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Pension Fund Calculation Using Projected Unit Credit, Entry Age Normal, and Attained Age Normal Method (Case Study : PT. Taspen (PERSERO) Cabang Pematang Siantar 2022)

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ABSTRACT

Pension fund (pension plan) is the determination that the employer (company) provides benefits (payments) to employees after they retire for the services that provided while still working. The purpose of establishing a pension funds program is to fulfill the employer's obligation, to guarantee the retirement period of the employees in the future, and to finance national development to create social welfare. In this study aim to determined normal costs and actuarial liabilities using the three methods consist of Projected Unit Credit (PUC) method, Entry Age Normal (EAN) method, and Attained Age Normal (AAN) method. The data used in this research is the information by PT. Taspen (Persero) Cabang Pematang Siantar such as date of birth, date of started work, basic salary, and the total of pension fund collected in the previous year. Otherwise, the data mortality rate of the employees from the 2022 employment mortality table (TMJ 2022) by PT. BPJS Ketenagakerjaan is also used. The result show that the best method for pension funds program in PT. TASPEN (Persero) Cabang Pematang Siantar is PUC method since the amount of unfunded actuarial liabilities (UAL) has the biggest difference between total actuarial liabilities and the amount that has been funded. It means that the pension funds program can give more surplus than the other methods.

Keywords: Pension Funds, Projected Unit Credit, Entry Age Normal, Attained Age Normal, Unfunded Actuarial Liabilities.

I. INTRODUCTION

Pension funds are very important in economic development, not only to guarantee employees's welfare during retirement but also help increase investment [1]. This welfare guarantee allows employees to avoid losses from risks that will be happen in the future. Based on Indonesian Accountants Association, pension fund legislation determines that the legal entity of a pension fund

must be separate from the employer. PT. Taspen (Persero) Cabang Pematang Siantar is a State-Owned Enterprise which provides Pension Funds Program for company's employees. Related to pension fund program, PT. Taspen (Persero) Cabang Pematang Siantar has to do calculation, contribution withdrawal, and tax recording based on the Income Tax Law article 21 [2]. Either private or government owned companies entrust PT. Taspen (Persero) Cabang Pematang Siantar to manage their pension fund. Employees of a company that listed in the pension fund are guaranteed to be registered as pension funding program participants since the first day of their work.

A pension fund program is a program that will provides a certain amounts of money that will be paid in a lumpsum or periodically to participants from the time they reach retirement age [3]. The amount that participants will receive should be has the same amount as total contributions that the company has been paid to PT. Taspen (Persero) Cabang Pematang Siantar. The contributions that has been paid by the company is called normal costs. Meanwhile PT. Taspen (Persero) Cabang Pematang Siantar must prepare a certain amount of money during the normal cost payment period until the retirement age so that the amount is sufficient to cover the benefits that employees will receive. A certain amount that PT. Taspen (Persero) Cabang Pematang Siantar must prepare is called actuarial liabilities. Both normal costs and actuarial liability need to be calculated using several assumptions, such as interest rate, salary increment rate, etc.

The calculation of normal costs and actuarial liabilities will be entrusted to actuaries because it requires an actuarial valuation method (actuarial cost method). In general, there are two categories for actuarial cost methods, which are Accrued Benefit Cost (ABC) method and Projected Benefit Cost (PBC) method. Projected Unit Credit (PUC) is one of the method that in ABC method category. Meanwhile, PBC method category consists of Entry Age Normal (EAN), Attained Age Normal (AAN), and Individual Level Premium [4].

Normal costs calculated using the ABC method will increase with age, while using the PBC method will be the same amount until the workers reaches retirement age [5]. The difference between both categories are interesting to calculating normal costs using the three methods from these two categories, therefore actuarial liabilities of pension funds can be determined. Furthermore, the total of actuarial liabilities can be calculated. The amount of total actuarial liabilities is then used to calculate the unfunded actuarial liabilities, it is the difference between the estimated total actuarial liabilities and the assets set aside to pay benefits. The result calculated using the three methods will be compared to determine the best method in calculation unfunded actuarial liabilities. The best method mentioned in this research is a method that provides benefits for both participants and the PT. Taspen (Persero) Cabang Pematang Siantar.

