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Total Actuarial Liabilities and Normal Costs Using The Unit Credit Method

Shindi Adha Gusliana[1*]

[1]*Department of Mathematics, Faculty of Mathematics and Natural Sciences, Padjadjaran University, West Java, Indonesia*

**Corresponding author email: shindi19001@mail.unpad.ac.id*

Abstract

The pension fund program requires an actuarial calculation, such as the amount of actuarial obligations and normal costs for each pension fund participant. Total actuarial liabilities are calculated to show the company's liability for pension benefits for pension fund participants. Funding in pension funds is obtained from the normal costs or contributions paid by participants to the pension fund. By using the unit credit method, the total value of actuarial liabilities at 1/1/2020 is IDR 405,338.5. Then by using the unit credit method, it is projected that the normal cost on 1/1/2019 is IDR 1,071.43. The calculation method on funding aims to ensure that the collected pension plan funds will be sufficient to pay pension benefits to participants when they retire.

Keywords: Pension fund, actuarial obligations, normal costs, unit credit method, actuarial liabilities

1. Introduction

A pension fund is a legal entity that manages and runs a program that promises retirement benefits (Baltas, et al., 2022; Shilton, 2021; Novy-Marx & Rauh, 2009). The pension fund intends to provide welfare to employees who have entered retirement age. The pension plan provides a certain formula for the benefits that employees will receive when they reach retirement age. On the basis of these pension benefits, actuarial obligations and normal costs can be calculated for each participant.

Actuarial liability is the value of pension benefits for participants in the pension program (Biggs, 2011; Gold, 2005; Asthana, 1999; Novy-Marx & Rauh, 2011). The total actuarial liabilities are obtained by adding up the individual actuarial liabilities for each active participant (Ananta, et al., 2021; Ridho, et al., 2021). Meanwhile, normal costs are costs or contributions paid by participants for the pension benefits to be received.

The calculation method on funding aims to ensure that the collected pension plan funds will be sufficient to pay pension benefits to participants when they retire. Various methods can be used to perform calculations, among which will be discussed actuarial calculations using the unit credit method. This discussion is carried out to find out the results of the calculation of total actuarial obligations which are useful for companies in knowing the value of the benefits that must be given, as well as the amount of normal contributions for active participants to fund part of the pension benefits that will be obtained.

2. Materials and Methods

2.1. Materials

The data to be calculated is contained in the material for Chapter 2 Mathematics of Pension Funds regarding the Credit Unit Method, which includes the traditional unit credit method and projected unit credit.

2.2. Method

2.2.1. Problem Solving Method-1

Problem-1 is solved by the unit credit method. The equation used in the calculation of total actuarial liabilities is as follows.

$$TAL_0 = \Sigma AL_x = \Sigma NC_x(x - e) \quad (1)$$

Information :
TAL_0 : total value of actuarial liabilities (TAL) at time 0.
AL_x : actuarial obligations from entry age e to age x.
NC_x : normal cost or normal cost at the beginning of each year x.
Before calculating the TAL value, the normal cost value for each year will be searched with the following equation.

$$NC_x = b_x.v^t.\ {}_tp_x.\ddot{a}_r^{(12)} \quad (2)$$

where $t = r - x$.
Normal costs in year x can be found by comparing normal costs in the previous year.

$$\frac{NC_{x-1}}{NC_x} = \frac{b_{x-1}.v^t.\ {}_tp_{x-1}.\ddot{a}_r^{(12)}}{b_x.v^t.\ {}_tp_x.\ddot{a}_r^{(12)}}$$

So that it is obtained

$$NC_x = \frac{NC_{x-1}}{vp_{x-1}} \quad (3)$$

Furthermore, the total actuarial liabilities can be calculated in equation (1).

2.2.2. Method of Solving Problem-2

Problem-2 is solved by the projected unit credit method. The equation used to calculate the projected normal costs using the salary scale is as follows.

$$NC_0 = \sum b_x \frac{D_r^{(\tau)}}{D_x^{(\tau)}} \ddot{a}_r^{(12)} \text{ where } b_x = B_r(\frac{S_{r-1}}{S_x})S_x$$

3. Results and Discussion

3.1. Problem-1 and Solution

Pension benefit : IDR 35 per month per year for services
Actuarial cost method : Credit Unit
Actuarial assumptions:
Interest : 6%
Mortality : q_40=0.01, q_41=0.02
Entry : age 35
Retirement : age 65
Participants on 1/1/2018 : 50, all ages 40
Normal fee on 1/1/2018 : IDR 50,000
Deaths and newcomers : None in 2018 or 2019
Compute the total actuarial liability at 1/1/2020.
Solution
To calculate the total actuarial liabilities, the following equation is used.

$$TAL_0 = \Sigma AL_x = \Sigma NC_x(x - e)$$

First, the normal cost value will be searched for each year.

