Jurnal Varian
Vol. 8, No. 3, Oktober 2025, pp 249–258
e-ISSN: 2581-2017

Pension Fund Calculation Using Attained Age Normal and Individual Level Premium Methods

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Article Info

Article history:

Received : 02-06-2025
Revised : 10-22-2025
Accepted : 10-25-2025

Keywords:

Actuarial;
Attained Age Normal;
Individual Level Premium;
Pension Fund.

ABSTRACT

The primary concern in the employer-employee relationship is the employees' worry regarding their post-retirement financial security, which necessitates that the company provide a structured pension program. This study aims to compare the results of actuarial calculations in corporate pension fund programming at PT. RAP. The methodologies employed were the Attained Age Normal (AAN) and Individual Level Premium (ILP) methods, utilizing a data sample consisting of one employee from the company's total of 38 employees. The findings indicate that the direct pension benefit, set at 20%, calculated using the AAN method amounts to IDR 80,022,877, compared to IDR 38,097,920 using the ILP method. Based on these results, the study offers insights to the company that the ILP method is more advisable than the AAN method.

Accredited by Kemenristekdikti, Decree No: 200/M/KPT/2020
DOI: https://doi.org/10.30812/varian.v8i3.4871

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How to Cite:
Hafizah, N., & Sari, D. P. (2025). Pension Fund Calculation Using Attained Age Normal and Individual Level Premium Methods. *Jurnal Varian*, *8*(3), 249–258.

A. INTRODUCTION

The issue of pension funds is not only a financial matter but also a human resource concern. Pension funds do not stand alone but are assumed to be related to other human resource variables (Kurniawan et al., 2021). The relationship between a company and its employees can be viewed as a mutually beneficial partnership. Employees need companies as a platform to develop their potential and earn a decent living. Retirement represents a stage in life where one ceases active work and relies on savings or pension programs to meet daily needs (Zumara & Dai, 2024). Meanwhile, companies need committed and competent human resources to achieve their business objectives. However, there is concern among employees about their financial condition after retirement when they no longer have a source of income from their previous jobs. Therefore, companies need to take action and recognize the importance of retirement planning and ensuring the financial well-being of their employees in their old age as a form of appreciation for their contributions during their employment (Norikun, 2024).

One form of planning to ensure the continuity of employees' lives during retirement is by establishing a pension fund program.

The benefits of this pension program will be paid by the company when the employee reaches retirement age, and each prospective pensioner is required to contribute to the pension fund through salary deductions, which will then be invested during their employment to generate sufficient funds for future pension benefits.

Several actuarial methods can be used to calculate normal cost, actuarial liability, and the benefits to be received by pension program participants. Research conducted by Miranda & Arnellis (2022) stated that the normal cost calculated using the Attained Age Normal (AAN) method showed a significant increase compared to the Projected Unit Credit (PUC) method, while the benefits obtained under AAN were also superior to those under PUC. Furthermore, a study by Putri S. R. et al. (2024) indicated that the PUC method performed better than the Entry Age Normal (EAN) and Individual Level Premium (ILP) methods in terms of the normal cost paid. In addition, research by Hukama et al. (2024) concluded that the Individual Level Premium method was more advantageous than the Projected Unit Credit method when viewed from the final funding calculation of the normal cost. Research conducted by Sari et al. (2024) concluded that the pension benefits obtained directly using the AAN and ILP methods showed equal and favorable value for employees. Consequently, the company should allocate additional funds to cover the pension benefits of program participants.

The research gap between this study and previous studies lies in the lack of an in-depth investigation into the extent of the difference between the AAN method and the ILP method, considering the basic actuarial assumption according to Winklevoss: the assumption of pension plan participant population decrement. According to Winklevoss (1993), participant population decrement is caused by four factors—mortality decrement, termination decrement, disability decrement, and retirement decrement. However, previous studies only considered the population decrement assumption caused by mortality decrement.