II. METHODS

Pension Funds

According to Kieso et al., a pension fund (pension plan) is the determination that the employer (company) provides benefits (payments) to employees after they retire for the services that provided while still working [6]. There are two types of pension funds program, such as Defined Contribution Pension Plan and Defined Benefit Pension Plan. Defined Contribution Pension Plan is a program that the normal costs that must be paid are determined in advance before determining the benefit that

employees will receive. Meanwhile Defined Benefit Pension Plan is the opposite, which is the benefit are set in advance and the normal cost determined after that. The purpose of establishing a pension funds program are to fulfill the employer's obligation, to guarantee the retirement period of the employees in the future, and to finance national development in order to create social welfare.

Interest and Salary Increment Rate

The calculation in pension fund is must be affected by several economic factors, including interest rates dan salary increment rates. Interest rate function is used to discounted payments in the future. Suppose i is an interest rate, which is assumed to be constant, so the discount factor for time t is denoted by v^t and given by [7] :

$$v^t = \frac{1}{(1+i)^t} \tag{1}$$

Every employees are entitled to get the increment in salary. The increment of employees's salary is determined by the employer regarding to the policy in the company and/or the country. Suppose s_t is denoted a yearly salary of employee at time t and S_x is denoted employees's salary cumulative from the beginning of the work at age e years old until age $x-1$ years old, so

$$S_x = \sum_{t=e}^{x-1} s_t. \tag{2}$$

If r is denoted the retirement age, s is the salary increment and s_x is denoted a yearly salary of employee at age x years old, so the last salary at age $(r-1)$ years old or a year before the employee retire is given by

$$s_{r-1} = s_x(1+s)^{r-x-1} \tag{3}$$

with x is age at calculating time.

Life Annuity

Life annuity is refer to a series of payments to (or from) an individual as long as the individual alive on the payment date. The payments are normally made at regular intervals and the most common situation is that the payments are of the same amount [8]. Suppose ${}_tp_x$ is a probability that someone aged x years old will survive until the next t years, so the expected present value of a term life annuity-due for someone aged x years old until retirement age r years old is obtained by

$$\ddot{a}_{x:\overline{r-x}|} = \sum_{t=0}^{r-x-1} v^{t+1}\ {}_tp_x. \tag{4}$$

Now, suppose payments are made whole life of the annuitants, so the expected present value of a whole life annuity-immediate for individual aged x years old is

$$a_x = \sum_{t=1}^{\omega-x} v^{t+1}\ {}_tp_x. \tag{5}$$

with ω is assumed someone highest age, which is $\omega \to \infty$. Although the summations are taken to ∞, the sums of course terminate at the highest age tabulated in the life table. It is simple to write down such mathematical expressions. Those expression is called commutation functions, that are an ingenious and effective system of tabulated functions that allow most of the expected present values in everyday use to be calculated with a minimal number of arithmetical operations [9]. Now, if we have

$$D_x^{(\tau)} = v^x l_x \text{ and } N_x = \sum_{i=x}^{\omega} D_i,$$

so the commutation to simplified summation in the equation (4) and (5) are

$$\ddot{a}_{x:\overline{r-x}|} = \frac{N_x - N_r}{D_x} \tag{6}$$

and

$$a_x = \frac{N_{x+1}}{D_x}. \tag{7}$$

Now, if payments are made m times in a year, hence

$$a_x^{(m)} = a_x - \left(\frac{m-1}{2m}\right), \tag{8}$$

can be used to simplify the expected present value of a m-thly whole life annuity immediate.

Projected Unit Credit (PUC) Method

Employees's salary and the benefits are usually made on a monthly basis, so that the expected present value of cumulative pension funds benefits for someone

aged x years old that has been work since aged e years old and will be retire at age r years old are defined by [10] :

$$B_r = 12k(r-e)(s_{r-1})a_r^{(12)}, \quad (9)$$

which k is the proportion of salary reserved for pension fund benefits. Whereas the expected present value of pension funds benefits for someone aged x years that has been work since aged e years old and will be retire at age r years old are denoted by b_x and determined by:

$$b_x = \frac{B_r}{(r-e)}, \quad (10)$$

The expected present value in equation (10) is used to calculate normal costs. The normal costs are the contributions to pension funds, either in yearly basis or monthly basis. The normal costs for someone aged x years old can be obtained using equation (10) as follows :

$${}^{PUC_r}NC_x = \frac{D_r}{D_x} b_x. \quad (11)$$

Therefore, the actuarial liabilities (AL_x) are also can be obtained as follows

$${}^{PUC_r}AL_x = {}^{PUC_r}NC_x(x-e). \quad (12)$$

If the normal costs is calculated using the initial salary when the employees start working at aged e years old, then the calculations uses Entry Age Normal (EAN) method.

