x_1)$.

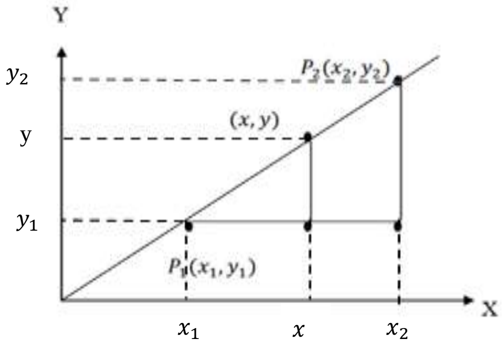

Figure 1. Linear Interpolation Graph

2.2 Multi-State Model

Multi-state models are models for a stochastic process, which at any time occupies one of a set of discrete states [10]. A state transfer is called a transition. In this study, there were eight states as follows: (1) healthy incidence, (2) incidence of cancer, (3) incidence of heart disease, (4) incidence of stroke, (5) incidence of death due to other causes, (6) incidence of death due to cancer, (7) incidence of death due to heart disease, and (8) incidence of death due to stroke. Therefore, the process of determining the states in this study can be seen in the following figure:

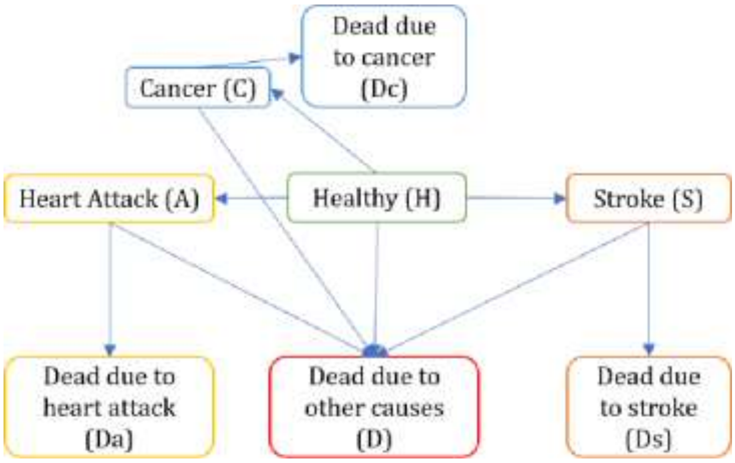

Figure 2. State and Transition [11]

Figure 2 presents some transitions ignored because the required data were not available. The transitions that were not available include the possibility of the insured suffering from cancer (*C*) dying due to a heart attack (*A*) or stroke (*S*), or vice versa.

2.3 Transition Probability

The condition of the insured at the time of issuance of the policy ($t = 0$) means that he is in good health. Determined that the random variable $Y(t)$ at t, for $t \geq 0$, the value of each state (*state space*) was $\mathcal{E} = \{H, C, A, S, D, Dc, Ds, Da\}$, defined as follows [11]:

$$Y(t) = i \qquad , t \geq 0, i \in \mathcal{E} \tag{2}$$

Implying that at time t the insured aged $x + t$ is either healthy alive (*H*), is diagnosed as having one of the diseases (*C*, *A*, *S*), or is dead due to one of the various causes described in our model (*D*, *Dc*, *Da*, *Ds*) [11].

The transition probability is defined as the conditional probability of an insured aged x being in state i, then being in state j at the age of $(x + t)$, expressed as follows [11]:

$${}_tp_x^{ij} = Pr\{Y(x+t) = j | Y(x) = i\}, x \geq 0, t \geq 0, i, j \in \mathcal{E} \tag{3}$$