The fundamental distinction between this study and previous research is its explicit examination of the sensitivity of actuarial calculations by substituting the mortality table used—specifically, moving from the Indonesian Mortality Table to the Group Annuity Mortality Rates 1971 (GAM-71) Table—which reflects a more specific characteristic of population decline assumptions. The objective of this research is to compare these two methods to determine the most realistic financial implications for companies in structuring their pension programs. The primary contribution of this study is to provide an empirical basis—in line with prevailing regulations—for pension fund managers and company management to evaluate the financial sensitivity of corporate pension programs.

B. RESEARCH METHOD

This case study employs an applied research approach grounded in theories and references related to normal retirement, utilizing both the AAN and ILP methods. The study collected a dataset of 38 employees to develop and apply these methods. The analysis calculates the normal costs to be paid, the actuarial liabilities to be met for pension benefits, and the pension benefits to be received by program participants. As illustrated by Figure 1, the process involves several stages:

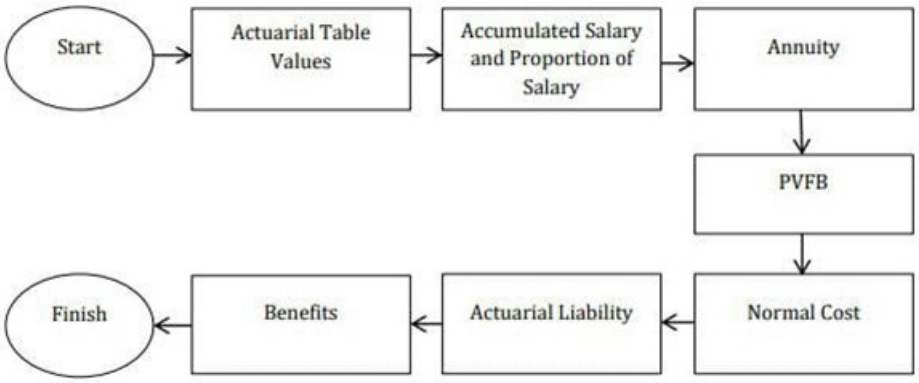

Figure 1. Research Steps

1. Actuarial Table Values

According to Winklevoss (1993), the probability that an active pension plan participant aged x will continue working for one more year is given by Equation (1).

$$p_x^{(T)} = \left(1 - q_x^{(m)}\right)\left(1 - q_x^{(d)}\right)\left(1 - q_x^{(t)}\right)\left(1 - q_x^{(r)}\right) \tag{1}$$

2. Salary Accumulation

The salary of an employee aged x is denoted by s_x, while S_x represents the accumulated salary of an employee from the age of pension program entry (y) to age ($x-1$), where $x > y$, as shown in Equation (2) (Aziz & Perdana, 2025).

$$S_x = \sum_{t=y}^{x-1} s_t \tag{2}$$

3. Benefit Function

The pension benefit, denoted as B, is calculated based on the average salary earned during participation in the pension program, as shown in Equation (3) (Winklevoss, 1993).

$$B_x = k \times S_x \tag{3}$$

4. Annuity

Two types of annuities are applied in pension fund calculations, which are presented in Equation (4) and Equation (5) (Hagen, 2022).

a. The Life Annuity Due

$$\ddot{a}_x = \frac{N_x}{D_x} \tag{4}$$

b. The Present Value of the $\boldsymbol{n}$ Year Term

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

If the annuity is paid m times per year with a payment amount of 1, it can be calculated using Equation (6) (Julianty et al., 2023).

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

5. Present Value of Future Benefit

The Present Value of Future Benefit (PVFB) represents the present value of pension benefits that will be paid or received by pension program participants, as shown in Equation (7) (Harahap et al., 2025).

$${}^{r}(PVFB)_x = B_r \ddot{a}_r^{(m)} v^{r-x}{}_{r-x}\, P_x^{(T)} \tag{7}$$

6. Normal Cost

The Normal Cost refers to the contributions or payments made by pension plan participants from the time they enter the program until retirement age to cover the cost of pension benefits, as shown in Equation (8) (Auliya et al., 2025).

