Calculation of Pension Funds with Entry Age Normal and Attained Age Normal Approaches in the Projected Benefit Cost Method

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Abstract

The welfare of workers at retirement age is an important factor in ensuring fulfillment of needs in old age. One of the ways to achieve this welfare is by participating in a pension fund program, which is a program designed to provide pension benefits to employees in order to ensure the fulfillment of workers' needs during retirement. Pension fund management can be done using the actuarial calculation method. This study aims to calculate the pension fund financing in which the methods used are Entry Age Normal and Attained Age Normal methods which are two of the four parts of Projected Benefit Cost Method. Based on this research, the amount of pension contribution, actuarial liability and pension benefit is obtained from each method. The normal contribution with Attained Age Normal method increases every year with the most significant increase occurring at the age before retirement, while with Entry Age Normal method, the pension contribution increases at the beginning and then continues to decline until retirement age. The pension benefits of both methods are both greater than the proportion of salary for pension benefits. Therefore, Entry Age Normal is recommended for the participants of pension fund program.

Keywords
Pension Fund Program, Entry Age Normal, Attained Age Normal.

1. Introduction

Not a few of the workers or those who earn, especially the younger generation, run out of their income just a few days after they get it. If this habit continues, financial difficulties may occur in the future, especially considering economic developments and technological advances that will lead to increased demand. On the other hand, a worker will certainly not always be able to work well. Upon reaching a certain age, worker productivity will decline and workers will enter retirement age. In the period when a worker enters retirement age until he/she reaches life expectancy, the needs still exist and will continue to exist while after retirement the worker no longer earns income from his previous job. Seeing these two conditions, an employee should have an early plan that can guarantee future welfare when entering retirement age. Setting up savings for old age by joining a pension program as early as possible is one solution. A pension plan is an agreement that stipulates that the employer provides benefits or payments to employees after they retire for the services they have provided while still working (Kieso et al., 2008).

According to the Statement of Financial Accounting Standards/*Pernyataan Standar Akuntansi Keuangan* (PSAK) No. 24 concerning Cost Accounting for Pension Benefits, actuarial valuation methods are generally divided into two broad categories, namely the Accrued Benefit-Cost Method and the Projected Benefit-Cost Method. The Accrued Benefit-Cost method is an actuarial calculation method that divides the total pension benefits expected to be entitled to the participants into pension benefit units that are allocated to each year of service, while the Projected Benefit-Cost method is an actuarial calculation method that emphasizes the projection of pension benefits when reaching the age of majority. pension. In general, the Accrued Benefit-Cost Method consists of two parts, namely the Unit Credit Method and the Projected Unit Credit Method, while the Projected Benefit-Cost Method consists of four parts, namely the Entry Age Normal (EAN) Method, the Individual Level Premium Method, the Aggregate Method, and the Attained Method. Age Normal (AAN).

The Entry Age Normal method is a method that assumes that every employee is already a participant in the pension plan when he or she is first hired or after fulfilling the requirements. The amount of periodic pension benefits that participants will receive after reaching retirement age under this method is based on participant's salary in the future, or the participant's last salary before retirement, or the participant's average salary during the participant's working period. The Attained Age Normal (AAN) method is an actuarial calculation method in which the present value of the participant's pension benefits is allocated between the participant's age on the calculation date to the normal retirement age. Each calculation method will show the value of normal contributions, actuarial obligations, and pension benefits. Pension contributions are payments made by participants in a pension fund program to meet the cost of retirement benefits (Bowers, 1997). The general equation for pension contributions for participants aged x is (Winklevoss, 1993). Actuarial liability or actuarial liability is the amount of pension program funds that should be collected at a certain time for the payment of future pension benefits (Anita, 2016). Pension benefits are periodic payments paid to participants at the time and in the manner stipulated in the pension fund regulations. The amount of pension contributions, actuarial obligations, and pension benefits is influenced by several factors such as interest rates, salaries, the proportion of salaries for pension benefits, and others.

Based on the description above, the purpose of this study is to calculate normal contributions, actuarial obligations, and pension benefits using the Entry Age Normal method and the Attained Age Normal method and determine which method is the most profitable for pension fund program participants by comparing the results of calculating normal contributions and benefits. retire both methods.

