Determination of the Annual Pension Fund Premium for Joint-Life Status Using the Aggregate Cost Method

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ABSTRACT

A pension fund is one of the responsibilities of an institution or company for all employees during their working life. In pension fund insurance, several agreements must be agreed upon by the insured and the insurer for the agreement, namely the premium. The premium to be paid by the insured (employee) of the pension fund insurance must adjust to the income earned, so that the premium to pay does not burden the insured. This study aims to determine the annual pension fund premium amount that must pay use the Aggregate Cost method in the joint-life case. The case study uses information from a husband and wife as civil servants with a husband class III B and wife III A participating in a pension program with a retirement age limit of 58 years (r = 58). The husband (insured x) was 28 years old, and the wife (insured y) was 24 when they started working and joined the pension program. The result of calculating the value of the annual pension fund insurance premium that must pay use the Aggregate Cost method is Rp.41,440,163. If the husband's age is lower than the wife's (x=24, y=28), then the value of the premium paid is more significant than when the husband's age is higher than the wife's (x=28, y=24), which is IDR 41,594,217. That is because the husband's working period is more extended than the wife's, while the chance of death for men is higher than for women. Meanwhile, premiums producing if the husband and wife are of the same age, which is cheaper than when the husband and wife are of different ages.

1. Introduction

The productivity of employees or employees can be optimized in several ways, one of which is guaranteeing welfare when they can no longer work by providing a pension fund. Employees will feel safe when they reach retirement age with that pension fund insurance. On the other hand, the positive impact that the company can receive if it provides insurance to employees is that it can ease the company's finances by transferring employee risks to insurance companies [1]. In addition, this can be a way for companies to repay employees who have dedicated their lives to the company.

Pension fund insurance provides benefits that can be taken every month or all at once in the form of cash to participants when they reach retirement age [2]. Pension benefits have stipulated in pension fund regulations, with all contributions being the employee's expense deducted from the salary [3]. Contributions, or, in this case, premiums, are a series of payments made by employees as policyholders. An institution or company can employ employees with family relationships such as husband and wife, mother and children, and others. In this case, the pension fund insurance company can provide coverage by grouping the age of the participants, for example, the status of husband and wife, aged x and y. The term of this grouping in the actuarial is called a joint (joint life).

The determination of retirement age is standard and accelerated retirement age. The standard retirement age is the lowest, and employees or employees are entitled to retire by obtaining full pension benefits without needing approval from the employer [4]. The standard retirement age is 56, but the average retirement age is 65 for educators. In contrast, the accelerated retirement age is a retirement age that has not met the normal retirement age or retires before reaching the retirement age limit [5].

The Aggregate Cost method is a premium calculation method by grouping certain characteristic equations. The method indicates the standard contribution rate or premium that must be paid depending on the level of actuarial liability financing at a specific time [6]. The value of pension benefits is based on past service when working up to a predetermined time. Applying this method assumes that all pension fund insurance participants do not see individually but as a unit.

This study discusses the amount of the annual pension fund premium in combined life insurance with two insureds (husband and wife) using the Aggregate Cost method. The case study in this research is when the husband is older than the wife ($x > y$), the husband is younger than the wife ($x < y$), and the husband is the same age as the wife ($x = y$). The calculation begins by collecting information on the 2019 Indonesian Mortality Table (TMI), interest rates, and initial working salaries of the two insureds consisting of husband (x) and wife (y). Next, calculate the joint lifetime annuity and the annual salary to get the total salary. After that, calculate the present value and the premium to be paid from the pension benefits using the Aggregate Cost method.

2. Research Methods

2.1 Pension Fund

The Pension Fund is a legal entity independent and separate from the employer, whose function is to manage and run the pension program following applicable regulations [7]. Pension programs divide into two types, namely Defined Benefit Pension Plans (PPMP) and Defined Contribution Pension Programs (PPIP) [8]. The Defined Benefit Pension Plan is a program in which pension benefits have to stipulate in the Pension Fund regulations. All contributions are charged to employees who are deducted from their salary. Meanwhile, the Defined Contribution Pension Plan is a program in which pension benefits depend on the results of the wealth development of the pension fund. All contributions are jointly borne by the employee and the employer [3].