$${}^{r}(NC)_x = b_x \ddot{a}_r^{(m)} v^{r-x}{}_{r-x}\, P_x^{(T)} \tag{8}$$

7. Actuarial Liability

The actuarial liability depends significantly on the Present Value of Future Benefits and the Present Value of Future Normal Cost, as shown in Equation (9) (Winklevoss, 1993).

$${}^{r}(AL)_x = {}^{r}(PVFB)_x - {}^{r}(PVFNC)_x \tag{9}$$

8. Actuarial Methods

a. Attained Age Normal

According to Sandy et al. (2018), the normal cost under the AAN method is paid by program participants starting from the age they become employees (y) until the retirement age (r), as shown in Equation (10).

$$^{AAN\ r}(NC)_x = \frac{^{r}(PVFB_y)}{\frac{N_x^{(T)} - N_r^{(T)}}{D_x^{(T)}}} \tag{10}$$

The actuarial liability for an individual aged x is expressed in Equation (11) (Winklevoss, 1993).

$$^{AAN\ r}(AL)_x = \left[B_r \ddot{a}_r^{(m)} v^{r-x}{}_{r-x}\, Px^{(T)}\right] - \left[^{AAN\ r}(NC)_x\, v^{t-x}{}_{t-x}\, P_x^{(T)}\right] \tag{11}$$

The benefit amount is significant when calculated using the AAN method, as shown in Equation (12).

$$^{AAN}M_r = 20\% \left(\sum_x^{r-1} {}^{AAN\ r}(AL)_x - \sum_x^{r-1} {}^{AAN\ r}(NC)_x\right) \tag{12}$$

b. Individual Level Premium

The normal cost calculated using the ILP method is paid by program participants not from the age of entry into employment, but from the actuarial valuation age until normal retirement age, as shown in Equation (13) (Hukama et al., 2024).

$$^{ILP\ r}(NC)_x \frac{N_x^{(T)} - N_r^{(T)}}{D_x^{(T)}} = B_r \ddot{a}_r^{(m)} \frac{D_r^{(T)}}{D_x^{(T)}} \tag{13}$$

The actuarial liability of an x-year-old is expressed in Equation (14) (Winklevoss, 1993).

$$^{ILP\ r}(AL)_x = \left[^{r}(PVFB)_x\right] - \left[^{ILP\ r}(NC)_x v^{r-x}{}_{r-x}\, P_x^{(T)}\right] \tag{14}$$

The benefit amount is significant when calculated using the ILP method—see Equation (15).

$$^{ILP}M_r = 20\% \left(\sum_x^{r-1} {}^{ILP\ r}(AL)_x - \sum_x^{r-1} {}^{ILP\ r}(NC)_x\right) \tag{15}$$

C. RESULT AND DISCUSSION

A sample calculation will be used for the pension fund program. A male participant joins the program at age 26 ($y = 26$) and is set to retire at 56 ($r = 56$). The initial base salary is IDR $4,200,000$. At the time of the actuarial calculation, the participant is 28 years old ($x = 28$). The company contributes 3% ($k = 3\%$) of the salary to the pension fund and assumes a salary increase rate of 4.5% ($R = 4.5\%$). The participant will receive a lump sum of 20% of the total pension benefit, with the remaining balance allocated to monthly pension payments (Terziev, 2019).

1. Actuarial Table Values

The following Table 1 is the calculation of the actuarial using the GAM Rates 1971 table.

Table 1. GAM Rates 1971

x	$q_x^{(m)}$	$q_x^{(t)}$	$q_x^{(d)}$	$q_x^{(r)}$	$p_x^{(T)}$	$l_x^{(T)}$
25	0.000554	0.211803	0.000268	0	0.787549	1000000.00
26	0.000593	0.174817	0.000274	0	0.824468	787549.39
27	0.000632	0.150526	0.000277	0	0.848701	649309.25
28	0.000672	0.133932	0.000280	0	0.865244	551069.70
29	0.000714	0.120636	0.000282	0	0.878488	476810.01
30	0.000767	0.105836	0.000379	0	0.893140	418872.08
31	0.000818	0.097339	0.000380	0	0.901580	374111.39
32	0.000879	0.089541	0.000382	0	0.909312	337291.33
33	0.000939	0.082643	0.000383	0	0.916144	306702.98