Entry Age Normal (EAN) Method

The assumption used in this method is that employees are registered in a pension funds program when they start working at aged e years old. Hence, age when they registered as pension funds program participants (a years old) is the age they start working ($a = e$). Supposed that $s_e$is initial salary, so that the expected present value of cumulative pension funds benefits for someone aged x years old that has been work since aged e years old and will be retire at age r years old are defined by

$$B_r = 12k\,(r-e)s_e(1+s)^{(r-1-e)}a_r^{(12)}. \quad (13)$$

Hence, the last salary at age $(r-1)$ years old or a year before the employees retire can be written by:

$$s_{r-1} = s_e(1+s)^{(r-1-e)}.$$

Normal costs are only calculated once at the beginning since the calculations is done when the employees start working, so that the contributions will have the same amount at any time until the employees retire. If the normal costs for someone aged e years old when they start working is determined as follows:

$${}^{EAN_r}NC_e = \left(\frac{D_r}{N_e - N_r}\right)B_r. \quad (14)$$

Unlikely normal costs, the actuarial liabilities will not have the same amount. The actuarial liabilities that are calculated when someone aged x years old is

$${}^{EAN_r}AL_x = {}^{EAN_r}NC_e\left(\frac{N_e - N_x}{D_x}\right). \quad (15)$$

Suppose the employees is registered at t years old after start working, it means that the age $y = e + t$ years old will be used to calculate the normal cost. Since there is difference among age when start working and registering to pension funds, the calculations could not use EAN method, otherwise will be using attained age normal (AAN) method.

Attained Age Normal (AAN) Method

Normal costs that is calculated using AAN method, has to fulfill equation below [5] :

$${}^{r}(PVFNC)_y = {}^{r}(PVFB)_y.$$

Therefore, normal cost is calculated using AAN method is as follows:

$${}^{AAN_r}NC_y = \left(\frac{D_r}{N_y}\frac{D_x}{(N_x - N_r)}\right)B_r \quad (16)$$

with the expected present value of future benefits of the pension fund is defined by

$$B_r = 12k\,(r-y)s_y(1+s)^{(r-1-y)}a_r^{(12)}. \quad (17)$$

Hence, the actuarial liabilities can be obtained by:

$${}^{AAN_r}AL_y = {}^{AAN_r}NC_y\left(\frac{N_y - N_x}{D_x}\right). \quad (18)$$

The measurement to determine whether the amounts are sufficient or not to covered the total actuarial

liabilities for all participants is called Unfunded Actuarial Liability (UAL).

Unfunded Actuarial Liabilities (UAL)

The amount of UAL can reflect whether the company that manage a pension fund program experienced losses or profits. There are two reflections of the amount of UAL, such as :

(i) The pension funds that has been managed is insufficient to cover the total actuarial liabilities if UAL has a positive amount.

(ii) The pension funds that has managed is sufficient to cover the total actuarial liabilities if the amount of UAL is negative.

Based on that description, UAL can be calculated using the difference between the total actuarial liabilities and the amount that has been collected from participants's contribution as follows

$$UAL = TAL_t - F_t, \quad (19)$$

with the total actuarial liabilities as follows

$$TAL_t = \sum_{i=1}^{N} AL_{xi}, \quad (20)$$

Therefore, the company that manage the pension funds program wants to has the best method that will make the UAL is sufficient to cover all of the liabilities.

Data and Data Sources

The data used in this research is mortality rate of the employees from the 2022 employment mortality table (*TMJ 2022*) which is conducted by PT. BPJS Ketegakerjaan and the information of the pension fund program participants that has been recorded by PT. Taspen (Persero) Cabang Pematang Siantar in 2022. The information is related to the participants's date of birth, date of started work, their basic salary, and the total of pensiun fund collected in the previous year.

Analysis Stages

1. Conduct descriptive statistics of the data.
2. Calculate last salary before the participants have reached the retirement age.
3. Calculate the expected present value of future benefits that will be paid to participants using PUC, EAN, and AAN method.
4. Calculate the present value of future benefits (PVFB) using PUC, EAN, and AAN methods which is given that the salary increment rate is 7% and the future benefits will be 2.5% of salary before retirement to be paid in each period of benefits payment for participant who has served for 40 years. Otherwise, for participants who has served for more than 40 years, the future benefits will be 80% of the salary before retirement.
5. Calculate the normal costs (NC) of each participanst and the total normal cost that will be paid in 2023 by all participants using PUC, EAN, and AAN methods
6. Calculate the actuarial liabilities (AL) of each participant and the total actuarial liabilities of all participants that should be reserved by PT. Taspen (Persero) Cabang Pematang Siantar for 2023, 2024, and 2025.
7. Calculate the unfunded actuarial liabilities (UAL) until 2023,2024, and 2024 using the amount of actuarial liabilities that has funded until 2022 with the investments interest rate 8% is assumed.
8. Determine the best method that should be applied by PT. Taspen (Persero) Cabang Pematang Siantar to manage the pension funds program based on the calculated UAL amount.

