



# Actuarial Analysis of PNS Group III/D Pension Fund: Comparison of Projected Unit Credit and Individual Level Premium Methods

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## Abstract

Indonesia's Civil Servants (PNS) pension system uses a defined benefit scheme managed by PT Taspen (Persero). However, the scheme faces serious challenges such as increasing life expectancy, a growing number of retirees, and an imbalance in pension contributions and liabilities. Evaluation of the liability calculation method is important to ensure the sustainability of the system. This study aims to compare the Projected Unit Credit (PUC) and Individual Level Premium (ILP) methods in calculating the pension fund for PNS Group III/D. This research uses a quantitative approach through actuarial simulation of data on civil servants of Group III/D with the assumptions of salary, retirement age, and annual salary increase. The analysis is done by calculating Actuarial Liability and Normal Cost for each method. The results show that the PUC method produces a Normal Cost that increases with the age of participants, while ILP provides a fixed contribution even though it is larger at the beginning. Both Actuarial Liability values also increase as the retirement age approaches, but ILP tends to be higher at all ages. From the manager's perspective, ILP is more stable and planned, while PUC is lighter on participants at the beginning and takes into account salary increases. Therefore, the choice of method must consider the ability of the agency to pay contributions consistently and the expectations of participants to get decent retirement benefits. The results of this study are expected to be taken into consideration in improving a fairer and more sustainable pension system for PNS, especially Group III/D.

**Keywords:** Pension Fund, PNS Group III/D, Projected Unit Credit, Individual Level Premium, Actuarial Liability, Normal Costs

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## 1. Introduction

The pension fund system for civil servants (PNS) in Indonesia is a form of social security organized by the government as a form of appreciation for service during the working period. The pension scheme is managed by PT Taspen (Persero) and uses a defined benefit approach, which guarantees a fixed pension payment until the end of life. However, the scheme faces significant challenges, such as an increasing number of retirees, increasing life expectancy, and an imbalance between contributions while actively working and payment obligations in retirement (Bappenas, 2020). These conditions prompt the need for a thorough evaluation of the method of calculating pension liabilities, in order to ensure sustainability and fairness in long-term pension fund management.

In actuarial practice, there are various methods that can be used to calculate pension liabilities and contributions, two of which are the Projected Unit Credit (PUC) and Individual Level Premium (ILP) methods. The PUC method calculates pension benefits proportionally based on years of service by taking into account projected salary increases, so that liabilities increase with working age (McGill et al., 2010). Meanwhile, the ILP method sets a fixed contribution that is allocated evenly over the working life to fund predetermined retirement benefits (Klaus, 2014). A study conducted by Rahayu and Firmansyah (2019) in the context of private companies found that ILP is more stable in terms of annual contributions, while PUC is more sensitive to changes in salary assumptions. Meanwhile, Siregar et al. (2021) emphasized the importance of accuracy in setting actuarial assumptions and proposed the use of model simulation as a basis for more measurable policy making.

Although there have been many studies comparing these actuarial methods, no research has specifically examined their application in the context of PNS Group III/D, a group with its own characteristics such as medium salary, relatively long service period, and significant population in the bureaucratic structure. This gap is an important basis for this research.

This study aims to simulate the calculation of pension funds for civil PNS Group III/D by comparing the results between the PUC and ILP methods. This simulation is expected to provide an overview of the differences in pension fund estimates generated by the two methods and their implications for long-term financial planning. With a focus on PNS Group III/D, this research also contributes to an in-depth understanding of the state's financial burden and policies related to pension system reform.

## **2. Literature Review**

### **2.1 Pension Fund**

According to Djojohadikusumo (1997), a pension fund is a legal entity that manages and runs a program that promises retirement benefits. Pension funds collect contributions from workers and/or employers to be invested. The proceeds from these investments will be used to pay retirement benefits to participants when they reach retirement age or experience certain conditions such as disability or death. In Indonesia, the pension fund for civil servants (PNS) is managed by PT Taspen and regulated under Law Number 11 of 1969. In this system, PNS continue to receive income after retirement, the amount of which is determined by the last salary and length of service. Therefore, the calculation of long-term financial obligations is very important so that the available funds remain sufficient to meet all future benefit payments.

