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# Calculation of Pension Funds Using the Unit Credit Method

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**Abstract:**

Everyone certainly wants a welfare in the future, including employees. The company provides a pension program as a form of the company's concern for its employees. This pension fund provides pension benefits to employees at the time of retirement. Funding for this pension requires actuarial calculations which are normal costs and actuarial obligations. This discussion aims to calculate the amount of normal costs and actuarial obligations that must be incurred. The method used in this discussion is the ordinary credit unit method and projecting credit units by analyzing the use of actuarial formulas from several literature studies. In the first discussion using the ordinary credit unit method, the total actuarial liability on 1/1/95 is IDR. 405,355, while in the second discussion using the projecting credit unit method, the normal cost for 1994 on 1/1/94 is IDR 1071, 42. It is hoped that this discussion can increase the reader's knowledge of pension fund mathematics, especially to determine normal costs and also the value of actuarial obligations using the ordinary credit unit method or the projecting credit unit method.

*Keywords:* Ordinary credit units, Projecting credit units, Normal costs, Actuarial liabilities

## 1. Introduction

According to Yunawati 2016, pension fund is a company that collects funds from employees of a company and provides income to pension participants in accordance with the agreement. This paper will discuss solving problems related to chapter 2 of Pension Fund Mathematics, namely the Credit Unit Method which is divided into 2 methods, namely the ordinary credit unit method and projecting credit units. The importance of making a discussion about this chapter is because the unit credit method is the most basic method in discussing pension funds.

The purposes of this discussion are: (a) Knowing and able to perform actuarial calculations regarding traditional unit credit; (b) Understand and be able to perform calculations on several methods of calculating the projected salary scale using actuarial calculation formulas from several literature studies

With the discussion of these questions, it is hoped that it can increase the reader's knowledge about pension fund mathematics, especially to determine normal costs and also the value of actuarial obligations using the ordinary credit unit method or the projecting credit unit method.

## 2. Materials and Method

### 2.1. Materials

The formulas used for problem solving are as follows:

#### 2.1.1. Actuarial Assumptions

Actuarial assumptions are a series of estimates used in calculating pension benefits related to future changes that affect pension plan financing. The assumptions used in the pension plan include: the assumption of a rate of increase in salary, the assumption of an actuarial interest rate and the assumption of depreciation. (Bauman and Shaw, 2014; Shaw et al., 2013)

**Basic Actuarial Functions** (Li, 2000; Nadarajah and Bakar, 2013)

a. Survival Function

The survival function is a function that states that an employee will continue to work for the duration of his active service until the time he is allowed to retire.(disney et al., 2006) Denoted by ${}_np_x$

b. Interest Rate Function
The interest function is used to discount a future payment to the present time. If i is the assumed interest rate for n years with a magnitude of i that does not change for each year, (Read et al., 2013)then:

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

c. Salary Function
The salary function is used to estimate the amount of employee salary in the future, which is accumulated from the total salary at entry age $e$ to age $x$ -1. Symbolized by

$$S_x = \sum_{t=e}^{x-1} st$$

**Normal Fee**

Normal cost or normal cost at the beginning of each year $x$ ($NC_x$) is the cost or contribution/premium for pension benefits received in year $x$.(Favreault et al., 2015) Formulated as follows:

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

In single-decrement situations, it will often be done using simple variations such as equations (1) and (2).

$$NC_x \;=\; b_x \;.\; \frac{N_r^{(12)}}{D_x} \;=\; b_x \,.\, v^t \;\; {}_tP_x \,.\; \ddot{a}_r^{(12)} \tag{1}$$

Where $t = r - x$, and

$$AL_x \;=\; NC_x\,(x - e\,) \tag{2}$$

**Actuarial Liability**

Actuarial liability is the value of the pension benefit increasing from age $e$ to age , (Donnelelly, 2014; Zhao et al., 2017; Matzger, 2018)given by equation (3).

$$AL_x \;=\; B_x \;.\; \frac{D_r^{(\tau)}}{D_x^{(\tau)}} \;.\; \ddot{a}_r^{(12)} \tag{3}$$

Where $\tau$ represents multiple decrement, and $D_r^{(\tau)}/D_x^{(\tau)}$ calculated based on the service table (murtalita table). This calculation includes interest, death, discharge, disability, and dismissal

**Total Actuarial Liability**

Based on the unit credit method, total actuarial liabilities (TAL) can be obtained at time 0 for all active participants in the pension program, by adding up the individual actuarial obligations for each active participant, so that equation (4) is obtained.

$$TAL_0 \;=\; \sum AL_x \;=\; \sum B_x \;.\; \frac{D_r^{(\tau)}}{D_x^{(\tau)}} \;.\; \ddot{a}_r^{(12)} \tag{4}$$

The actuarial obligations for each participant increase with age. Therefore, if no participant leaves the group, and no new participant enters the group, the total actuarial liability will also increase over time.

