Pension Fund Calculation Using Traditional and Projected Unit Credit Methods for Total Actuarial Liability and Normal Cost Cases

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Abstract

The DSH Meat Kiosk is a kiosk that sells one of the foodstuffs, namely Beef. This DSH Meat Kiosk has been around for more than 20 years. However, as long as this kiosk is established, the manager still finds it difficult to analyze the profit from the sale. Therefore, this Profit and Loss Financial Statement is intended to assist traders in managing the profits generated. In this report a financial analysis is made in November 2021 and February 2022. The method used in making this report is to use primary data by collecting data in the form of interviews with kiosk owners relating to things needed in making profit and loss statements such as assets that owned, total revenue, operating costs and others. The results of this report show that sales in February 2022 decreased by 17.88% compared to November 2021. With this report, it is hoped that this report will help and make it easier to manage the profits generated and make decisions to generate the best profits.

The discussion of the selected questions will look for what actuarial obligations are and what normal costs are based on the data provided. The purpose of this discussion is to know, understand, and be able to perform actuarial calculations regarding the unit credit method used. The unit credit method used is the traditional unit credit and the projected unit credit. The formula used for each question is as follows.

$$TAL_0 = \sum AL_x = \sum B_x \cdot \frac{D_r^{(\tau)}}{D_x^{(\tau)}} \cdot \ddot{a}_r^{(12)} \text{ and } NC_0 = \sum b_x (1+i)^{-(r-x)} \cdot {}_{r-x}p_x \ddot{a}_r^{(12)}$$

The result of solving the first problem shows that the total actuarial liability on 1/1/95 is IDR 405,339.095. While the results of the second question show that the normal cost for 2021 on 1/1/2021 was IDR 1,071.43. From these results, users can find out how much actuarial obligations are and what normal costs are based on the data that has been provided.

Keyword: Pension Fund, credits method, normal cost, actuarial liability

1. Introduction

The unit credit method is the most basic method in the discussion of pension funds (Ananta,et al., 2021; Smyrnova, et al., 2021; Orakwe, 2021; Hosang, et al., 2022). The pension fund program itself is a form of future planning that aims to ensure the survival of employees in retirement. The importance of discussing the selected questions is to find out how much pension benefits will be received and the (Egli, et al., 2022; Gunadi, et al., 2021; Ridho, et al., 2021). normal contributions that must be paid by employees using the existing actuarial calculation methods. And also knowledge of this unit credit method is very necessary.

The purpose of solving the questions that will be discussed is of course to know and be able to perform actuarial calculations on traditional unit credit, understand and be able to perform calculations on several methods of calculating the projected salary scale, and understand and be able to perform actuarial calculations based on the projected unit credit cost method. The problem is solved by means of Traditional Unit Credit (TUC) and Projected Unit Credit (PUC) (Lutz & Sheiner, 2014; Morais, 2010; D'Ambrogi-Ola & Brown, 2018; Cho, et al., 2014; Billig & Ménard, 2018). Usefulness for the user himself is to find out how much is the actuarial liability and what is the normal cost based on the data provided.

2. Method

There will be two issues discussed in this solution. For the first question, traditional unit credit (TUC) will be used. The actuarial liability of TUC is the present value at the valuation date. The first thing to do is to find the normal cost each year with the following formula.

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

After finding the normal cost for each year, we will first find AL_x with the formula:

$$AL_x = NC_x \, (x - e)$$

Then the total actuarial liability will be obtained by calculating

$$TAL_0 = \sum AL_x = \sum B_x \cdot \frac{D_r^{(\tau)}}{D_x^{(\tau)}} \cdot \ddot{a}_r^{(12)}$$

For the second question, projected unit credits will be used. The pension benefits where the increase every year follows the age of x is:

$$b_x = 0{,}01 \left(\frac{S_{r-1}}{S_x}\right) S_x$$

Then, for the normal total cost, you can use the following formula.

$$NC_0 = \sum b_x (1 + i)^{-(r-x)} \cdot {}_{r-x}p_x \ddot{a}_r^{(12)}$$

3. Results and Discussion

3.1. Numerical Illustration for Actuarial Liability Case

Pension benefit	: IDR 35 per month per year for services
Actuarial cost method	: Unit of credit
Actuarial assumptions:	
Interest	: 6%
Mortality	: $q_{40} = 0.01$, $q_{41} = 0.02$
Entry	: Age 35
Retirement	: Age 65
Participants on 1/1/2020	: 50, all ages 40
Normal fee on 1/1/2020	: IDR 50,000