### **2.2 Actuarial Science on Pension Fund Calculation**

Actuarial science is a discipline that combines mathematics, statistics, and financial theory to analyze risk, especially in the fields of insurance and pension funds. In the context of pension funds, actuarial is used to estimate the present value of pension benefit obligations and determine the amount of contributions required each year (Bowers et al., 1997). The calculation methods used are divided into several types of methods. Two of the most common are the Projected Unit Credit (PUC) and Individual Level Premium (ILP) methods.

### **2.3 Projected Unit Credit (PUC) Method**

The PUC method is an actuarial method that calculates pension benefits based on a participant's years of service to date, with projected salary until retirement. In this method, each year of the participant's employment is considered to generate one unit of pension benefit, and the liability is calculated as the present value of the benefits that have been earned to date (Brown, 2003). This method is in line with international standards such as IAS 19 (International Accounting Standard), which recommends the PUC method as an approach in calculating employee benefit obligations (IASB, 2011). PUC is also considered more realistic as the liability increases with years of service (Brown, 2003).

### **2.4 Individual Level Premium (ILP) Method**

Unlike the PUC, the ILP method determines a fixed premium or contribution from the start of participation, which is sufficient to finance all future pension benefits. In other words, this method is prospective and considers the full pension benefits from the beginning of the calculation (Bowers et al., 1997). The ILP method is often used for pension systems that emphasize the stability of contributions from year to year. However, this method is very sensitive to changes in assumptions, such as interest rates and mortality rates.

### **2.5 PUC and ILP Method Comparison**

The choice of actuarial method can significantly affect the results of the liability calculation. The PUC method results in a cost burden that increases over time, as more benefits are accumulated by participants. In contrast, ILP makes fixed contributions, but can lead to surpluses or deficits if assumptions do not match reality (Milevsky, 2006).

Some studies show that the PUC method is more suitable for defined benefit systems such as civil servant pension funds. For example, research by Purwoko (2015) in the Indonesian Actuarial journal shows that the PUC method provides an estimate of liabilities that better reflects the actual conditions of participants' working lives. In addition, a study by Trowbridge (1989) states that the PUC method is more adaptive to changes in economic conditions than ILP.

### 3. Materials and Methods

#### 3.1. Materials

This research uses a quantitative approach through actuarial simulation to compare two methods of calculating pension liabilities, namely Projected Unit Credit (PUC) and Individual Level Premium (ILP) for Civil Servants (PNS) Group III/D based on Actuarial Liability and Normal Cost. The entire analysis process was carried out using Microsoft Excel.

Simulations were conducted on six PNS participants, consisting of three men and three women, with age groups of 40, 43, and 50 years respectively. All participants in the simulation are assumed to have the same starting age, namely 28 years and the same normal retirement age, namely 60 years, so the full service period taken into account is 32 years. The basic salary data used in the simulation is taken from the Appendix to Government Regulation No. 5 of 2024 on PNS Salaries. Based on this regulation, the basic salary for PNS Group III/D with 31 years of service is recorded at Rp5,022,500 so that this value is used as an estimate of the basic salary one year before retirement age ( $s_{r-1}$ ) by considering the uniform characteristics of the working period of all participants. Given this, this study calculates pension benefits based on basic salary without considering benefits so that the simulation is compiled fully referring to the basic salary component in accordance with applicable regulations.

In this study, a discount rate assumption of 6% per year is used ( $i = 6\%$ ). Meanwhile, the amount of annual pension benefits is set at 2.5% of basic salary per year of service ( $k = 2.5\%$ ), referring to Article 11 Paragraph 1 of Law No. 11 of 1969 concerning Employee Pensions and Employee Widow/Widower Pensions.

To calculate the probability of survival and death of participants, Tabel Mortalitas Penduduk Indonesia 2023 is used, which reflects the current mortality conditions and is relevant for actuarial valuation purposes in pension programs. All parameters and assumptions are applied consistently in the simulation to obtain an objective comparison of results between the PUC and ILP methods.

#### 3.2. Methods

This research uses a quantitative approach with an actuarial simulation method. The main objective of this research is to compare two methods of calculating pension liabilities, namely Projected Unit Credit (PUC) and Individual Level Premium (ILP). The comparison is done by analyzing two main components in the calculation of actuarial liabilities, namely Normal Cost and Actuarial Liability.