Figure 2 shows that the recovery of the insured's illness state is not considered. Hence, there is a possibility that some transitions are zero and the healthy insured will not switch to death from the disease directly. The transition probability matrix for insurance from age x to $(x+t)$ is as follows:

$$
{}_t\boldsymbol{P}_x = \begin{array}{c} \\ \end{array}
\begin{array}{c}
\begin{matrix} H & C & A & S & D & Dc & Da & Ds \end{matrix} \\
\begin{bmatrix}
{}_tp_x^{HH} & {}_tp_x^{HC} & {}_tp_x^{HA} & {}_tp_x^{HS} & {}_tp_x^{HD} & 0 & 0 & 0 \\
0 & {}_tp_x^{CC} & 0 & 0 & 0 & {}_tp_x^{CDc} & 0 & 0 \\
0 & 0 & {}_tp_x^{AA} & 0 & 0 & 0 & {}_tp_x^{ADa} & 0 \\
0 & 0 & 0 & {}_tp_x^{SS} & 0 & 0 & 0 & {}_tp_x^{SDs} \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix}
\end{array}
\begin{matrix} \\ H \\ C \\ A \\ S \\ D \\ Dc \\ Da \\ Ds \end{matrix} \tag{4}
$$

2.4 Premium for LTC Annuity as A Rider Benefit Insurance

Annuity as a Rider Benefit is a product of the LTC insurance that provides benefits for medical treatment costs for a period of time and death benefits if the insured person dies, either dies due to the illness he or she suffers from, or dies without experiencing any prior illness[12]. In the Annuity as A Rider Benefit product, there is no transition from a sick state to a healthy state[13]. c is denoted as death compensation given when the insured dies, while b is denoted as a benefit paid regularly every year if the insured experiences a treatment period. It is assumed that $b = \frac{c}{r}$, with r is the maximum value of the annuity payment period if the dependent is in treatment. The discount factor is formulated as $v = \frac{1}{1+a}$ where a is the interest rate.

Based on Figure 2 and Equation 5, then net single premium value of the LTC insurance is based on Annuity as a Rider Benefit as follows:

$$
A_{x:n]}^{LTC} = \left(c\sum_{e=1}^{n-1} v^e \; {}_{e-1}p_x^{11} p_{x+e-1}^{15} \right) + \left(\sum_{e=1}^{n-1} v^e \; {}_{e-1}p_x^{11} p_{x+e-1}^{12} \times b\ddot{a}_{x+e:r]}^{22} + CD \right) + \left(\sum_{e=1}^{n-1} v^e \; {}_{e-1}p_x^{11} p_{x+e-1}^{13} \times b\ddot{a}_{x+e:r]}^{33} + AD \right) + \left(\sum_{e=1}^{n-1} v^e \; {}_{e-1}p_x^{11} p_{x+e-1}^{14} \times b\ddot{a}_{x+e:r]}^{44} + SD \right) \tag{5}
$$

Equation (5) is divided into four components, consisting of:

$$A_{x:n]}^{LTC} = D + P_C + P_A + P_S$$

CD equation:

$$CD = \sum_{h=1}^{r} (c - hb) v^h \times {}_{h-1}p_{x+e}^{22} \times p_{x+e+h-1}^{26} \tag{6}$$

AD equation:

$$AD = \sum_{h=1}^{r} (c - hb) v^h \times {}_{h-1}p_{x+e}^{33} \times p_{x+e+h-1}^{37} \tag{7}$$

SD equation:

$$SD = \sum_{h=1}^{r} (c - hb) v^h \times {}_{h-1}p_{x+e}^{44} \times p_{x+e+h-1}^{48} \tag{8}$$

If the LTC insurance premium is paid at the beginning of each year for m years when the insurance is still in good health, then the value of the insurance premium [1] is the following:

$$P\ddot{a}_{x:m]}^{11} = A_{x:n]}^{LTC} \tag{9}$$

$$\ddot{a}_{x:m\rceil}^{11} = \sum_{e=0}^{m-1} v^e \ {}_e p_x^{11} \tag{10}$$

3. RESULTS AND DISCUSSION

Data on Indonesia's population based on age range in 2018 obtained from Statistics Indonesia is presented in Figure 3 [14]. Based on Figure 3, the data obtained were still based on age groups. Accordingly, interpolating is necessary to get the number of people for each age. The interpolation used was linear interpolation. Linear interpolation is a simple way of finding the value between two points. The male population data were used as an illustrative example. The male population in Indonesia for 15-19 years was 11,378,700 people. In interpolation, it took y_1 as the total population of Indonesia who was exactly at the age of 15 years, then it was assumed that the number of people aged 15 years was obtained from the total population aged 15-19 years divided by 5 [6]. The same method was used to obtain the number of residents who were exactly 20 years old, 25 years old, and so on. Therefore, the Indonesian male population at the age of 15 was 2,275,740.

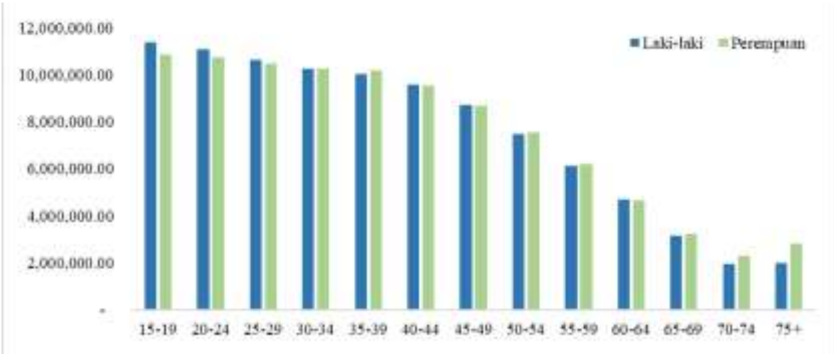

Figure 3. Total Indonesian Population Based on Age Range in 2018 [14]

Then, to find out the proportion (y) of the male population at the age of 16 years, the calculation done was as follows:

x = 16 years old — y : the number of the male population in Indonesia aged 16 years
x_1 = 15 years old — y_1 : the number of the male population in Indonesia aged 15 years
x_2 = 20 years old — y_2 : the male population in Indonesia aged 20 years.

Thus, the number of the male population at the age of 16 years was obtained as follows:

$$y = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1) + y_1 = \frac{2.219.420 - 2.275.740}{20 - 15}(16 - 15) + 2.275.740 = 2.264.476$$

From the calculation, the total population of Indonesia at the age of 16 years was 2,264,476 people. The following is the result of the interpolation of population data for each age based on gender.

Table 1. Result of Interpolation of Indonesia's Population in 2018

Age	Male	Female
15	2.275.740	2.172.840
16	2.264.476	2.167.320
17	2.253.212	2.161.800
18	2.241.948	2.156.280
19	2.230.684	2.150.760
20	2.219.420	2.145.240
⋮	⋮	⋮
72	393.652	497.956
73	396.588	518.964
74	399.524	539.972
75	402.460	560.980

3.1. Prevalence Data of Cancer, Heart Disease, and Stroke

Based on 2018 Basic Health Research data, the number of people with cancer, heart disease, and stroke in Indonesia was 4,743,774 people, 3,975,230 people, and 2,888,667 people [6]. Compared to the total population of Indonesia, the percentage of patients with cancer, heart disease, and stroke was 1.79%, 1.50%, and 1.09%.

In determining critical illness insurance premiums, data on the prevalence of each disease and age are needed. Disease prevalence data were calculated for the population aged 18-75 years. The prevalence of the disease for each age was calculated as follows:

$$Prev_x^{(i)} = (L_x^g \times prev^i)/L^g \tag{11}$$

$Prev_x^{(i)}$: prevalence of disease i at age x
L_x^g : the number of populations by gender at age x, where $g = male, female$
$prev^i$: percentage of total patients in disease i, where $i = C, A, S$
L^g : the number of populations by gender at the age of 18-75 years, where $g = male, female$