$NC_x = b_x.v^t.\ {}_tp_x.\ddot{a}_r^{(12)}$, where $t = r - x$

$NC_{40} = (35 \times 12)v^{25}.\ {}_{25}p_{40}.\ddot{a}_{65}^{(12)}$

$NC_{41} = (35 \times 12)v^{24}.\ {}_{24}p_{41}.\ddot{a}_{65}^{(12)}$

$NC_{42} = (35 \times 12)v^{23}\ {}_{23}p_{42}.\ddot{a}_{65}^{(12)}$

Note that

$$\frac{NC_{40}}{NC_{41}} = \frac{(35 \times 12)v^{25}.\ {}_{25}p_{40}.\ddot{a}_{65}^{(12)}}{(35 \times 12)v^{24}.\ {}_{24}p_{41}.\ddot{a}_{65}^{(12)}}$$

$$NC_{41} = \frac{NC_{40}}{vp_{40}} = \frac{\frac{50{,}000}{50}}{\frac{0.99}{1.06}} = \frac{1060}{0.99} = 1{,}070.71$$

Then the normal cost of participants at the age of 41 is IDR 1,070.71
Note that

$$\frac{NC_{41}}{NC_{42}} = \frac{(35 \times 12)v^{24}.\ {}_{24}p_{41}.\ddot{a}_{65}^{(12)}}{(35 \times 12)v^{23}\ {}_{23}p_{42}.\ddot{a}_{65}^{(12)}}$$

$$NC_{42} = \frac{NC_{41}}{vp_{41}} = \frac{1{,}070.71}{\frac{0.98}{1.06}} = \frac{1{,}134.95}{0.98} = 1{,}158.11$$

Then the normal cost of participants at the age of 42 is Rp1,158.11

Actuarial liability value

$AL_{42} = NC_{42}(42 - 35) = 1{,}158.11(7) = 8{,}106.77$

Total actuarial liabilities were obtained on 1/1/95, namely

$$TAL_0 = \Sigma AL_{42}$$
$$= 50.\, AL_{42}$$
$$= 50(8{,}106.77)$$
$$= 405{,}338.5$$

So the total actuarial liability on 1/1/2020 is IDR 405,338.5.

3.2. Problem-2 and Solution

Retirement benefits : 1% of last salary per year from service
Actuarial cost method : Projecting Credit Units
Assumed retirement age : 65
Annuity factor : $\ddot{a}_{65}^{(12)} = 10$

There is no discontinuation before age 65 other than death.

Participant data on 1/1/2019 and a change of function was selected:

Age When Renting	Reaching Age x	Number of Employees	Total Annual Salary	s_{64}/s_x	D_x
30	30	1	IDR 20,000	4.0	140
-	31	0	IDR 0	3.9	138
40	50	1	IDR 30,000	2.0	120
-	51	0	IDR 0	1.9	116
-	65	0	IDR 0	1.0	10

What is the normal cost for 2019 on 1/1/2019?

Solution

Let 1/1/2017 be time 0. The total normal cost of planning is given by the following equation.

$$NC_0 = \sum b_x \frac{D_r^{(\tau)}}{D_x^{(\tau)}} \ddot{a}_r^{(12)}$$

where $b_x = B_r(\frac{s_{r-1}}{s_x})S_x$

Since there is no decrement other than death, an appropriate single-decrement table is used regarding the use of D_x. Then the normal cost calculation on 1/1/2019 is as follows.

$$NC_0 = \sum b_x \frac{D_r}{D_x} \ddot{a}_r^{(12)}$$
$$= \sum B_r \left(\frac{s_{r-1}}{s_x}\right) S_x \frac{D_r}{D_x} \ddot{a}_r^{(12)}$$
$$= \sum 0.01 \left(\frac{s_{64}}{s_x}\right) S_x \frac{D_r}{D_x} \ddot{a}_r^{(12)}$$
$$= 0.01 \left(\frac{s_{64}}{s_{30}}\right) S_{30} \frac{D_{65}}{D_{30}} \ddot{a}_{65}^{(12)} + 0.01 \left(\frac{s_{64}}{s_{50}}\right) S_{50} \frac{D_{65}}{D_{50}} \ddot{a}_{65}^{(12)}$$
$$= 0.01(4.0)20{,}000 \,.\frac{10}{140}.10 + 0.01(2.0)30{,}000 \,.\frac{10}{120}.10$$
$$= 571.428 + 500$$
$$= 1{,}071.43$$

So the normal cost on 1/1/2019 is IDR 1,071.43.

3.3. Discussion (Analysis)

With the unit credit method in question-1, the total actuarial liability on 1/1/2020 is IDR 405,338.5, which is the company's liability for pension benefits for pension fund participants. In question-2, the normal cost on 1/1/2019 is IDR 1,071.43 for pension participants which is allocated in the current year to fund part of the value of the pension benefit.

4. Conclusion

Based on the results of the discussion, the calculation value of the total actuarial liability shows the amount of the company's liability for pension benefits for pension fund participants. And the results of normal cost calculations show the amount of contributions that must be paid while being an active participant to fund part of the pension benefits that will be obtained. The results of these calculations can guarantee that the collected pension program funds will be sufficient to pay pension benefits to participants at the time of retirement.

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