##### 3.2.1. Mortality Table

According to Pitacco (2014), the mortality table or life table is the main tool used in actuarial to develop premium schemes and calculate reserves in various products such as life insurance, annuities, and pension programs. The number of people expected to die between the ages of  $x$  and  $x + n$ , expressed by the symbol  ${}_nd_x$ . According to Bowers et al. (1997), it can be mathematically written as follows

$${}_nd_x = l_x - l_{x+n} \quad (1)$$

where:

${}_nd_x$  : Number of people who died between  $x$  and  $x + n$  years

$l_x$  : Number of people who are still alive at age  $x$

$l_{x+n}$  : Number of people who are still alive at age  $x + n$

$x$  : Current age of the participant

$n$  : Period of time (usually in years) since age  $x$

##### 3.2.2. Commutation Symbol

Actuarial experts developed commutation symbols to simplify the actuarial calculation process. According to Larson et al. (1951), here are some of the commutation symbols.

$$D_x = v^x \cdot l_x \quad (2)$$

$$N_x = \sum_{t=0}^{\omega-x-1} D_{x+t} \quad (3)$$

where:

$D_x$  : Commutation symbol define as  $l_x \cdot v^x$

$v$  : Discount factor

$l_x$  : Number of people who are still alive at age  $x$

$N_x$  : Accumulated value of  $D_x$  from  $t = 0$  years to  $\omega - x - 1$

$D_{x+t}$  : The value of D at age  $x + t$

$\omega$  : Maximum age in the mortality table

$x$  : Current age of the participant

$t$  : Period of time in years since age  $x$

### 3.2.3. Interest Function

The interest function is used to calculate the present value of a payment to be received in the future (Winklevoss, 1993). In this study, the interest rate is considered fixed every year so that the present value of 1 unit of payment received in  $n$  years is as follows.

$$v^n = \frac{1}{(1+i)^n} \quad (4)$$

where:

$v^n$  : Present value of a unit of payment received in  $n$  years

$i$  : Annual interest rate

$n$  : Period of employment

### 3.2.4. Life Annuity

According to Bowers et al. (1997), a life annuity is a series of payments made continuously or at the same time interval. In this study, an early life annuity (annuity-due) form is used, where payments are made at the beginning of each period. There is a relationship between the early life annuity and the late life annuity, where payments on the early life annuity are made one year earlier than the late life annuity (Neil, 1997). The following is a mathematical early life annuity.

$$\ddot{a}_x = \frac{N_x}{D_x} \quad (5)$$

The above formula represents the present value of a series of payments of 1 unit paid at the beginning of each year as long as the individual is alive. If payments are made on a monthly basis ( $m$  times per year), then the early monthly life annuity form is used with the following formula.

$$\ddot{a}_x^{(m)} = \ddot{a}_x - \frac{m-1}{2m} \quad (6)$$

where:

$\ddot{a}_x$  : Present value of a whole life annuity due at age  $x$

$N_x$  : Accumulated value of  $D_x$  from  $t = 0$  years to  $\omega - x - 1$

$D_x$  : Commutation symbol define as  $l_x \cdot v^x$

$\ddot{a}_x^{(m)}$  : Present value of a monthly whole life annuity-due (paid  $m$  times per year)

$m$  : Payment frequency per year

$x$  : Current age of the participant

$t$  : Time difference between the maximum age in the mortality table and the current age of the participant, represented by  $\omega - x$

### 3.2.5. Benefit Function

The benefit function plays a role in determining the amount of pension received by participants when entering retirement, either due to early retirement, disability, death, or because they have reached the appropriate retirement age (Winklevoss, 1993). In this study, pension benefits are calculated based on the last salary approach with the equation:

$$B_r = k(r - e)s_{r-1} \quad (7)$$

Where  $B_r$  is the cumulative retirement benefit at normal retirement age. The retirement benefit at the participant's current age is expressed by:

$$B_x = k(x - e)s_{r-1} \quad (8)$$

The difference between the two is that the reference age  $B_r$  is calculated at normal retirement age, while  $B_x$  is calculated at the participant's current age. In addition, an approach according to Aitken (1994) is also used to derive the average annual pension benefit

$$b_x = \frac{B_r}{r - e} \quad (9)$$

where:

$B_r$  : Full annual pension benefit at normal retirement age  $r$

$B_x$  : Accrued annual pension benefit up to age  $x$

$b_x$  : Annual pension benefit per year of service up to age  $x$

$k$  : Years of service up to retirement age ( $r - e$ )

$s_{r-1}$  : Final salary in the year before retirement

$x$  : Current age of the participant

$r$  : Normal retirement age

$e$  : Entry age

### 3.2.6. Projected Unit Credit (PUC)

According to Aitken (1994), Normal Cost with the Project Unit Credit method is formulated with the following equation.