x	$q_x^{(m)}$	$q_x^{(t)}$	$q_x^{(d)}$	$q_x^{(r)}$	$p_x^{(T)}$	$l_x^{(T)}$
34	0.001010	0.076345	0.000385	0	0.922368	280984.13
35	0.001080	0.070746	0.000386	0	0.927892	259170.76
36	0.001160	0.065744	0.000483	0	0.932721	240482.51
37	0.001260	0.061342	0.000581	0	0.936931	224303.08
38	0.001359	0.057440	0.000679	0	0.940640	210156.51
39	0.001469	0.054038	0.000778	0	0.943839	197681.55
40	0.001588	0.051135	0.000876	0	0.946528	186579.47
41	0.001746	0.048632	0.000975	0	0.948781	176602.74
42	0.001952	0.046525	0.001171	0	0.950499	167557.41
43	0.002208	0.044718	0.001367	0	0.951870	159263.13
44	0.002512	0.043210	0.001563	0	0.952894	151597.75
45	0.002856	0.042001	0.001760	0	0.953582	144456.65
46	0.003249	0.040891	0.001956	0	0.954123	137751.32
47	0.003671	0.040081	0.002152	0	0.954338	131431.76
48	0.004142	0.039268	0.002446	0	0.954414	125430.33
49	0.004642	0.038654	0.002739	0	0.954263	119712.42
50	0.005181	0.038040	0.003033	0	0.954074	114237.11
51	0.005750	0.037426	0.003326	0	0.953856	108990.64
52	0.006348	0.036810	0.003718	0	0.953517	103961.36
53	0.006986	0.035995	0.004109	0	0.953336	99128.96
54	0.007654	0.035181	0.004501	0	0.953125	94503.21
55	0.008286	0.000000	0.004854	0.049663	0.937887	90073.36
56	0.009004	0.000000	0.005241	0.049634	0.936872	84478.66

2. Accumulated Salary and Proportion of Salary

First step, calculate the accumulated salary with assumes a salary increase rate of 4.5% ($R = 4.5\%$).

$$\begin{aligned} S_{56} &= \textstyle\sum_{t=28}^{56} s_t \\ S_{56} &= s_{28} + s_{29} + \ldots + s_{56} \\ S_{56} &= \text{Rp } 50{,}400{,}000 + \text{Rp } 50{,}400{,}000 + \ldots + \text{Rp } 129{,}664{,}609.12 \\ S_{56} &= \text{Rp } 2{,}460{,}321{,}051.15 \end{aligned}$$

Next step, calculate the accumulated pension benefit value using the predetermined salary proportion percentage (k).

$$\begin{aligned} B_r &= k \times S_r \\ B_{56} &= 3\% \times \text{IDR } 3{,}085{,}784{,}550.34 \\ B_{56} &= \text{IDR } 92{,}573{,}536.51 \end{aligned}$$

3. Annuity

After calculating the accumulated salary for pension benefits, the next step is to calculate the annuity to be paid by the pension program participants. The annuity used in this study is a life annuity due.

$$\ddot{a}_x = \frac{N_x}{D_x}$$

$$\ddot{a}_{56} = \frac{N_{56}}{D_{56}} = \frac{3{,}044.81}{3{,}044.81} = 1$$

Then, annual annuity payments is $\ddot{a}_{56}^{(12)} = \ddot{a}_{56} - \frac{(12-1)}{2(12)} = 0.541667$.

4. Present Value of Future Benefit

To calculate the actuarial liability and normal cost for receiving pension benefits, it is necessary to calculate the PVFB as the present value of the pension benefits received by program participants after reaching the normal retirement age (r). PVFB is the present value of a series of pension payments that will be received by the participants of the pension program when they have entered the normal retirement age.