Table 2. Prevalence Data for Each Disease

Age	Male (%)			Female (%)		
	Cancer	Heart Disease	Stroke	Cancer	Heart Disease	Stroke
18	0.0472	0.0396	0.0288	0.0452	0.0378	0.0275
19	0.0470	0.0394	0.0286	0.0450	0.0377	0.0274
⋮	⋮	⋮	⋮	⋮	⋮	⋮
74	0.0084	0.0071	0.0051	0.0113	0.0095	0.0069
75	0.0085	0.0071	0.0052	0.0117	0.0098	0.0072
Total	**1.7900**	**1.5000**	**1.0900**	**1.7900**	**1.5000**	**1.0900**

For example, to get the prevalence of a male with cancer at the age of 18, by using the following Equation (11):

$$\begin{aligned} Prev_{18}^c &= \frac{L_{18}^{male} \times prev^c}{L^{male}} \\ &= \frac{2{,}241{,}948 \times 1.79\%}{170{,}409{,}172} \\ &= 0.0472\% \end{aligned}$$

This means that of the 2,241,948 male population aged 18 years, 0.0472% suffered from cancer, or around 1,059 people. The same calculation was also carried out for the other two diseases.

3.2. Death Probability Data

The 2019 Indonesian Mortality Table (TMI 2019) was used as the probability of death reference [15]. Based on the 2018 Basic Health Research data, the number of deaths from cancer in Indonesia was 234,511 people, or the probability was $f^C = 4.94\%$ of the total number of sufferers. In patients with heart disease, the number of deaths in Indonesia was 2,784,064 people or the probability was $f^A = 14.4\%$ of the number of patients. Then, the number of deaths due to stroke was 4,493,612 people or the probability was $f^S = 15.4\%$ of the number of sufferers.

In determining critical illness insurance premiums, mortality prevalence data for each disease and age is needed. Mortality prevalence data was calculated in the population aged 17-75 years. The prevalence of mortality for each age was calculated as follows:

$$prev\ q_x^i = q_x^g \times f^i \tag{12}$$

$prev\ q_x^i$: prevalence of mortality of disease i at age x
q_x^g : the probability of a person dying by gender at the age x, where $g = male, female$

f^i : the percentage of deaths in disease i, where $i = C, A, S$

Below is an example of the probability of death prevalence for a male with cancer at the age of 18 years using Equation (11):

$$prev\ q_{18}^{C} = q_{18}^{male} \times f^{C}$$
$$= 0.0004 \times 4.94\% = 0.002124\%$$

Thus, men aged 18 years have a probability of dying from cancer of 0.002124%. The same calculation was done at other ages. Some data on the prevalence of disease mortality for males and females are presented in Table 3 below:

Table 3. Probability of Death Due to Critical Illness

Age	Male (%)			Female (%)		
	Cancer	Heart Disease	Stroke	Cancer	Heart Disease	Stroke
18	0.00212	0.00619	0.00662	0.00124	0.00360	0.00385
19	0.00232	0.00677	0.00727	0.00128	0.00374	0.00400
20	0.00242	0.00706	0.00755	0.00133	0.00389	0.00416
⋮	⋮	⋮	⋮	⋮	⋮	⋮
75	0.10008	0.0071	0.31200	0.08610	0.25099	0.24948

3.3. Transition Matrix Development

In preparing the matrix, a one-way transition was used with an eight-state model. The eight states include 1) healthy, 2) cancer, 3) heart disease, 4) stroke, 5) died of other causes, 6) died of cancer, 7) died of heart disease, 8) died of a stroke. The transition diagram in this study is visualized in Figure 4.