2.2 Salary Function

Salary is remuneration received by workers based on a specific time. Suppose a pension plan has benefits related to the rate of increase in the salary of the pension program participants. In that case, it is necessary to formulate a salary notation and a procedure for calculating the estimated salary. Suppose a model salary increase rate per year is c%. Then the salary increase rate becomes [6]:

$$s_{x+t} = s_x(1+c)^t \tag{1}$$

The total amount of the insured's salary at retirement,

$$S_r = \sum_{t=0}^{r-x-1} s_{x+t} \tag{2}$$

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with:

x : Age of the insured when starting work (years)
t : Time (years)
r : Retirement age
c : Salary increases rate (%)
s_x : The amount of the insured's salary when starting work
S_r : The total amount of the insured's salary at retirement

2.3 Benefit Function

The size of the pension benefit (B_r) obtained from the employee's total salary after being registered as a pension program life insurance insured until retirement age multiplied by the percentage of salary prepared for retirement benefits (k). The formula used to calculate the number of pension benefits[4], namely:

$$B_r = k \times S_r \tag{3}$$

2.4 Joint Life Annuity

An annuity is a series of payments continuously made at specific intervals with the same amount of money [9]. A joint life annuity is a series of payments by two or more insureds, with payments stopping when one of the insureds dies or, in this study, retirement. The n-year initial life annuity value for the two insureds aged x dan y [9] is:

$$\ddot{a}_{xy:\overline{n}} = \sum_{t=0}^{n-1} v^t \, ({}_t p_{xy}) = \sum_{t=0}^{n-1} v^t ({}_t p_x)({}_t p_y) \tag{4}$$

The notation $_t p_x$ is probability of a person aged x surviving t years later. Meanwhile, v is the discount function of an interest rate.

2.5 *Aggregate Cost*

The premium calculation using the Aggregate Cost method uses the total salary from the length of service as a reference for calculating the premium amount. However, for the nominal price, the premium paid and the benefits received are fixed (agreement price) according to the contract. For example, l_x is the number of pension fund insurance participants aged x while l_r is the number of participants at retirement age. Then a lifetime initial annuity for a person of retirement age.

The present value of pension benefits for the insured aged x years uses the following **Equation [2]**:

$$A_x = B_r \frac{D_r}{D_x} \ddot{a}_r = B_r \frac{v^r l_r}{v^x l_x} \ddot{a}_r \tag{5}$$

The present value of retirement benefits for the joint life of a man aged x and a woman aged y uses the following **Equation [2]**:

$$A_{xy} = \left(B_{r(x)} + B_{r(y)}\right) \frac{D_{rr}}{D_{xy}} \ddot{a}_{rr} \tag{6}$$

The amount of retirement benefits for men aged x, denoted $B_{r(x)}$, while the amount of pension benefits for women aged y, denoted $B_{r(y)}$.

The commutation function for the joint life status of the two insureds state as follows:

$$D_{xy} = v^{\frac{1}{2}(x+y)} l_{xy} \tag{7}$$

Then for participants who retire at the same age, namely r years, it becomes:

$$D_{rr} = v^{\frac{1}{2}(r+r)} l_{rr} \tag{8}$$

The combined initial lifetime annuity cash value of two pension fund participants aged x and y, retiring at the same age, i.e., r years, is stated as follows:

$$\ddot{a}_{rr} = \sum_{t=0}^{\omega-r} v^t \, {}_t p_{rr}$$

In practice, the total funds collected will be invested and developed by the insurer so that the insurer will have accumulated funds based on investment management. At the end of the pension fund, the insurance year will have an accumulation of F_n. The life insurance pension program has accumulated funds originating from funds accumulated at the beginning of F_{n-1}, namely funds stored in the system at the initial agreement between the insured and the insurer, plus the actual contribution (life insurance pension program contribution) received AC_n for the insured x years is obtained as follows:

$$AC_n^{(x)} = i[S_x(1+i)^m] \left(\frac{v^r l_r + \cdots + v^\omega l_\omega}{(v^x l_x + \cdots + v^\omega l_\omega) - (v^r l_r + \cdots + v^\omega l_\omega)}\right) \tag{10}$$

with:

m : Payment period (monthly)

i : Interest rate

v : Discount rate

r : Interest age

ω : Maximum age limit

l_r : The number of people living at the age of r years

l_ω : The number of people living when they are ω years

The actual contribution value received for the joint life of two people aged x and y uses the following equation:

$$AC_n = AC_n^{(x)} + AC_n^{(699i9 \quad n\ jeuu)}$$

The actual return on investment (IR_n) for insured x is obtained as follows:

$$IR_n^{(x)} = \left((1+i)^{m-1}\left(F_{n-1}^{(x)}\right)\right) + AC_n^{(x)} + (1+i)^{m-1}$$

