



# Comparison of Projected Unit Credit, Entry Age Normal, and Individual Level Premium Methods in Calculation of Normal Retirement on PNS Pension Funds

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## Abstract

Every individual's desire for a prosperous old age lead to the need for a pension fund program to ensure the welfare of every employee in their old age. The calculation of pension fund in this study was carried out using the Projected Unit Credit, Entry Age Normal and Individual Level Premium methods. This study aimed to determine the value of normal cost and actuarial liability using Projected Unit Credit method, Entry Age Normal method, and Individual Level Premium. Then the best method was determined based on the comparison results of the normal cost value and the actuarial liability value obtained using the three methods. The data used in this study is secondary data from PT Taspen (Persero) KCU Bandung. The results showed that the best method among the three methods studied was the Projected Unit Credit method because it produced the highest total normal cost with the lowest actuarial liability value each year.

*Keywords:* Pension fund, normal cost, actuarial liability, Projected Unit Credit, Entry Age Normal, Individual Level Premium

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## 1. Introduction

Every individual wants a prosperous old age with sufficient finances. The increasing price of living necessities requires every individual to find a job that can guarantee their well-being in old age. Therefore, an old age program planning is needed in the form of a pension fund program. The pension fund program is a form of compensation from the government for employees who are no longer working.

According to Law Number 11 of 1969 concerning Employee Pension and Employee Widows/Widowers, pension is an old-age guarantee and an award given by the government for the services of Pegawai Negeri Sipil (PNS) for many years of service to the state. The pension fund program is a form of compensation from the government for employees who are no longer working.

According to the records of the Badan Pemeriksa Keuangan (BPK) on the 2021 Laporan Keuangan Pemerintah Pusat (LKPP), the government has a long-term obligation to pension PNS reaching IDR 2,929 trillion. The budget used for pension spending every year is increasing because the number of PNS continues to increase. Therefore, the government needs to prepare and take into account periodic payments for employees in the form of a pension fund program and it is necessary to make special calculations to project the funds that will be spent on employee pensions.

Calculation of pension fund is carried out using actuarial method. The actuarial method for calculating pension fund is divided into two, namely Accrued Benefit Cost method and Projected Benefit Cost method. The Accrued Benefit Cost method is a form of a defined benefit pension program, where the amount of pension benefits is determined first before determining the normal contributions that must be paid by participants. Normal cost with this method tend to increase as the age of retirement participants increases (SPA-DP No. 3.02, 2019). One of the methods included in the Accrued Benefit Cost method is Projected Unit Credit method (PUC).

The Projected Benefit Cost method is a form of a defined benefit pension program that is applied by first determining the present value of the total pension benefits that will be obtained when reaching retirement age, then allocated equally throughout the working period until the normal retirement age is reached (SPA-DP No. 3.02, 2019). Normal cost with this method have an even pattern throughout the rest of the working period until retirement age.

Methods included in the Projected Benefit Cost method are Entry Age Normal (EAN) and Individual Level Premium (ILP).

Research on the application of the Projected Unit Credit (PUC), Entry Age Normal (EAN) and Individual Level Premium (ILP) methods in the calculation of pension funds has been carried out before. Syahrini et al. (2019) use the Projected Unit Credit and Entry Age Normal methods on calculation of PNS pension fund with the result obtained is the PUC method is better from the company's side and the EAN method is better form the employee's side. Rembet et al. (2023) use the Projected Unit Credit and Individual Level Premium methods on pension funding with the result obtained is the PUC method is better from the company's side and the ILP method is better form the employee's side.

This study is different from previous research because it uses the Projected Unit Credit, Entry Age Normal, and Individual Level Premium methods in calculating normal pensions on PNS pension fund with the aim of determining the best method from the company's side. The mortality table used is the Indonesian Mortality Table IV 2019 and the data used is secondary data for Civil Servants (PNS) obtained from PT Taspen (Persero) KC Bandung.

## 2. Literature Review

### 2.1. Pension Fund

Pension fund is a set of assets that are run and managed by an institution with the aim of generating a pension benefit in the form of a periodic payment paid to a retirement participant at the time of reaching retirement age or at another time and in a manner stipulated in the provisions that are the basis for the implementation of the pension program where the payment of the benefit is associated with the achievement of a certain age. According to Law Number 11 of 1992, a pension program is any program that provides retirement benefits for participants.