III. RESULTS AND DISCUSSION

Descriptive Statistics

There are several information can be obtained from the participants's information data that has been recorded by PT. TASPEN (Persero) Cabang Pematang Siantar, such as the participants's starting age to work, age when the calculating process is being held, service's year of participants until they reach retirement, and their basic salary. The statistics

descriptive of the participants starting age to work as describe as follows

TABLE I
STATISTICS DESCRIPTIVE OF PARTICIPANTS'S INFORMATION DATA

Descriptive	*Started age*	*Service's year*	*Basic salary*	*Age at calculations*
Minimum	18 years old	7 years	Rp 1.69 Mio	24 years old
Q_1	23 years old	27 years	Rp 3.14 Mio	41 years old
Median	26 years old	32 years	Rp 3.59 Mio	47 years old
Average	27.41 years old	30.59 years	Rp 3.69 Mio	47.28 years old
Q_3	31 years old	35 years	Rp 4.24 Mio	54 years old
Maximum	51 years old	40 years	Rp [illegible]io	60 years old

Table 1 show that most participants was started working at the age of under 31 years old with an average of 27,41 years old. Meanwhile, there were also those who started working above that age because they previously worked for other company. The data also contain information of those who has reach retirement age when the calculation was being held in 2023. The table also show that there were those who had been work for 40 years, it is the longest service's year has been recorded in 2022. Participants basic salary is their initial salary in 2022 without any allowance included. It shown in the table that the basic salary were from Rp 1.69 Mio to Rp 5.43 Mio.

Expected Last Salary Before Reached The Retirement Age

The calculating process demonstrated in this section is using is one participant as sample. Given the information of those participants as follows:

(i) The participant is 3 years old when the calculation was being held.
(ii) He had been work for 3 years since 22 years old
(iii) Basic salary when he started working was Rp 1,608,385
(iv) The participant is expected will be retire in 36 years ahead with the total service's years until retirement age will be 38 years.

The expected last salary is calculating using equation (3). Therefore, the expected salary a year before retirement age has reached whether using initial salary at the beginning, basic salary when registered, or basic salary in 2023 will be

$$\begin{aligned} s_{60-1} &= s_{24}(1+0.07)^{60-24-1} \\ &= Rp\ 1{,}841{,}440(1.07)^{35} \\ &= Rp\ 19{,}660{,}284. \end{aligned}$$

The amount of the last salary before reach the retirement will be used to calculating the expected present value of future benefits

Expected Present Value of Future Benefits

The expected present value of future benefits calculating is depend on participants's service years. Based on Undang-Undang No. 11 Tahun 1969 related to employee's and widow/widower retirement benefits, the proportion of salary reserved for pension fund benefits (k) is 2.5% of the last salary before retirement age for those who have worked for less than 40 years and 80% of the last salary before retirement age has reached for those who have

worked for 40 years or more. The calculation result for the participant above using the three methods are as follows

a. *Projected Unit Credit (PUC) Method and Entry Age Normal (EAN) Method*

The expected present value of future benefits for pension funds program using PUC or EAN will result the same amount since the total service's year are calculating from the first day he started working . Hence,

$$B_{60} = 0.025(12)(36)(Rp\ 19{,}660{,}284)(0.1344) = Rp\ 30{,}117{,}193.$$

b. *Attained Age Normal (AAN) Method*

This method is provide pension fund for those who is registered a year or more after they had started work. Suppose the participant was registered one year after they started to work, so the initial was $y = 22 + 1 = 23$. Therefore, the expected present value of future benefits is depend on the service's year since the day he was registered to pension funds program, such as

$$B_{60} = 0.025(12)(35)(Rp\ 19{,}660{,}284)(0.1344) = Rp\ 29{,}324{,}635$$

Normal Costs

The normal costs is only calculated until retirement age and the payment is made at the beginning of each year. So, for those who has retired, the normal costs will not longer be calculated and also there will no payment is made.

a. *Projected Unit Credit (PUC) Method*

To calculate the normal costs for PUC method is using equation (10) and (11) with the amount of B_{60} is Rp 30,117,193 that was calculated previously. Therefore, the normal costs for participants who aged 24 years old that will be paid at that age is determined by

$${}^{PUC_{60}}NC_{25} = \frac{D_{60}}{D_{25}}\frac{B_{60}}{(60-25)} = Rp\ 89{,}560$$