Deaths and newcomers: None in 2018 or 2021
Compute the total actuarial liability at 1/1/2022

Discussion:
Calculate the normal cost of each year:

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

$$\frac{50000}{50} = 420 \cdot v^{25} \cdot {}_{25}p_{40} \cdot \ddot{a}_{65}^{(12)}$$

$$1000 = 420 \cdot v^{25} \cdot {}_{25}p_{40} \cdot \ddot{a}_{65}^{(12)}$$

$$NC_{41} = (35 \times 12) \cdot v^{(65-41)} \cdot {}_{(65-41)}p_{41} \cdot \ddot{a}_{65}^{(12)} = 420 \cdot v^{24} \cdot {}_{24}p_{41} \cdot \ddot{a}_{65}^{(12)}$$

$$NC_{42} = (35 \times 12) \cdot v^{(65-42)} \cdot {}_{(65-42)}p_{42} \cdot \ddot{a}_{65}^{(12)} = 420 \cdot v^{23} \cdot {}_{23}p_{42} \cdot \ddot{a}_{65}^{(12)}$$

Will be calculated NC_{41},

$$\frac{NC_{40}}{NC_{41}} = \frac{420 \cdot v^{25} \cdot {}_{25}p_{40} \cdot \ddot{a}_{65}^{(12)}}{420 \cdot v^{24} \cdot {}_{24}p_{41} \cdot \ddot{a}_{65}^{(12)}} = v \cdot p_{40}$$

$$\frac{1000}{NC_{41}} = \left(\frac{1}{1.06}\right)(1 - q_{40})$$

$$\frac{1000}{NC_{41}} = (0.9434)(0.99)$$

$$NC_{41} = 1070.7071$$

Then be calculated NC_{42},

$$\frac{NC_{40}}{NC_{41}} = \frac{420 \cdot v^{25} \cdot {}_{25}p_{40} \cdot \ddot{a}_{65}^{(12)}}{420 \cdot v^{24} \cdot {}_{24}p_{41} \cdot \ddot{a}_{65}^{(12)}} = v \cdot p_{40}$$

$$\frac{1000}{NC_{41}} = \left(\frac{1}{1.06}\right)(1 - q_{40})$$
$$\frac{1000}{NC_{41}} = (0.9434)(0.99)$$
$$NC_{41} = 1070.7071$$

Then look for AL_{42}

$$AL_{42} = NC_{42}(42 - 35)$$
$$= 1158.1117(7)$$
$$= 8106.7819$$

Will be able to calculate the total actuarial liability
$$TAL_0 = 50(8106.7819)$$
$$= \text{IDR } 405339.095.$$

3.2. Numerical Illustration for Normal Cost Case

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 1/1/2021 and a change in function was selected:

Age When Renting	Reaching Age x	Number of Employees	Total Annual Salary	$\frac{S_{64}}{S_x}$	D_x
30	30	1	IDR20.000	4.0	140
-	31	0	IDRp0	3.9	138
40	50	1	IDR30.000	2.0	120
-	51	0	IDR0	1.9	116
-	65	0	IDR0	1.0	10

What is the normal cost for 2021 on 1/1/2021?

Discussion:
We need to find the value of b_x. First

$$b_{30} = 0.01\left(\frac{S_{65-1}}{S_{30}}\right)S_{30} = 0.01\left(\frac{S_{64}}{S_{30}}\right)S_{30} = 0.01(4)(20000) = 800$$
$$b_{50} = 0.01\left(\frac{S_{65-1}}{S_{50}}\right)S_{50} = 0.01\left(\frac{S_{64}}{S_{50}}\right)S_{50} = 0.01(2)(30000) = 600$$

Then, the normal cost at time 0 where 1/1/94 as time 0 is as follows

$$NC_0 = b_{30} \cdot \frac{D_{65}^{(65)}}{D_{30}^{(65)}} \cdot \ddot{a}_{65}^{(12)} + b_{50} \cdot \frac{D_{65}^{(65)}}{D_{50}^{(65)}} \cdot \ddot{a}_{65}^{(12)}$$
$$NC_0 = 800 \cdot \frac{10}{140} \cdot 10 + 600 \cdot \frac{10}{120} \cdot 10$$
$$NC_0 = 571.43 + 500$$
$$NC_0 = 1071.43.$$

4. Conclusion

The results of the discussion of the first question show that the total actuarial liability on 1/1/2022 is IDR 405,339.095. While the results of the discussion of the second question show that the normal cost for 2021 on 1/1/2021 was IDR 1,071.43.

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