### 2.2. Mortality Table

The mortality table is a hypothetical table of a group of people born at the same time whose numbers decrease over time until they finally run out due to death. This table contains the chances of someone dying based on their age from the group of insured people. Chance of the insured aged  $x$  will live until the next  $n$  years is expressed in symbols  ${}_n p_x$ .

$${}_n p_x = \frac{l_{x+n}}{l_x}. \quad (1)$$

### 2.3. Commutation Symbol

Actuarial experts created commutation symbols to simplify calculations. According to Larson et al. (1951), the commutation symbols used include the following.

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

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

### 2.4. Life Annuity

A living annuity is a series of payments made continuously (continuously) or at equal intervals (Bowers, 1997). Life annuity payments are made as long as the insured is alive, either for a certain period of time or for life. The lifetime annuity due formulated as  $\ddot{a}_x$ .

$$\ddot{a}_x = \frac{N_x}{D_x}. \quad (4)$$

Calculation of the present value of the  $n$  year term annuity due is formulated as  $\ddot{a}_{x:\overline{n}|}$ .

$$\ddot{a}_{x:\overline{n}|} = \frac{N_x - N_{x+n}}{D_x}. \quad (5)$$

## 2.5. Basic Actuarial Function

Basic actuarial functions include all the basic functions that support the actuarial calculation process. According to Winklevoss (1993), the basic actuarial functions used in calculating pension funds include the survival function, interest function, salary function, benefit function and annuity function.

Interest function is used to discount a future payment to the present. There are two types of approaches that can be used to calculate interest, namely simple interest and compound interest. In this research, a compound interest approach is used. The function of compound interest is simplified as follows.

$$v^n = \frac{1}{(1+i)^n}. \quad (6)$$

According to Aitken (1994), a large level of salary increase was assumed  $s$  per year, then the amount of the employee's final salary before retirement is at age  $r-1$  based on salary at age  $x$  are as follows.

$$s_{r-1} = (1+s)^{r-1-x} \cdot s_x. \quad (7)$$

The benefit function is used to determine the amount of pension benefits that participants receive when they retire, whether due to early retirement, disability, death, or because it is time to retire (Winklevoss, 1993). In this study, pension benefits are calculated using final average assumption. The cumulative pension benefit using final average assumptions denoted as follows.

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

## 2.6. Present Value of Future Benefit

Present Value of Future Benefit (PVFB) is the present value of the projected pension benefits that will be received by pension program participants when they retire (Caraka, 2016). Present Value of Future Benefit of participant aged  $x$  that will retire at age  $x$  defined as follows.

$${}^r(PVFB)_x = B_r \cdot v^{r-x} \cdot {}_{r-x}p_x \cdot \ddot{a}_r. \quad (9)$$

## 2.7. Projected Unit Credit Method

Projected Unit Credit method is a method that divides the total pension benefit at the normal retirement age by the total length of service into pension benefit units which are then allocated to each year during the work period. The normal cost of this method calculated as follows.

$${}^{PUC}(NC)_x = \frac{1}{r-y} \cdot {}^r(PVFB)_x. \quad (10)$$

The actuarial liability of this method is defined as the accumulated Present Value of Future Benefits before the calculation age ( $x$ ) and calculated by

$${}^{PUC}(AL)_x = \frac{x-y}{r-y} \cdot {}^r(PVFB)_x. \quad (11)$$

## 2.8. Entry Age Normal Method

Entry Age Normal method is an actuarial valuation method that finances the present value of pension benefits for each employee allocated evenly from the age at which they enter work to the normal retirement age. The normal cost of this method according to Winklevoss (1993) is defined as follows.

$${}^{EAN}(NC)_x = \frac{B_r \cdot v^{r-y} \cdot {}_{r-y}p_y \cdot \ddot{a}_r}{\ddot{a}_{y:\overline{r-y}|}}. \quad (12)$$

The actuarial liability of this method is defined as follows.

$${}^{EAN}(AL)_x = {}^r(PVFB)_x - {}^{EAN}(NC)_x \cdot \ddot{a}_{x:\overline{r-x}|}. \quad (13)$$