2. Research Methods
2.1 Object
The object studied in this research is hypothetical data that is made in the form of years of service, initial salary, the proportion of salaries for pension funds, and the proportion of pension benefits that will be received at once. The salary scale table used in this study was taken from the book "PENSION MATHEMATICS with Numerical Illustrations" by Howard E. Winklevoss. Data analysis was carried out with the help of Microsoft Excel software.

2.2 Methods
The research method used is a quantitative approach and literature study by collecting literature/references from various sources related to the actuarial calculation method of pension funds to support the discussion in this study. The first step is to make a hypothetical case, and then calculate the pension fund by calculating the accumulated salary value during work, the proportion of salary for pension benefits, the present value of future benefit (PVFB). Then calculate normal contributions, actuarial obligations, and pension benefits using the Entry Age Normal and

Attained Age Normal methods. The last step is to compare the two methods by analyzing the results of the calculation of pension contributions and pension benefits.

3. Results and Discussion
3.1 Hypothetical Case
It is assumed that a worker is 20 years old when he starts working and becomes a participant in the pension program ($y = 20$) and will retire when he is 60 years old ($r = 60$). The first salary that the worker received was IDR 2,399,200.00 ($s_y = 2,399,200$), from the second year until the time of retirement there was an increase in salary of 4% ($i = 4\%$). The interest rate is 10%. The company processes salaries for pension funds by 5% ($k = 5\%$). At the time of retirement, workers will receive 20% of the total pension benefits directly and the remainder will be allocated to their monthly retirement salary.

3.2 Pension Fund Calculation
3.2.1 Salary Accumulation
The accumulated salary is obtained by first calculating the salary per month and yearly each year of calculation.

- Salary per month 20 years old: $s_{20} = (3,399,200) \frac{1}{1} (1 + 4\%)^0 = 2,399,200$
  Salary in a year at 20 years old: $12 s_{20} = 12 \cdot 2,399,200 = 28,790,400$,
- Salary per month 21 years old: $s_{21} = (3,399,200) \frac{1.045}{1} (1 + 4\%)^1 = 2,607,450.56$
  Salary in a year at 20 years old: $12 s_{21} = 12 \cdot 2,607,450.56 = 31,289,406.72$.

The result of calculating the accumulated salary starting from the age of entering the retirement program to the age before retirement ($r - 1$) with the help of Ms. Excel software is IDR 5,935,519,716.81 ($S_{60} = 5,935,519,716.81$).

3.2.2 Salary Proportion to Retirement Benefits
The calculation of the salary proportion in this case is carried out using a salary scale during work or a predetermined percentage of k proportions, namely

$$B_{60} = k S_{60} = 5\%(5,935,519,716.81) = 296,775,985.84.$$

3.2.3 Present Value of Future Benefit (PVFB)
The present value of future benefit is calculated by

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

The results of calculating the present value of future benefits with the help of Ms. Excel software are presented in Table 1.

Table 1. Summary of Calculation Results of Present Value of Future Benefits (PVFB) with $i = 10\%$

x	B_r	v^{r-x}	${}_{r-x}p_x$	$\ddot{a}_r$	$^r(PVFB)_x$
20	296,775,985.84	0.022094928	0.028737000	8.304621	1,564,885.604
21	296,775,985.84	0.024304421	0.037997178	8.304621	2,276,067.825
22	296,775,985.84	0.026734863	0.049037241	8.304621	3,231,116.098
23	296,775,985.84	0.029408349	0.061897705	8.304621	4,486,356.396
24	296,775,985.84	0.032349184	0.076558708	8.304621	6,103,887.244
25	296,775,985.84	0.035584103	0.092959988	8.304621	8,152,684.810

3.2.4 Calculating Retirement Contribution
Normal Entry Age Method

The pension contribution in this method is calculated by first calculating the normal contribution which is the same every year, namely

$$
^{EAN}(NC)_t = \frac{B_{60} v^{60-20} {}_{60-20}p_{20} \ddot{a}_{60}}{a_{20:\overline{60-20}|}}
$$
$$
= \frac{(296,775,985.84)(0.022094928)(0.028737)(8.304621)}{10.59571548}
$$
$$
= 147,690.4127.
$$

Then the final value of normal contributions is calculated, the results of which are calculated with the help of Ms. Excel software are presented in Table 2.