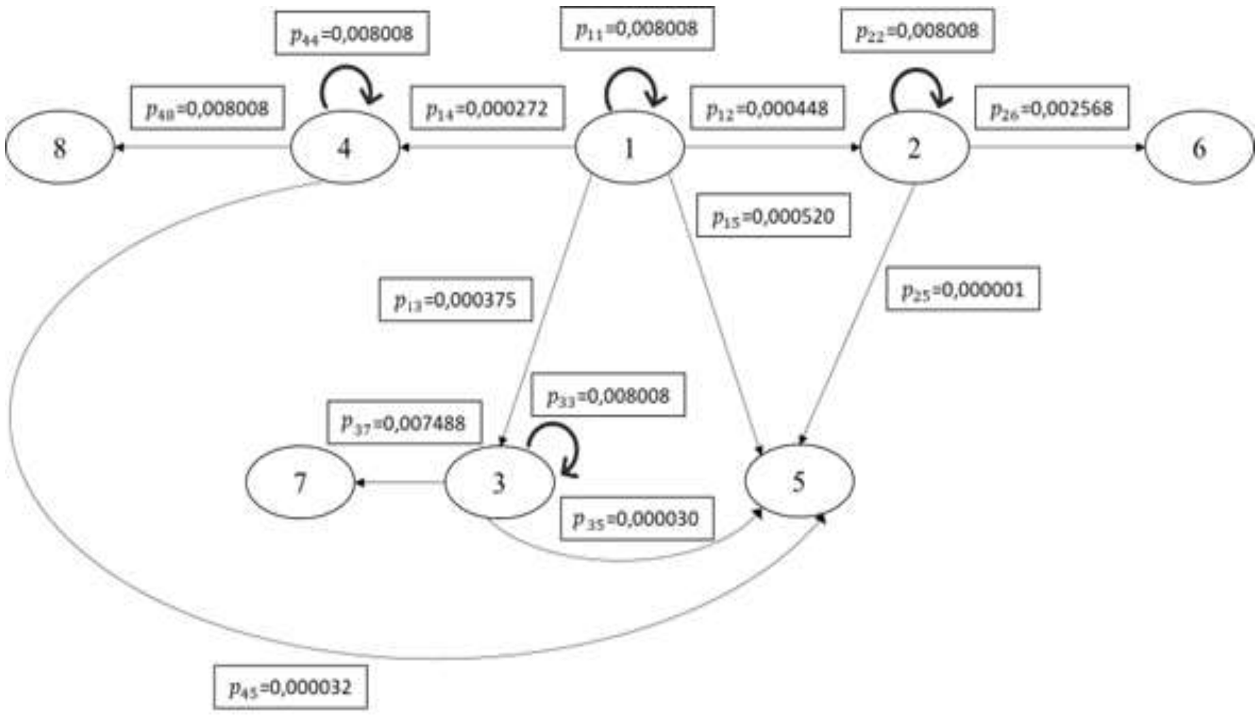

Figure 4. The Eight-State Model Transition Diagram

Then, the transition probability matrix h steps for 25-year-old male with a coverage period of 5 years was calculated by multiplying the matrix with $h = 1,2,3,4,5$. 5 steps transition matrix is as follows:

$$ {}_{1}p_{25}^{ij} = \begin{bmatrix} 0{,}980319 & 0{,}000448 & 0{,}000375 & 0{,}000273 & 0{,}000520 & 0 & 0 & 0 \\ 0 & 0{,}997431 & 0 & 0 & 0 & 0{,}002569 & 0 & 0 \\ 0 & 0 & 0{,}992512 & 0 & 0 & 0 & 0{,}007488 & 0 \\ 0 & 0 & 0 & 0{,}991992 & 0 & 0 & 0 & 0{,}008008 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \quad {}_{2}p_{25}^{ij} = \begin{bmatrix} 0{,}9599814 & 0{,}000883 & 0{,}000738 & 0{,}0005361 & 0{,}0010592 & 0 & 0 & 0 \\ 0 & 0{,}9947212 & 0 & 0 & 0 & 0{,}000829 & 0 & 0 \\ 0 & 0 & 0{,}9846513 & 0 & 0 & 0 & 0{,}001538 & 0 \\ 0 & 0 & 0 & 0{,}9835898 & 0 & 0 & 0 & 0{,}002678 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} $$