## 2.9. Individual Level Premium Method

According to Wardhani et al. (2014), Individual Level Premium method is the present value of the total pension benefits allocated evenly each year during the working period. The normal cost of this method is defined as follows.

$${}^{ILP}(NC)_x = B_r \cdot \ddot{a}_r \cdot \frac{D_r}{N_y - N_r} \quad (14)$$

The actuarial liability of this method calculated by

$${}^{ILP}(AL)_x = {}^{ILP}(NC)_x \cdot \frac{N_y - N_x}{D_x} \quad (15)$$

## 3. Materials and Methods

### 3.1. Materials

This study used secondary data of PNS from PT Taspen (Persero) KC Bandung. The data contains gender, age appointed as PNS, normal retirement age, working period, basic salary, and class. The proportion of salary used government provisions for the pension fund of PNS.

In this study, the present value of pension benefits (PVFB), the amount of normal contribution, and the amount of actuarial liability were determined using the Projected Unit Credit (PUC), Entry Age Normal (EAN), and Individual Level Premium (ILP) methods with the help of Microsoft Excel to then make a comparison.

### 3.2. Methods

Methods include: the stages and formulas that are used in data analysis, arranged sequentially step by step.

- 1) Processing data based on the Indonesian Mortality Table IV 2019 assuming an interest rate of 8%,
- 2) Calculate pension benefit ( $B_r$ ) based on final average assumption by knowing the age appointed as PNS ( $y$ ), normal retirement age ( $r$ ), basic salary of employee for the last year ( $s_{r-1}$ ), and the proportion of salary according to government provision for the pension fund of PNS ( $k = 2,5\%$ ) using equation 8,
- 3) Calculate the present value of retirement benefits  ${}^r(PVFB)_x$ , using the lifetime annuity ( $\ddot{a}_x$ ) using equation 9,
- 4) Calculate the amount of normal cost (NC) using the Projected Unit Credit (PUC) method by using equation 10, Entry Age Normal (EAN) method by using equation 12, and Individual Level Premium (ILP) method by using equation 14,
- 5) Calculate the amount of actuarial liabilities (AL) using the Projected Unit Credit (PUC) method by using equation 11, Entry Age Normal (EAN) method by using equation 13, and Individual Level Premium (ILP) method by using equation 15,
- 6) Analyze the results of calculations and draw conclusions.

## 4. Results and Discussion

Calculation results of the normal cost and actuarial liability using the Projected Unit Credit, Entry Age Normal, and Individual Level Premium methods have different values. To determine the best method, look at the total value of normal cost and the value of actuarial liability. Method with the highest total value of normal cost and the lowest increase in actuarial liability value each year is the best method because this situation is more profitable for pension fund company. Results of the normal cost calculation are presented in Table 1.

**Table 1:** Normal cost values using the PUC, EAN, and ILP methods

x	${}^{PUC}(NC)_x$	${}^{EAN}(NC)_x$	${}^{ILP}(NC)_x$
24	615,475.32	1,690,918.06	1,690,918.06
25	665,045.87	1,690,918.06	1,690,918.06
26	718,623.22	1,690,918.06	1,690,918.06
27	776,540.18	1,690,918.06	1,690,918.06
28	839,166.89	1,690,918.06	1,690,918.06
29	906,889.72	1,690,918.06	1,690,918.06
30	980,126.99	1,690,918.06	1,690,918.06
31	1,059,331.65	1,690,918.06	1,690,918.06
32	1,145,005.63	1,690,918.06	1,690,918.06
33	1,237,682.87	1,690,918.06	1,690,918.06