Meanwhile, for joint life, two people aged x and y are:

$$IR_n = IR_n^{(x)} + IR_n^{(y)}$$

So that the amount of accumulated funds for the x-year-old insured is obtained as follows:

$$F_n^{(x)} = F_{n-1}^{(x)} + AC_n^{(x)} + IR_n^{(x)}$$

Meanwhile, for joint life, two people aged x and y are:

$$F_n = F_n^{(x)} + F_n^{(y)} \tag{11}$$

So that premiums are obtained using the Aggregate Cost method for the insured x-year life insurance pension fund program, which is written as follows:

$$P_x = \frac{A_x - F_n^{(x)}}{\ddot{a}_x}$$

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A_x : Present value of pension fund insurance benefits

F_n : The amount of accumulated funds

$\ddot{a}_x$: initial annuity for life

Meanwhile, the premium for joint life uses the Aggregate Cost method for the insured x and y [2], expressed by the following **Equation [12]**:

$$P_{xy} = \frac{A_{xy} - F_n}{\ddot{a}_{rr}} \tag{12}$$

3. Results And Discussion

Using the Aggregate Cost method, this research uses case studies to determine pension fund premiums with joint-life status. Doing a case study with three participant conditions, namely when the husband is older than the wife ($x > y$), the husband is younger than the wife ($x < y$), and the husband is the same age as the wife ($x = y$). Husband and wife life probability data, were obtained using the 2019 Indonesian Mortality Table (TMI). The assumptions used include:

- Age is used as a comparison, namely: a). $x = 28$ *and* $y = 24$; b). $x = 24$ and $y = 28$; c). $x = 24$ *and* $y = 24$.
- Retirement age (r) is set at 58 years old according to Government Regulation (PP) Number 11 of 2017.
- The salary increase rate (c) is 6.5% per year following Government Regulation Number 15 of 2019.
- The proportion of salary for pension benefits (k) is 4.75%. The proportion is based on information from PT. TASPEN, an Indonesian state-owned company engaged in the insurance sector of old-age savings and pension funds for civil servants and state officials.
- Based on the BI rate, the interest rate (i) is set at 5,25% per year.
- The basic salary x receives Rp2.688.500, while y is Rp2.579.400.

The cash value of the initial joint life annuity for the two insureds $x=28$ and $y=24$ using **Equation 4** to obtain the following results:

$$\ddot{a}_{xy} = \sum_{t=0}^{58-max(28,24)-1} \left(\frac{1}{1+0.0525}\right)^t ({}_t p_{28}^{male})({}_t p_{24}^{female})$$

Meanwhile, the initial joint-life annuity cash value of retirement age r uses Equation 5, obtained as follows:

$$\ddot{a}_{rr} = \sum_{t=0}^{110-58} \left(\frac{1}{1+0.0525}\right)^t ({}_t p_{58}^{male})({}_t p_{58}^{female}) = 12,1867$$

The basic salary of the insured x is Rp2.688.500, so within one year, a total salary of Rp32.262.000 will be obtained. The basic salary of the insured y is Rp2.579.400, so within one year, a total salary of Rp30.952.800 will be obtained. **Table 1** calculates salary up to retirement age with a yearly salary increase rate of 6,5%.

Table 1. Annual Salary Table

t	x	S_{x+t}	y	S_{y+t}	S_{xy+t}
0	28	Rp32.262.000	24	Rp30.952.800	Rp63.214.800
1	29	Rp34.359.030	25	Rp32.964.732	Rp67.323.762
2	30	Rp36.592.367	26	Rp35.107.440	Rp71.699.807
⋮	⋮	⋮		⋮	⋮
29	57	Rp200.368.715	53	Rp192.237.702	Rp392.606.417
30		-	54	Rp204.733.153	Rp204.733.153
31		-	55	Rp218.040.808	Rp218.040.808
32		-	56	Rp232.213.460	Rp232.213.460
33		-	57	Rp247.307.335	Rp247.307.335

The total combined salary of the husband (x) and wife (y), is:
$$S_{58(28;24)} = Rp63.214.800 + \cdots + Rp247.307.335$$
$$= Rp6.162.095.798$$