$${}^{PUC}(NC)_x = b_x \ddot{a}_r^{(12)} \frac{D_r^{(\tau)}}{D_x^{(\tau)}} \quad (10)$$

Meanwhile, the Actuarial Liability is formulated as follows.

$${}^{PUC}(AL)_x = B_x \ddot{a}_r^{(12)} \frac{D_r^{(\tau)}}{D_x^{(\tau)}} \quad (11)$$

where:

${}^{PUC}(NC)_x$ : Present value of normal cost under the Projected Unit Credit method at age  $x$

${}^{PUC}(AL)_x$ : Present value of actuarial liability under the Projected Unit Credit method at age  $x$

$b_x$  : Annual pension benefit per year of service up to age  $x$

$B_x$  : Accrued annual pension benefit up to age  $x$

$\ddot{a}_r^{(12)}$  : Present value of monthly annuity payments starting at retirement age  $r$

$D_r^{(\tau)}$  : Actuarial discount (probabilistic discount factor) at retirement age  $r$

$D_x^{(\tau)}$  : Actuarial discount at current age  $x$

$x$  : Current age of the participant

$r$  : Normal retirement age

### 3.2.7. Individual Level Premium (ILP)

According to Aitken (1994), Normal Cost with the Individual Level Premium method is formulated with the following equation.

$${}^{ILP}(NC)_a = B_r \ddot{a}_r^{(12)} \frac{D_r^{(\tau)}}{N_a - N_r} \quad (12)$$

The equation above shows the amount of annual contributions required from the time the pension program starts at age  $a$  until normal retirement age  $r$  to finance retirement benefits of  $B_r$ . Meanwhile, the Actuarial Liability is formulated as follows

$${}^{ILP}(AL)_x = {}^{ILP}(NC)_a \left( \frac{N_a - N_x}{D_x^{(\tau)}} \right) \quad (13)$$

where:

${}^{ILP}(NC)_a$  : Present value of normal cost under the Individual Level Premium method at the age of joining the pension program

${}^{ILP}(AL)_x$  : Present value of actuarial liability under the Individual Level Premium method at age  $x$

$B_r$  : Full annual pension benefit at normal retirement age  $r$

$\ddot{a}_r^{(12)}$  : Present value of monthly annuity payments starting at retirement age  $r$

$D_r^{(\tau)}$  : Actuarial discount (probabilistic discount factor) at retirement age  $r$

$D_x^{(\tau)}$  : Actuarial discount at current age  $x$

$N_a$  : Accumulated value of  $D_x$  from  $t = 0$  years to  $\omega - a - 1$

$N_x$  : Accumulated value of  $D_x$  from  $t = 0$  years to  $\omega - x - 1$

$N_r$  : Accumulated value of  $D_x$  from  $t = 0$  years to  $\omega - r - 1$

$a$  : Participant's age when joining the pension program

$x$  : Current age of the participant

$r$  : Normal retirement age

### 3.2.8. Simulation Steps

The following are the simulation steps.

1. Compile a calculation table to determine the value of  $D_x^{(\tau)}$  and  $N_x$  based on mortality data from the Indonesian Population Mortality Table 2023, using an assumed interest rate of 6%.
2. Calculate the amount of annual pension benefits for each participant based on pension program contributions of 2,5% of the proportion of salary and length of service so as to obtain annual benefits per year of service ( $b_x$ ), annual benefits that have been obtained until age  $x$  ( $B_x$ ), and full pension benefits at retirement age  $r$  ( $B_r$ ).
3. Calculate the annual life annuity value ( $\ddot{a}_{60}^{(12)}$ ) with monthly payments ( $m = 12$ ), based on the interest rate and the probability of survival to retirement age.
4. Calculate the Normal Cost and Actuarial Liability of all participants using the PUC and ILP methods.
5. Compare the results of both methods graphically and numerically to see observe trends and differences in the magnitude of the liability.

## 4. Results and Discussion

Actuarial calculations in this study were carried out for six PNS Group III/D grouped by gender (male and female) and age (40, 43, and 50 years). The purpose is to compare two calculation methods, namely Projected Unit Credit (PUC) and Individual Level Premium (ILP) by calculating the Normal Cost and Actuarial Liability of each participant.