x	$PUC(NC)_x$	$EAN(NC)_x$	$ILP(NC)_x$
34	1,337,941.78	1,690,918.06	1,690,918.06
35	1,446,409.07	1,690,918.06	1,690,918.06
36	1,563,795.06	1,690,918.06	1,690,918.06
37	1,690,860.06	1,690,918.06	1,690,918.06
38	1,828,451.00	1,690,918.06	1,690,918.06
39	1,977,475.77	1,690,918.06	1,690,918.06
40	2,138,989.26	1,690,918.06	1,690,918.06
41	2,314,111.81	1,690,918.06	1,690,918.06
42	2,504,073.62	1,690,918.06	1,690,918.06
43	2,710,253.66	1,690,918.06	1,690,918.06
44	2,934,145.24	1,690,918.06	1,690,918.06
45	3,177,455.99	1,690,918.06	1,690,918.06
46	3,442,047.46	1,690,918.06	1,690,918.06
47	3,730,018.72	1,690,918.06	1,690,918.06
48	4,043,664.83	1,690,918.06	1,690,918.06
49	4,385,489.36	1,690,918.06	1,690,918.06
50	4,758,264.11	1,690,918.06	1,690,918.06
51	5,165,164.27	1,690,918.06	1,690,918.06
52	5,609,566.60	1,690,918.06	1,690,918.06
53	6,095,453.24	1,690,918.06	1,690,918.06
54	6,627,293.55	1,690,918.06	1,690,918.06
55	7,209,892.95	1,690,918.06	1,690,918.06
56	7,848,609.92	1,690,918.06	1,690,918.06
57	8,548,907.97	1,690,918.06	1,690,918.06
58	9,316,482.62	1,690,918.06	1,690,918.06
Total	111,348,706.25	59,182,131.96	59,182,131.96

Table 1 indicates that the normal cost values using the Projected Unit Credit method experienced an increase as the employee's length of service increased with a total normal cost value of IDR111.348.706,25. Meanwhile, the normal cost value using the Entry Age Normal and Individual Level Premium methods does not increase or has a constant value from the age the employee is appointed as a PNS until retirement age with a total value of normal contributions from each method of IDR 59,182,131.96.

Visualization of the calculation results in Table 1 can be seen in Figure 1 as follows.