PVFB at the age for 26 years ($y = 26$)

$$
\begin{aligned}
{}^{r}\,(PVFB)_{y} &= B_r \ddot{a}_r^{(m)}\; v^{r-y}{}_{r-y}P_y^{(T)} \\
{}^{5}6(PVFB)_{26} &= B_{56}\ddot{a}_{56}^{(12)} v^{56-26}{}_{56-26}\; P_{26}^{T} \\
{}^{56}\,(PVFB)_{26} &= (\text{IDR } 92{,}573{,}536.51)\,(0.541667)(0.168603)(0.107268) \\
{}^{56}\,(PVFB)_{26} &= \text{IDR } 906{,}885.11
\end{aligned}
$$

PVFB at the age for 28 years ($x = 28$)

$$
\begin{aligned}
{}^{56}\,(PVFB)_{28} &= B_{56}\ddot{a}_{56}^{(12)} v^{56-28}{}_{56-28}\; P_{28}^{(T)} \\
{}^{56}\,(PVFB)_{28} &= (\text{IDR } 92{,}573{,}536.51)\,(0.541667)\,(0.189848)\,(0.153299) \\
{}^{56}\,(PVFB)_{28} &= \text{IDR } 1{,}459{,}371.74
\end{aligned}
$$

The PVFB calculation will be computed until the normal retirement age of 56 ($r = 56$).

5. Normal Cost

a. Attained Age Normal Method

$$
\begin{aligned}
{}^{AAN\ r}\,(NC)_{x} &= \frac{{}^{r}\,(PVFB)_{y}}{\dfrac{N_x^{(T)} - N_r^{(T)}}{D_x^{(T)}}} \\
{}^{AAN\ 56}\,(NC)_{28} &= \frac{{}^{56}\,(PVFB)_{26}}{\dfrac{N_{28}^{(T)} - N_{56}^{(T)}}{D_{28}^{(T)}}} \\
{}^{AAN\ 56}\,(NC)_{28} &= \frac{\text{IDR } 906{,}885.11}{\dfrac{720{,}232.82 - 3{,}044.81}{104{,}619.59}} \\
{}^{AAN\ 56}\,(NC)_{28} &= \text{IDR } 132{,}291.60
\end{aligned}
$$

Therefore, the normal cost using the AAN method that a program participant aged 28 ($x = 28$) must pay is IDR 132,291.60, and actuarial calculations are performed up to age ($r - 1$).

b. Individual Level Premium Method

$$
\begin{aligned}
{}^{ILP\ r}\,(NC)_{x} &= B_r \ddot{a}_r{}^{(m)} \frac{D_r{}^{(T)}}{N_x{}^{(T)} - N_r{}^{(T)}} \\
{}^{ILP\ 56}\,(NC)_{28} &= B_{56}\ddot{a}_{56}^{(12)} \frac{D_{56}^{(T)}}{N_{28}^{(T)} - N_{56}^{(T)}} \\
{}^{ILP\ 56}\,(NC)_{28} &= (\text{IDR } 92{,}573{,}537) \cdot (0.541667) \cdot \left(\tfrac{3{,}044.81}{720{,}232.82 - 3{,}044.81}\right) \\
{}^{ILP\ 56}\,(NC)_{28} &= \text{IDR } 212{,}885.42
\end{aligned}
$$

As a result, the normal cost calculated using the ILP method for a 28-year-old participant ($x = 28$) amounts to IDR 212,885.42. The actuarial calculation is carried out until the age of ($r - 1$) years.

DOI: https://doi.org/10.30812/varian.v8i3.4871

6. Actuarial Liability

a. Attained Age Normal Method

$$
\begin{aligned}
{}^{AAN\ r}(AL)_x &= [^r(PVFB)_x] - [^r(PVFNC)_x] \\
{}^{AAN\ r}(AL)_x &= [^r(PVFB)_x] - \left[{}^{AAN\ r}(NC)_x \cdot v^{r-x} \cdot {}_{r-x}P_x^{(T)}\right] \\
{}^{AAN\ 56}(AL)_{28} &= \left[^{56}(PVFB)_{28}\right] - \left[{}^{AAN\ 56}(NC)_{28} \cdot v^{56-28} \cdot {}_{56-28}P_{28}^{(T)}\right] \\
{}^{AAN\ 56}(AL)_{28} &= (\text{IDR } 1{,}459{,}371.74) - (\text{IDR } 132{,}291.60 \cdot 0.189848 \cdot 0.153299) \\
{}^{AAN\ 56}(AL)_{28} &= \text{IDR } 1{,}455{,}521.57
\end{aligned}
$$