All calculations refer to the Indonesian Population Mortality Table 2023 and use the assumption of the discount rate:  $i = 6\%$  so that  $v = \frac{1}{1+i} = 0,943396$ ,  $l_0 = 10.000.000$ , basic salary one year before retirement:  $s_{r-1} = Rp5.022.500$ , retirement age:  $r = 60$  years, entry age:  $e = 28$  years, and pension payment frequency: monthly ( $m = 12$ ).

The first step is to determine the value of  $l_x$  by using the value of  $d_x$  taken from the mortality table. For example, for a male participant with  $x = 40$ ,

$$l_{40} = l_{39} - d_{39} = 9.496.307 - 24.247 = 9.472.060$$

which means that out of 10.000.000 individuals born, approximately 9.472.060 males are expected to be alive at age 40. Here is the table for  $l_x$  values for all participants:

| Table 1: Calculation of $l_x$ values |              |                |
|--------------------------------------|--------------|----------------|
| $x$                                  | $l_x$ (Male) | $l_x$ (Female) |
| 40                                   | 9.472.060    | 9.577.154      |
| 43                                   | 9.388.527    | 9.508.118      |
| 50                                   | 9.108.237    | 9.276.594      |

Next, calculate the value of  $D_x$  which shows the present value of one unit of payment deferred to age  $x$ . With a discount factor value of  $i = 6\%$ ,  $v = 0,943396$  has been obtained. For example, for a male participant with  $x = 40$ ,

$$D_{40} = v^{40} \cdot l_{40} = 0,943396^{40} \cdot 9.472.060 = 920.894,40$$

The following table calculates  $D_x$  for all participants:

| Table 2: Calculation of $D_x$ values |              |                |
|--------------------------------------|--------------|----------------|
| $x$                                  | $D_x$ (Male) | $D_x$ (Female) |
| 40                                   | 920.894,40   | 931.111,86     |
| 43                                   | 766.381,92   | 776.144,09     |
| 50                                   | 494.471,27   | 503.611,09     |

Then calculate the value of  $N_x$  which is the sum of  $D_x$  forward, from age  $x$  to the maximum age ( $\omega = 111$ ). This implies that  $N_x$  is the present value of all possible payments to individuals aged  $x$  or older. An example calculation for a male participant with  $x = 40$  is as follows:

$$\begin{aligned}
 N_{40} &= \sum_{t=0}^{111-40-1} D_{40+t} \\
 &= D_{40} + D_{41} + D_{42} + \dots + D_{110} \\
 &= 920.894,40 + 866.208,88 + 814.842,55 + \dots + 10.842,04 \\
 &= 14.646.379,48
 \end{aligned}$$

The following table calculates  $N_x$  for all participants:

| Table 3: Calculation of $N_x$ values |               |                |
|--------------------------------------|---------------|----------------|
| $x$                                  | $N_x$ (Male)  | $N_x$ (Female) |
| 40                                   | 14.646.379,48 | 15.116.539,29  |
| 43                                   | 12.044.433,65 | 12.484.357,16  |
| 50                                   | 7.557.015,09  | 7.931.214,03   |

Then, calculate the initial life annuity value of  $\ddot{a}_{60}$  where this value will show the present value of a series of payments of 1 unit paid at the beginning of each year as long as the individual is alive. The calculation of this value considers the chance of survival from retirement age to the following years ( ${}_tp_x$ ) and the discount factor ( $v^t$ ). So for a participant with a retirement age of  $x = 60$  the formula used will be:

$$\ddot{a}_{60} = \frac{N_{60}}{D_{60}} = \frac{3.807.178,95}{255.012,27} = 14,93$$

Then the following calculation will be obtained:

**Table 4:** Calculation of  $\ddot{a}_{60}$

| $\ddot{a}_{60}$ (Male) | $\ddot{a}_{60}$ (Female) |
|------------------------|--------------------------|
| 14,93                  | 15,45                    |

Initial life annuity which represents the present value of pension payments over the life after retirement. Since payments are made on a monthly basis ( $m = 12$ ), the annuity value is calculated with a correction to the annual annuity so for each gender the calculation formula will be:

$$\ddot{a}_{60}^{(12)} = \ddot{a}_{60} - \frac{m-1}{2 \cdot m} = \ddot{a}_{60} - \frac{12-1}{2 \cdot 12} = \ddot{a}_{60} - \frac{11}{24}$$

Thus obtained:

**Table 5:** Calculation of  $\ddot{a}_{60}^{(12)}$

| $\ddot{a}_{60}^{(12)}$ (Male) | $\ddot{a}_{60}^{(12)}$ (Female) |
|-------------------------------|---------------------------------|
| 14,47                         | 14,99                           |

In order to design the annual pension benefits that participants will receive, first calculate the amount of full benefits earned at retirement age. By using a benefit rate of 2,5% per year and 32 years of service, as well as a base salary one year before retirement of Rp5.022.500, the full annual retirement benefit earned is:

$$B_{60} = k(r - e)s_{r-1} = 0,025 \cdot (60 - 28) \cdot 5.022.500 = 4.018.000$$

Furthermore, the retirement benefit that the participant has earned at the current age, expressed as  $B_x$ , is calculated by considering the length of service that has run from the age of entry into employment (28 years old) to the current age. For example, for a 40 years old male participant who has worked for 12 years:

$$B_{40} = k(x - e)s_{r-1} = 0,025 \cdot (40 - 28) \cdot 5.022.500 = 1.506.750$$

The following is the calculation of the  $B_x$  value for all participants:

**Table 6:** Calculation of  $B_x$

| $x$ | $B_x$       |
|-----|-------------|
| 40  | 1.506.750   |
| 43  | 1.883.437,5 |
| 50  | 2.762.375   |

Then, the  $b_x$  value is also calculated, which is the amount of average annual pension benefits calculated per year of service until the current age which serves to calculate the accumulated pension obligation based on the proportion of annual benefits that have been formed.

$$b_x = \frac{B_{60}}{r - e} = \frac{4.018.000}{60 - 28} = 125.562,5$$

The  $b_x$  value is the same for all participants of all ages and genders because this value only reflects the value of benefits per working year based on a fixed salary and a fixed percentage. Henceforth, this  $b_x$  value is used in the calculation of Normal Cost in the Projected Unit Credit (PUC) method. For example, the calculation of Normal Cost using the PUC method for a 40 years old male participant is as follows:

$${}^{PUC}(NC)_{40} = b_{40} \ddot{a}_{60}^{(12)} \frac{D_{60}^{(\tau)}}{D_{40}^{(\tau)}} = 125.562,5 \cdot 14,47 \cdot \frac{255.012,27}{920.894,40} = 503.166,36$$

Meanwhile, the calculation of Normal Cost using the Individual Level Premium (ILP) method does not use the  $b_x$  value. For example, with the same participants, the Normal Cost calculation for this method is as follows:

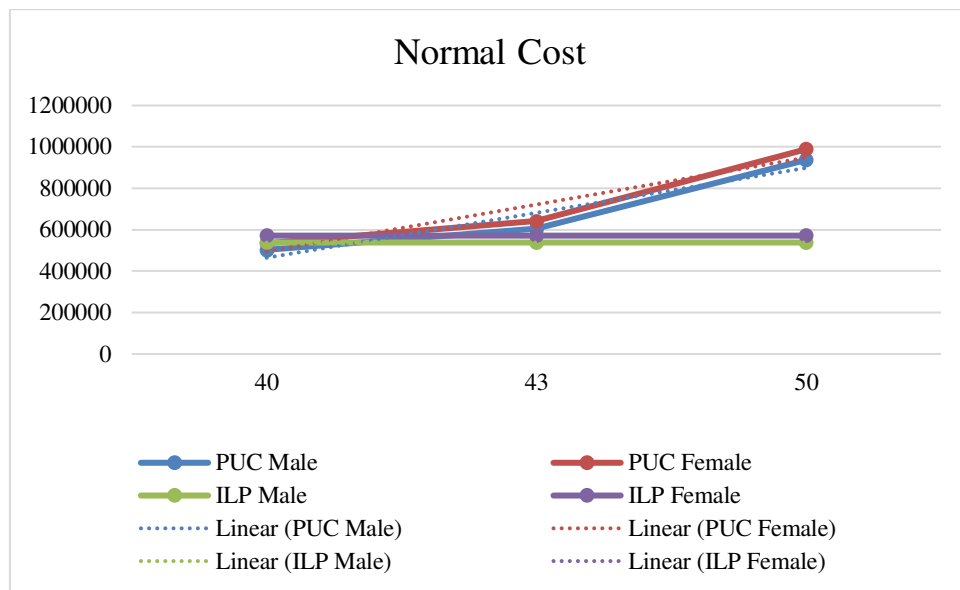
$${}^{ILP}(NC)_a = B_{60} \ddot{a}_{60}^{(12)} \frac{D_{60}^{(\tau)}}{N_{28} - N_{60}} = 4.018.000 \cdot 14,47 \cdot \frac{255.012,27}{31.354.743,34 - 3.807.178,95} = 538.255,16$$