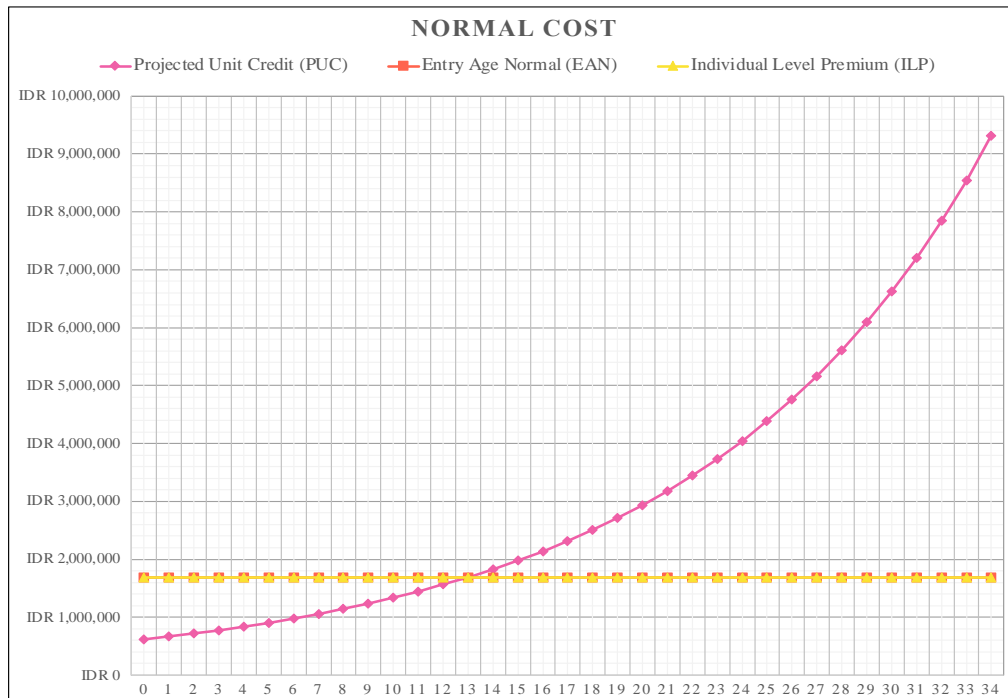


Figure 1: Normal cost values using the PUC, EAN, and ILP methods

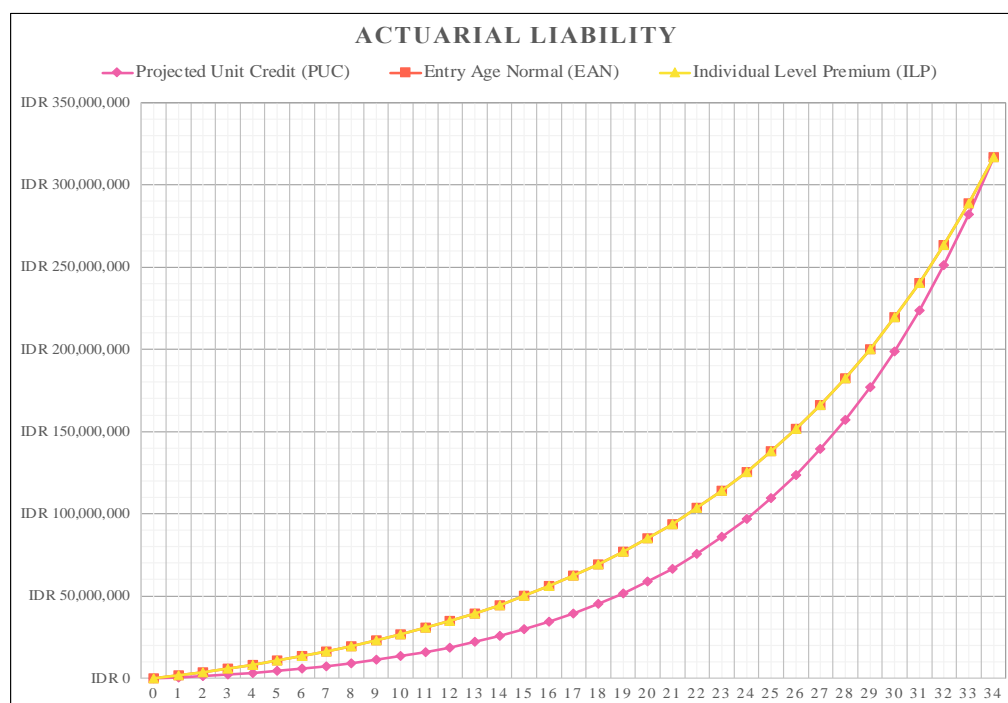
The results of these calculations show that the Entry Age Normal and Individual Level Premium methods are more profitable for employees rather than the company because the total normal cost that have to be paid are smaller than the total normal cost calculated using the Projected Unit Credit method. Results of the actuarial liability calculations are presented in Table 2

**Table 2:** Actuarial liability values using the PUC, EAN, and ILP methods

x	$PUC(AL)_x$	$EAN(AL)_x$	$ILP(AL)_x$
24	0	0	0
25	665,045.87	1,827,105.05	1,827,105.05
26	1,437,246.44	3,801,441.71	3,801,441.71
27	2,329,620.53	5,935,012.80	5,935,012.80
28	3,356,667.57	8,240,949.90	8,240,949.90
29	4,534,448.61	10,733,394.10	10,733,394.10
30	5,880,761.93	13,427,656.48	13,427,656.48
31	7,415,321.52	16,340,315.74	16,340,315.74
32	9,160,045.06	19,489,519.01	19,489,519.01
33	11,139,145.80	22,894,790.50	22,894,790.50
34	13,379,417.82	26,577,282.11	26,577,282.11
35	15,910,499.76	30,559,910.49	30,559,910.49
36	18,765,540.67	34,868,203.81	34,868,203.81
37	21,981,180.75	39,529,706.07	39,529,706.07
38	25,598,313.93	44,574,884.16	44,574,884.16
39	29,662,136.49	50,036,617.30	50,036,617.30
40	34,223,828.17	55,952,464.50	55,952,464.50
41	39,339,900.85	62,362,740.70	62,362,740.70
42	45,073,325.20	69,311,723.08	69,311,723.08
43	51,494,819.54	76,848,845.94	76,848,845.94
44	58,682,904.85	85,027,862.26	85,027,862.26
45	66,726,575.86	93,909,839.31	93,909,839.31
46	75,725,044.03	103,561,573.91	103,561,573.91
47	85,790,430.46	114,058,208.07	114,058,208.07
48	97,047,955.91	125,482,123.82	125,482,123.82
49	109,637,234.03	137,923,405.06	137,923,405.06
50	123,714,866.80	151,481,800.06	151,481,800.06
51	139,459,435.31	166,271,193.23	166,271,193.23
52	157,067,864.88	182,413,298.12	182,413,298.12
53	176,768,144.00	200,050,863.23	200,050,863.23
54	198,818,806.46	219,344,149.27	219,344,149.27
55	223,506,681.58	240,466,060.97	240,466,060.97
56	251,155,517.54	263,609,415.64	263,609,415.64
57	282,113,962.92	288,971,952.83	288,971,952.83
58	316,760,409.03	316,760,409.03	316,760,409.03