The amount of benefits or claims that will be received by the insured of the pension fund program uses the assumption of total salary while working, knowing that the proportion of salary prepared for pension benefits is 4.75%, namely:
$$B_r = (Rp6.162.095.798) \times 0,0475$$
$$= Rp292.699.550$$

The present value of retirement benefits for $x = 28$ and $y = 24$ uses Equation 9, namely:
$$A_{xy} = (Rp292.699.550) \frac{0,9501^{\frac{1}{2}(58+58)}}{0.9501^{\frac{1}{2}(28+24)}} \frac{90580}{98974} \frac{93846}{99402} 12,5940$$
$$= Rp619.453.321$$

The amount of life insurance contributions or denoted by AC_n, where the value for the interest rate *(i)* is obtained from the interest rate of Bank Indonesia. The contribution amount for a husband who is 28 years old $(x = 28)$ is obtained from the following calculation:

$$AC_n^{(x)} = 0,0575[2.688.500(1+0,0575)^{12}]\left(\frac{v^{58}l_{58}+\cdots+v^{110}l_{110}}{(v^{28}l_{28}+\cdots+v^{110}l_{110})-(v^{58}l_{58}+\cdots+v^{110}l_{110})}\right) = 44.596$$

Furthermore, the number of contributions for a wife who is 24 years $(y = 24)$ is obtained from the following calculation:

$$AC_n^{(y)} = 0,0575[2.579.400(1+0,0575)^{12}]\left(\frac{v^{58}l_{58}+\cdots+v^{110}l_{110}}{(v^{24}l_{24}+\cdots+v^{110}l_{110})-(v^{58}l_{58}+\cdots+v^{110}l_{110})}\right) = 36.031$$

The total contribution of pension program life insurance for a husband aged 28 and a wife aged 24 is $Rp.44.596 + Rp.36.031 = Rp.80.627$.

The amount of investment obtained is denoted by IR_n, and the amount of investment obtained for an insured aged 28 years is obtained from the following calculation:

$$IR^{(x)} = \left((1+0,0575)^{12-1}(F_0)\right) + 44.596 + (1+0,0575)^{12-1} = 44.598$$

Furthermore, for wives aged 24 $(y = 24)$ as follows:

$$IR^{(y)} = \left((1 + 0,0575)^{12-1}(F_0)\right) + 36.031 + (1 + 0,0575)^{12-1} = 36.033$$

So that the actual total income received by the husband, aged 28, and the wife, aged 24, is $Rp44.598 + Rp36.033 = Rp80.631$.

The accumulated funds denoted by F_n for a husband aged 28 and a wife aged 24 are as follows:

$$F_n = F_{n-1} + AC_n + IR_n$$
$$= 0 + Rp80.627 + Rp80.631$$
$$= Rp161.258$$

Annual premiums paid by the insured husband aged 28 and wife aged 24 each year using **Equation 12** are as follows:

$$P_{xy} = \frac{619.453.321 - 161.258}{14,9320} = 41.437.880$$

So that the total annual premium for a husband aged 28 and a wife aged 24 is $Rp.\,41.440.163$.

Table 2. Comparison of Annual Premiums with Various Ages

	Comparison of the ages of husband *(x)* wife *(y)*		
	x=28* and *y=24	***x=28* and *y=28***	***x=24* and *y=28***
A_{xy}	619.453.321	589.406.557	622.270.735
AC_n	80.627	91.200	81.032
IR_n	80.631	91.204	81.036
F_n	161.258	182.404	162.068
P_{xy}	41.440.163	39.569.119	41.594.217

Based on **Table 2**, if the husband's age is lower than the wife's ($x = 24, y = 28$), then the value of the premium paid is more significant than when the husband's age is higher than the wife's ($x = 28, y = 24$) which is Rp. 41.594.217. That is because the husband's working duration is longer than the wife, while the chance of death for men is higher than for women.

4. Conclusions

Based on the research results, the conclusion is that the joint life pension fund annual premium for a husband aged 28 and a wife aged 24 using the Aggregate Cost method is Rp41.594.217. The monthly basic salary the husband receives is Rp2.688.500, while that of the wife is Rp2.579.400, with a retirement age of 58 years. The interest rate used is 5.25%, the salary increase rate is 6.5% per year, and the proportion of salary for pension benefits is 4.75%. Then, the research also obtained information that if the husband's age is lower than the wife, then the value of the premium paid is more significant than when the husband's age is higher than the wife's. That is influenced by the extended working period of husbands than wives, while the chance of death for men is higher than for women.

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