This amount will has the different amount for each year. So the participant will be paid the contributions in different amount at the beginning of each year until retire and will increase with age.

b. *Entry Age Normal (EAN) Method*

The normal costs for EAN method is calculate using equation (14) with the amount of B_{60} is Rp 30,117,193 that was calculated previously. Therefore, the normal costs that will be paid each year from the aged 22 years old until retire is determined by

$${}^{EAN_{60}}NC_{22} = \left(\frac{D_{50}}{N_{22} - N_{60}}\right)B_{60} = Rp\ 184{,}033$$

This amount of NC will remain the same for each year until retire and will be paid at the beginning of each year.

c. *Attained Age Normal (AAN) Method*

The normal costs for AAN method is calculate at the beginning the participant is registered to pension fund programs at age 23 years old with the amount of B_{60} is Rp 29,324,635 that was calculated previously. Therefore, the normal costs that will be paid each year from the aged 23 years old and so on is determined by

$${}^{AAN_{60}}NC_{23} = \left(\frac{D_{60}\ \ D_{25}}{N_{23}\ \ \left(N_{25} - N_{60}\right)}\right)B_{60} = Rp\ 194{,}934$$

This amount of NC will remain the same for each year until retire and will be paid at the beginning of each year.

Actuarial Liabilities

The actuarial liabilities of pension funds program can be calculated using each method based on the normal costs that had calculated in previous section. The actuarial liabilities that will be calculated is an amount that PT. Taspen (Persero) Cabang Pematang Siantar should have reserved for one participant until certain

time. The amount of actuarial liabilities for the sample participant using each method is describe as follows

a. Projected Unit Credit (PUC) Method

To calculate using PUC method is refer to equation (12), the actuarial liabilities will be

$$^{PUC_{60}}AL_{25} = {}^{PUC_{60}}NC_{25}(25-22)$$
$$= Rp\ 89{,}560(3) = Rp\ 268{,}679$$

Therefore, the total actuarial liabilities for all participants in 2024 can be obtained by

$$TAL_{2024} = Rp\ 12{,}685{,}296{,}534$$

b. Entry Age Normal (EAN) Method

The actuarial liabilities of the participant if using EAN method can be obtain form equation (15)

$$^{EAN_{60}}AL_{25} = {}^{EAN_{60}}NC_{22}\left(\frac{N_{22} - N_{25}}{D_{25}}\right)$$
$$= Rp\ 621{,}633.$$

Hence, the total actuarial liabilities for all the participants using EAN method in 2024 is

$$TAL_{2024} = Rp\ 13{,}503{,}500{,}944$$

c. Attained Age Normal (AAN) Method

Using AAN method can obtain the actuarial liabilities is only from the day the participant was registered until current time (when the calculation was being held)

$$^{AAN_{60}}AL_{25} = {}^{AAN_{60}}NC_{23}\left(\frac{N_{23} - N_{25}}{D_{25}}\right)$$
$$= Rp\ 425{,}966$$

The total actuarial liabilities for all participants in 2024 can be obtained based on equation (20). The amount of total actuarial liabilities using AAN method is

$$TAL_{2024} = Rp\ 49{,}579{,}997{,}519$$

The best method among the three methods are used can be obatain using unfunded actuarial liabilities alongside with the funded amount until last year.

Unfunded Actuarial Liabilities

As mentioned previously, to calculate the unfunded actuarial liabilities needs the information of the amount that PT TASPEN (Persero) Cabang Pematang Siantar has been funded until last year. In this research, those amounts was given by PT TASPEN (Persero) Cabang Pematang Siantar. The total amounts that has been funded until last year was Rp391,610,000,000. Therefore, the unfunded actuarial liabilities can be calculated using equation (19) for all methods are shown in the table below

TABLE 2
THE UNFUNDED ACTUARIAL LIABILITIES FOR ALL METHODS

Unfunded Actuarial Liabilites Amount	
PUC Method	- Rp 410,802,609,751
EAN Method	- Rp 409,450,237,577
AAN Method	- Rp 377,393,556,581

IV. CONCLUSION

The result from Table 2 show that the best method for pension funds program in PT. TASPEN (Persero) Cabang Pematang Siantar is AAN method since the amount of unfunded actuarial liabilities has the biggest difference between total actuarial liabilities and the amount that has been funded. It means that the pension funds program can give more surplus than the other methods.

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