Table2 indicates that the actuarial liability values from each methods are increasing over the years and are heading towards the same value, which is IDR 316,760,409.03. However, the increase in the actuarial liability value using the Projected Unit Credit method is smaller each year compared to the values of actuarial liability using Entry Age Normal and Individual Level Premium methods.

Visualization of the calculation results in Table 2 can be seen in Figure 2 as follows.



**Figure 2:** Actuarial liability values using the PUC, EAN, and ILP methods

The results of these calculations show that the values of actuarial liability that the company has to prepare each year using the Projected Unit Credit method are smaller than using the Entry Age Normal and Individual Level Premium method. As the result, the Projected Unit Credit method is more profitable for the company.

## 5. Conclusion

Based on the results of the calculations that have been done, it can be concluded that the best method among the three methods used is the Projected Unit Credit method. This is caused by the total value of normal cost calculated by Projected Unit Credit method has a higher value compared to other methods, with the values of actuarial liability that have to be prepared every year using the Projected Unit Credit method are smaller than using the Entry Age Normal and Individual Level Premium methods. In other words, Projected Credit Unit Method is more profitable from the company's side.

## References

- Bowers, N. L., Gerber, H. U., Hickman, J. C., Jones, D. A., & Nesbitt, C. J. (1997). *Actuarial Mathematics* (2 ed.). Schaumburg: The Society of Actuaries.
- Caraka, R. (2018). Study of Pension Fund Calculations Using Accrued Benefit Cost. *BPPK Journal: Financial Education and Training Agency*, 9(2), 160-180. Available at: <https://jurnal.bppk.kemenkeu.go.id/jurnalbppk/article/view/125> (Accessed: 3 Agustus 2023).
- House of Representatives of the Republic of Indonesia (1992). Law of the Republic of Indonesia Number 11 of 1992 concerning Pension Funds. Available at: <https://www.dpr.go.id/dokjdih/document/uu/627.pdf> (Accessed: 14 August 2023).
- Kellison, S. G. (1991). *The Theory of Interest* (2 ed.). Illinois: Richard D. Irwin, Inc.
- Larson, R. E., dan Gaumnitz, E. A. (1951). *Life Insurance Mathematics*. New York: John Wiley & Sons, Inc.
- Persatuan Aktuaris Indonesia (2019). *Pension Fund Actuarial Practice Standards*. Jakarta: Indonesian Actuaries Association
- Rembet, K. O. P., Salsabila, N. I., Talarima, G., & Unwaru, D. F. (2023). Comparison of Projected Unit Credit and Individual Level Premium Methods in Pension Fund Financing. *Variance: Journal of Statistics and its Applications*, 5(1), 99-108. doi: 10.30598/variancevol5iss
- Syahrini, I., Alfira, M., Nurmaulidar, & Maulidi, I. (2019). Application of the Normal Age Entry Method and Projected Unit

Credit for Normal Contributions and Actuarial Liabilities in Civil Servant Pension Funds. *Journal of Data Analysis*, 2(1), 43-52 . doi: 10.24815/jda.v2i1.14377

Wardhani, I. G. A. K., Widana, I. N., & Tastrawati, N. K. T. (2014). Calculation of Pension Funds using the Projected Unit Credit Method and Individual Level Premium. *Mathematics E-Journal*, 3(2), 64-74. doi: 10.24843/MTK.2014.v03.i02.p067

Winklevoss, H. E. (1993). *Pension Mathematics with Numerical Illustrations* (2 ed.). Philadelphia: Pension Research Council of the Wharton School of the University of Pennsylvania.