## 3. Materials and Method

### 3.1. Question-1 and its 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 1/1/2008 : 50, all ages 40
Normal fee on 1/1/2008 : IDR 50,000
Deaths and newcomers: None in 2008 or 2009
Compute the total actuarial liability at 1/1/2010.

Answer :
Total actuarial liabilities at 1/1/2010 are total actuarial liabilities for employees aged 42 $(TAL_{42})$
The formula used is:

$$TAL_x = NC_x \ (x - e \ )$$
$$i$$

Where:
$NC_x$is the normal cost at age $x$
$x$ is the age of the employee at age $x$ which is 42
$e$ is the age of the employee at the time of entry which is 35
To search for $NC_{42}$, look for $NC_{40}$ and $NC_{41}$ first
Normal cost of employee at age 40 ($NC_{40}$) is

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

Normal cost of employee at age 41 ($NC_{41}$) is

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

Normal cost of employee at age 42 ($NC_{42}$) is

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

Obtained the equation:

$$\frac{NC_{40}}{NC_{41}} = vp_{40}\ dan\ \frac{NC_{42}}{NC_{41}} = vp_{41}$$

Then the following results are obtained

$NC_{41} = \frac{NC_{40}}{vp_{40}}$, where:
$NC_{40} = \frac{50000}{50} = 1000$ and
$vp_{40} = \frac{1}{1+0.06}(1 - 0.01) = \frac{0.99}{1.06}$ So
$NC_{41} = \frac{NC_{40}}{vp_{40}} = 1000\ \left(\frac{1.06}{0.99}\right) =$ IDR 1,070.7
$\frac{NC_{42}}{NC_{41}} = vp_{41} \rightarrow NC_{42} = \frac{NC_{41}}{vp_{41}}$
$vp_{41} = \frac{1}{1+0.06}(1 - 0.02) = \frac{0.98}{1.06}$ So
$NC_{42} = 1{,}070.7\ \left(\frac{1.06}{0.98}\right) =$ IDR 1,158.10.

So obtained

$$AL_{42} = NC_{42}\,(42-35)$$
$$AL_{42} = 1{,}158.10\,(7) = 8{,}106.7$$

And total actuarial liabilities:

$$TAL_{42} = 50\,.\,AL_{42} \rightarrow 50(8{,}106.7) = \text{IDR } 405{,}355$$

So the total actuarial liability on 1/1/2010 is IDR 405,355

### 3.2. Problem-2 and its Solution

Pension benefits : 1% 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 1/1/2009 and a change of function was selected:

| Age at Rent | 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 2009 on 1/1/2009?
Answer :
The pension benefit is 1% where the annual increase follows the age of x, using the normal cost formula as follows:

$$NC_x = 0.01(S_{r-1}/S_x)S_x \frac{D_r^{(T)}}{D_x^{(T)}} \ddot{a}_r^{(12)}$$

For age $x$ = 30

$$NC_{30} = 0.01(4)20000 \frac{10}{140} 10 = \text{IDR } 571.42$$

For age $x$ = 40

$$NC_{40} = 0.01(2)30000 \frac{10}{120} 10 = \text{IDR } 500$$

So the normal cost for 1994 on 1/1/94 is $\text{IDR } 571.42 + \text{IDR } 500 = \text{IDR } 1{,}071.42$

## 4. Conclussion

In a single-decrement situation, to calculate the total actuarial liability using the ordinary credit unit method, the equation $TAL_x = NC_x\,(x-e\,)$ that is by calculating the normal cost. The amount of the total value of actuarial obligations depends on the actuarial assumptions obtained such as interest rates, normal costs and the number of participants.

Meanwhile, to calculate normal costs with the method of projecting credit units, you can use the formula

$$NC_x = 0.01(S_{r-1}/S_x)S_x \frac{D_r^{(T)}}{D_x^{(T)}} \ddot{a}_r^{(12)}$$

The amount of the normal cost with this method depends on the pension benefits obtained, the total annual salary and also the annuity factor

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