As comparison, the following table calculates the Normal Cost value with the PUC and ILP methods for all participants

**Table 7:** Normal Cost calculation of PUC and ILP methods

| Gender | $x$ | $^{PUC}(NC)_x$ | $^{ILP}(NC)_x$ |
|--------|-----|----------------|----------------|
| Male   | 40  | 503.166,36     | 538.255,16     |
|        | 43  | 604.611,18     | 538.255,16     |
|        | 50  | 937.087,99     | 538.255,16     |
| Female | 40  | 534.878,86     | 571.589,52     |
|        | 43  | 641.675,93     | 571.589,52     |
|        | 50  | 988.923,78     | 571.589,52     |

Based on the table, the Normal Cost value for male and female participants using the PUC method increases significantly with age. In contrast, the ILP value for male and female participants is fixed at all ages. The increase in Normal Cost in the PUC method is due to its approach that calculates the cost of benefits based on the projected credit units of the actual working period that participants have passed. Thus, the older the participant's age, the shorter the remaining time to retirement and the contribution burden per year becomes greater in order to fulfill the same value of retirement benefits. On the other hand, the ILP method uses a fixed contribution approach throughout the participant's working life, so the Normal Cost value is constant. This makes ILP more predictable and stable on an annual installment basis, but it does not explicitly adjust for actual conditions such as age or remaining working life.

**Figure 1:** Normal Cost values using PUC and ILP methods

The figure shows that the Normal Cost of the ILP method forms a horizontal line, indicating the stability of the value throughout working age. Meanwhile, the PUC method shows a consistent linear increasing trend in both male and female groups. This pattern suggests that the PUC method is more sensitive to ageing than the ILP method. In addition, it can be observed that the Normal Cost value of women is slightly higher than that of men in the PUC method, while it is lower in the ILP method. This difference is likely due to differences in mortality assumptions and retirement ages between men and women, which affect the actuarial burden of each method.

In addition to Normal Cost, one of the important components in assessing pension fund liabilities is Actuarial Liability. Furthermore, the Actuarial Liability value will be calculated using both methods as a comparison. For example, using the PUC method, the calculation of the Actuarial Liability value of a 40-year-old male participant will be obtained:

$$^{PUC}(AL)_{40} = B_{40} \ddot{a}_{60}^{(12)} \frac{D_{60}^{(\tau)}}{D_{40}^{(\tau)}} = 1.506.750 \cdot 14,47 \cdot \frac{255.012,27}{920.894,40} = 6.037.996,35$$

With the same participants, the calculation of the Actuarial Liability value with the ILP method will be obtained:

$$^{ILP}(AL)_{40} = ^{ILP}(NC)_a \left( \frac{N_{28} - N_{40}}{D_{40}^{(\tau)}} \right) = 538.255,16 \cdot \frac{31.354.743,34 - 14.646.379,48}{920.894,40} = 9.765.900,52$$

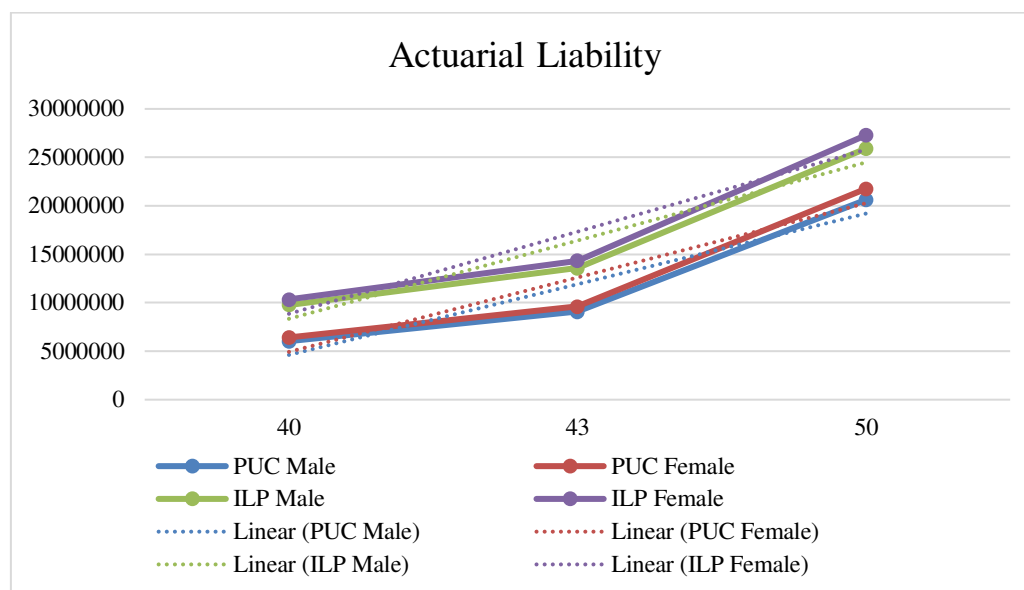
For comparison, the following table shows the calculation of Actuarial Liability for all participants:

**Table 8:** Actuarial Liability calculation of PUC and ILP methods

| Gender | $x$ | $^{PUC}(AL)_x$ | $^{ILP}(AL)_x$ |
|--------|-----|----------------|----------------|
| Male   | 40  | 6.037.996,35   | 9.765.900,52   |
|        | 43  | 9.069.167,76   | 13.562.263,78  |

|        |    |               |               |
|--------|----|---------------|---------------|
|        | 50 | 20.615.935,71 | 25.904.943,11 |
|        | 40 | 6.418.558,33  | 10.345.795,89 |
| Female | 43 | 9.625.138,98  | 14.349.939,81 |
|        | 50 | 21.756.323,15 | 27.283.255,18 |

Table 8 shows the results of the Actuarial Liability (AL) calculation using the Projected Unit Credit (PUC) and Individual Level Premium (ILP) methods for male and female participants at the ages of 40, 43, and 50 years. From the table, it can be seen that both the PUC and ILP methods show an increasing actuarial liability value as the age of participants increases. The increase in the value of Actuarial Liability is due to the accumulation of a longer working period and the closer participants are to retirement age. This causes the present value of retirement benefits that must be prepared to be greater. In addition, female participants tend to have a higher AL value than male participants. This is due to the longer life expectancy of women, so that the duration of pension payments becomes longer and increases the total liabilities that must be recorded.



**Figure 2:** Actuarial Liability values using PUC and ILP methods

Figure 2 shows that the Actuarial Liability value increases consistently for all categories of participants and both methods. The trend line patterns of the PUC and ILP methods show similar increases, reflecting that although the calculation approaches are different, both still illustrate the growth of liabilities proportional to age and length of service. The line for female participants is generally above that of male participants, indicating that the pension liability for women is greater. This is consistent with mortality assumptions, where women have longer life expectancies and therefore longer pension payment periods. Overall, both the PUC and ILP produce similar trends and values, with the ILP being slightly higher due to its more equitable and conservative financing approach.

## 5. Conclusion

This study aims to compare two methods of calculating pension funds, namely Projected Unit Credit (PUC) and Individual Level Premium (ILP), in the context of PNS Group III/D who have a long service period and a large population in the bureaucratic environment. The simulation results show that the PUC method produces a Normal Cost that gets bigger as the age of participants increases. This means that the contribution burden will feel heavier when participants approach retirement age. In contrast, the ILP method provides a fixed annual contribution, although the amount is greater from the beginning of the working period. However, if you look at the Actuarial Liability value, the calculation results with both methods increase as the participant's age gets closer to his retirement age, although when compared, the Actuarial Liability value of the ILP method tends to be higher than the PUC method at all ages.

From the perspective of pension fund managers, ILP is more profitable because it makes contribution expenditures more planned and stable each year. However, from the participant's side, the PUC method feels lighter at the beginning and the retirement benefits received tend to be greater because it takes into account salary increases until retirement arrives.

The ILP method is more suitable if the main objective is to maintain the agency's financial balance in the long term because it does not cause sudden spikes in contributions. Meanwhile, PUC is more suitable if you want to provide maximum retirement benefits for participants, even though contributions will get higher over time. Therefore, the choice of method should consider the ability of the agency to pay contributions consistently and the expectations of participants

to get decent retirement benefits. The results of this study are expected to be taken into consideration in improving a fairer and more sustainable pension system for PNS, especially Group III/D.

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