$$ {}_{3}p_{25}^{ij} = \begin{bmatrix} 0{,}9383575 & 0{,}0013047 & 0{,}0010871 & 0{,}0007895 & 0{,}001635 & 0 & 0 & 0 \\ 0 & 0{,}9917728 & 0 & 0 & 0 & 0{,}008227 & 0 & 0 \\ 0 & 0 & 0{,}997519 & 0 & 0 & 0 & 0{,}023856 & 0 \\ 0 & 0 & 0 & 0{,}99578 & 0 & 0 & 0 & 0{,}025498 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \quad {}_{4}p_{25}^{ij} = \begin{bmatrix} 0{,}915550 & 0{,}001712 & 0{,}001422 & 0{,}001032 & 0{,}002245 & 0 & 0 & 0 \\ 0 & 0{,}988588 & 0 & 0 & 0 & 0{,}011411 & 0 & 0 \\ 0 & 0 & 0{,}967007 & 0 & 0 & 0 & 0{,}03299 & 0 \\ 0 & 0 & 0 & 0{,}964746 & 0 & 0 & 0 & 0{,}035253 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} $$

$$ {}_{5}p_{25}^{ij} = \begin{bmatrix} 0{,}891669 & 0{,}0021054 & 0{,}0017422 & 0{,}0012643 & 0{,}002886 & 0 & 0 & 0 \\ 0 & 0{,}9851697 & 0 & 0 & 0 & 0{,}014830295 & 0 & 0 \\ 0 & 0 & 0{,}9572598 & 0 & 0 & 0 & 0{,}0427402 & 0 \\ 0 & 0 & 0 & 0{,}9543467 & 0 & 0 & 0 & 0{,}0456533 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} $$

3.4. Calculation of Net Premiums for Long-Term Insurance

In this study, an example of a premium calculation case with a policy agreement was taken as follows:

1. At the policy agreement, the insured (policyholder) was a 25-year-old male in good health ($x = 25$).
2. The insurance coverage period is 5 years ($n = 5$).
3. If the insured dies during the coverage period due to other cases, the heirs will receive a lump sum compensation of 100 million rupiah ($c = 100{,}000{,}000$).
4. If the insured suffers from cancer/heart/stroke (i) during the coverage period, then at the beginning of each year, the insured will receive treatment compensation of b, with $b = c/r$.
5. If the insured dies before the compensation payment period ends (before the length of the insurance period ends), namely in the h year, the heirs will receive compensation of ($c - b$ min (h, r)).
6. Premiums are paid at the beginning of each year as long as the insured is in good health with an interest rate of 5% ($a = 0{,}05$), $v = \frac{1}{1+0.05}$

The calculation of the net premium was based on Equation 5 to Equation 10 as follows:

1. The premium for death due to other cases (D). For example, the calculation of the net single premium for a 25-year-old man, namely:

$$ D = 100{,}000{,}000 \times \sum_{e=1}^{5-1} (1+0.05)^{-e} \times {}_{e-1}p_{25}^{11} \times p_{25+e-1}^{15} = 196{,}356 $$

2. The amount of premium when someone from a healthy state then switches to suffering from cancer (C). For example, the calculation of the net single premium for a 25-year-old man, namely:

$$ CD = \sum_{h=1}^{r} (100{,}000{,}000 - hb)(1+0.05)^{-h} \times {}_{h-1}p_{25+e}^{22} \times p_{25+e+h-1}^{26} $$

$$ P_C = \sum_{e=1}^{5-1} (1+0.05)^{-e} \times {}_{e-1}p_{25}^{11} \times p_{25+e-1}^{12} \times b\ddot{a}_{x+e:r\rceil}^{22} + CD = 3{,}131{,}238 $$