So, the amount of actuarial liability received by participants at one time at the age of 28 years with the AAN method is IDR 1,455,521.57.

b. Individual Level Premium Method

$$
\begin{aligned}
{}^{ILP\ r}(AL)_x &= [^r(PVFB)_x] - [^r(PVFNC)_x] \\
{}^{ILP\ r}(AL)_x &= [^r(PVFB)_x] - \left[{}^{ILP\ r}(NC)_x \cdot v^{r-x} \cdot {}_{r-x}P_x^{(T)}\right] \\
{}^{ILP\ 56}(AL)_{28} &= \left[^{56}(PVFB)_{28}\right] - \left[{}^{ILP\ 56}(NC)_{28} \cdot v^{56-28} \cdot {}_{56-28}P_{28}^{(T)}\right] \\
{}^{ILP\ 56}(AL)_{28} &= (\text{IDR } 1{,}459{,}371.74) - (\text{IDR } 212{,}885.42 \cdot 0.189848 \cdot 0.153299) \\
{}^{ILP\ 56}(AL)_{28} &= \text{IDR } 1{,}453{,}176
\end{aligned}
$$

So, the amount of actuarial liability received by participants at one time at the age of 28 with the ILP method is IDR 1,453,176.

7. Calculate the Amount of Benefits

a. Attained Age Normal Method

$$
\begin{aligned}
{}^{AAN}(M)_r &= 20\% \left[\sum_x^{r-1} {}^{AAN\ r}(AL)_x - \sum_x^{r-1} {}^{AAN\ r}(NC)_x\right] \\
{}^{AAN}(M)_{56} &= 20\% \left[\sum_x^{r-1} {}^{AAN\ 56}(AL)_x - \sum_{28}^{55} {}^{AAN\ 56}(NC)_x\right] \\
{}^{AAN}(M)_{56} &= 20\% \cdot (\text{IDR } 405{,}260{,}452 - \text{IDR } 5{,}146{,}019) \\
{}^{AAN}(M)_{56} &= \text{IDR } 80{,}022{,}887
\end{aligned}
$$

DOI: https://doi.org/10.30812/varian.v8i3.4871

b. Individual Level Premium Method

$$
\begin{aligned}
{}^{ILP}(M)_r &= 20\% \left(\sum_{x}^{r-1} {}^{ILP\ r}(AL)_x - \sum_{x}^{r-1} {}^{ILP\ r}(NC)_x \right) \\
{}^{ILP}(M)_{56} &= 20\% \left(\sum_{x}^{r-1} {}^{ILP\ 56}(AL)_x - \sum_{28}^{55} {}^{ILP\ 56}(NC)_x \right) \\
{}^{ILP}(M)_{56} &= 20\% \cdot (\text{IDR } 320{,}721{,}249 - \text{IDR } 130{,}231{,}651) \\
{}^{ILP}(M)_{56} &= \text{IDR } 38{,}097{,}920
\end{aligned}
$$

Figure 2 and 3 are visual displays showing the sizes of the normal cost and actuarial liabilities.