3. The amount of premium when someone from a healthy state then switches to suffering from heart disease (A). For example, the calculation of the net single premium for a 25-year-old man, namely:

$$AD = \sum_{h=1}^{r} (100{,}000{,}000 - hb)(1+0.05)^{-h} \times {}_{h-1}p_{25+e}^{33} \times p_{25+e+h-1}^{37}$$

$$P_A = \sum_{e=1}^{5-1} (1+0.05)^{-e} \times {}_{e-1}p_{25}^{11} \times p_{25+e-1}^{13} \times b\ddot{a}_{x+e:r]}^{22} + AD = 9{,}067{,}110$$

4. The amount of premium when someone from a healthy state then switches to suffering a stroke (S). For example, the calculation of the net single premium for a 25-year-old man, namely:

$$SD = \sum_{h=1}^{r} (100{,}000{,}000t - hb)(1+0.05)^{-h} \times {}_{h-1}p_{25+e}^{44} \times p_{25+e+h-1}^{48}$$

$$P_S = \sum_{e=1}^{5-1} (1+0.05)^{-e} \times {}_{e-1}p_{25}^{11} \times p_{25+e-1}^{14} \times b\ddot{a}_{x+e:r]}^{44} + SD = 9{,}691{,}307$$

5. Based on Equation 5, the calculation of the net single premium is as follows

$$A_{x:n]}^{LTC} = D + P_C + P_J + P_S$$
$$= 196{,}356 + 3{,}131{,}238 + 9{,}067{,}110 + 9{,}691{,}307 = 22{,}086{,}011$$

Hence, the annual net premium is:

$$P = \frac{A_{25:5]}^{LTC}}{\ddot{a}_{25:5]}^{11}} = \frac{22{,}086{,}011}{4.160174} = 5{,}308{,}915$$

The insurance premium for a 25-year-old male with a coverage period of 5 years for a lump sum payment is IDR 22,086,011. Meanwhile, the annual premium is IDR 5,308,915. The amount of insurance premium is cheaper if paid all at once compared to being paid periodically every year. This is because the premium payment, as well as the administration fee, is charged only once. If the premium is paid periodically, then the administrative process and financing that will be charged will also be periodic.

3.5. Net Single Premium and Variable Interest Rate

The premium calculation was also carried out for varied gender and interest rate. Table 4 presents the net single premium with maturities of 3 years, 4 years, and 5 years, based on gender and interest rate.

Table 4. The LTC Single Premium with Varied Interest

Inte-rest	3 years		4 years		5 years	
	Male	Female	Male	Female	Male	Female
4%	11,164,241	8,369,000	16,796,607	12,590,307	22,519,144	16,873,343
5%	11,019,118	8,261,649	16,526,475	12,388,486	22,086,011	16,548,670
6%	10,877,524	8,156,008	16,264,059	12,192,413	21,667,201	16,235,681

Based on Table 4, it can be concluded that the value of insurance premiums for males is greater than for females. This is influenced by the probability of death or the probability of contracting an illness where a male is greater than a female. Moreover, it can also be concluded that the higher the interest rate, the lower the premium value. This is because the risk-free interest rate is a discount variable.

4. CONCLUSIONS

1. The annual net premium that must be paid by the male insured to the insurer for the age of 25 years with 5% interest is IDR 5,308,915.
2. Based on the results of the case study in this study, the premium amount with varying interest rates for a person who is male and female aged 25 years is as follows. If the annuity is 4%, the net premium for a male is IDR 22,519,144 and for a woman, the net premium to be paid is IDR 16,873,343. If the annuity is 5%, the net premium for a male is IDR 22,086,011 and for a woman, the premium to be

paid is IDR 16,548,670. If the annuity is 6%, the net premium for a male is IDR 21,667,201 and for a woman, the premium to be paid is IDR 16,235,681. Accordingly, it can be concluded that the premium for men aged 25 years tends to be higher than the premium for women of the same age. This is because the number of sufferers and the probability of death of a person is higher than that of a female. Meanwhile, based on the interest rate, the higher the interest rate taken, the cheaper the premium paid. This is because the risk-free interest rate is a discount variable.

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