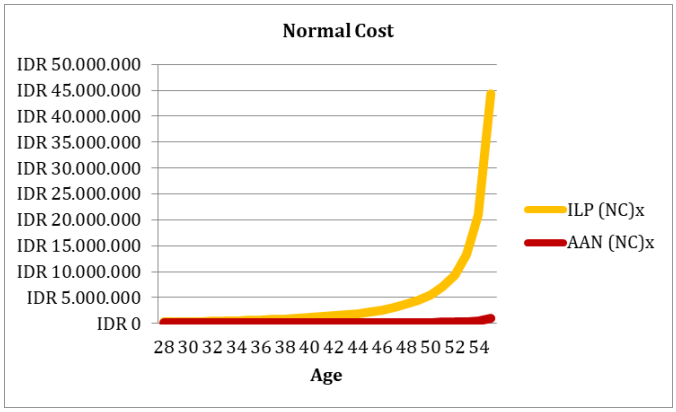

Figure 2. Normal Cost

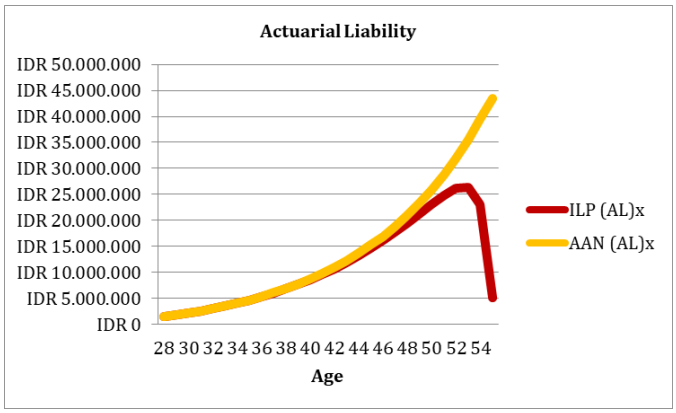

Figure 3. Actuarial Liabilty

Figure 2 shows that normal cost calculated using the Individual Level Premium method go up a lot as participants get older. However, when using the Attained Age Normal method, contributions only increase significantly in the last year before retirement. This means that using the ILP method is not as good for par-ticipants because they have to pay more and more each year.

Based on the visualization in Figure 3, the actuarial liability calculated using the AAN method consistently increases as the age of the pension program participants increases. On the other hand, the ac-tuarial liability calculated using the ILP method shows a decrease in the actuarial liability in the final year before the participants reach the normal retirement age. Therefore, it can be concluded that the actuarial liability using the AAN method is greater than the actuarial liability using the ILP method.

Consistent with the findings of Sari et al. (2024) study, the results of this research also indicate that the normal cost under the AAN method tends to remain constant, whereas under the ILP method, it in-creases annually. Furthermore, the actuarial liability calculated using the AAN method increases with the participant's age, while under the ILP method, it decreases as participants approach normal retirement age.

Table 2. The Result of Actuarial Calculations

Method	Normal Cost	Actuarial Liability	Benefit
AAN	Smaller	Higher	Higher
ILP	Higher	Smaller	Smaller

Table 2 shows that smaller accumulation of pension contributions corresponds to higher pension benefits for participants, whereas higher normal costs result in smaller benefits upon retirement. The determination of a pension fund program requires careful consideration of three key aspects: normal cost, actuarial liabilities, and pension benefits. However, differences in actuarial assumptions and calculation methodologies across studies have led to inconsistencies in the results. Previous research concluded that the AAN and ILP methods yield equivalent pension benefit values, which are consid-ered advantageous for employees and may require companies to allocate additional funds for pension ben-efit payments. In contrast to those findings, this study concludes that the AAN method is more beneficial for employees, whereas the ILP method provides greater advantages for the company.

D. CONCLUSION AND SUGGESTION

Based on the calculation results, it can be concluded that the comparison between the AAN and ILP meth-ods reveals a new finding: the normal cost calculated using the AAN method tends to be more stable than that obtained with the ILP method. This indicates that pension fund calculations using the AAN method are more advantageous for employees, whereas pension programs applying the ILP method are more beneficial for companies.

ACKNOWLEDGEMENT

The authors would like to express their deepest gratitude to all those who have contributed to the completion of this research. Our thanks also go to the Department of Matehmatics at the State University of Padang for providing resources and facilities that greatly assisted in conducting this research. We thank the author's family and our colleagues for their assistance in reviewing this article.

DECLARATIONS

AUTHOR CONTIBUTION

All authors contributed to the writing of this article.

FUNDING STATEMENT

This study was conducted without any financial support.

COMPETING INTEREST

The author declares that there is no conflict of interest in publishing this article.

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