Table 2. Summary of Calculation Results of the Final Value of Normal Contribution with Normal Entry Age Method with $i = 10\%$

x	$^{EAN}(NC)_t$	$_{r-x}p_x$	$(1+i)^{r-x}$	Dues
20	147,690.4127	0.028737000	45.25925557	192,088.3997
21	147,690.4127	0.037997178	41.14477779	230,897.0437
22	147,690.4127	0.049037241	37.40434344	270,894.6110
23	147,690.4127	0.061897705	34.00394859	310,853.8160
24	147,690.4127	0.076558708	30.91268053	349,529.2816
25	147,690.4127	0.092959988	28.10243685	385,826.7583

The total pension contribution obtained under this method is IDR 14,381,648.7808.

Normal Attained Age Method

The calculation of the amount of pension contributions using the Attained Age Normal method is carried out by first calculating the present value of the pension benefits at entry age ($y = 20$), namely

$$
^{r}(PVFB)_y = B_r v^{r-y} {}_{r-y}p_y \ddot{a}_r
$$
$$
^{60}(PVFB)_{20} = B_{60} v^{60-20} {}_{60-20}p_{20} \ddot{a}_{60}
$$
$$
= (296,775,985.84)(0.022094928)(0.028737)
$$
$$
= (8.304621)
$$
$$
= 1,564,885.604.
$$

Furthermore, the calculation of pension contributions will be carried out as follows.

- Retirement contribution at the age of 20 years:

$$
^{AAN}(NC)_{20} = \frac{^{60}(PVFB)_{20}}{\dfrac{N_{20} - N_{60}}{D_{20}}} = \frac{1,564,885.604}{10.59557834} = 147,692.3254.
$$

- Retirement contribution at the age of 21 years:

$$
^{AAN}(NC)_{21} = \frac{^{60}(PVFB)_{20}}{\dfrac{N_{21} - N_{60}}{D_{21}}} = \frac{1,564,885.604}{10.5705691} = 148,041.7553.
$$

The results of calculating the final value of retirement contributions using the Attained Age Normal method with the help of Microsoft Excel are presented in Table 3.

Table 3. Summary of Retirement Contribution Calculation Results Normal Attained Age Method with $i = 10\%$

x	$^r(PVFB)_y$	$\dfrac{N_x - N_r}{D_x}$	$^{AAN}(NC)_x$
20	1,564,885.604	10.59557834	147,692.3254
21	1,564,885.604	10.57056910	148,041.7553
22	1,564,885.604	10.54312441	148,427.1211
23	1,564,885.604	10.51268001	148,856.9616
24	1,564,885.604	10.47893290	149,336.3512
25	1,564,885.604	10.44134042	149,874.0143

The total pension contribution obtained under this method is IDR 10,232,276.3380.

3.2.5 Calculating Actuarial Liability
Normal Entry Age Method
- Actuarial liability at the age of 20 years:

$$^{EAN\ r}(AL)_{20} = {}^r(PVFB)_{20} - {}^{EAN}(NC)_{20}a_{20:\overline{60-20}|}$$
$$= 1,564,885.604 - (147,690.4127)(10.59557834)$$
$$= 20.266.$$

- Actuarial liability at the age of 21 years:

$$^{EAN\ r}(AL)_{21} = {}^r(PVFB)_{21} - {}^{EAN}(NC)_{21}a_{21:\overline{60-21}|}$$
$$= 2,276,067.825 - (147,690.4127)(10.5705691)$$
$$= 714,896.112.$$

The results of the calculation of actuarial liabilities using the Entry Age Normal method with the help of Microsoft Excel are presented in Table 4.

Table 4. Summary of Normal Liability Calculation Results Normal Entry Age Method with $i = 10\%$

x	$^r(PVFB)_x$	$^{EAN}(NC)_t$	$a_{x:\overline{r-x}|}$	$^{EAN\ r}(AL)_x$
20	1,564,885.604	147,690.4127	10.59557834	20.266
21	2,276,067.825	147,690.4127	10.57056910	714,896.112
22	3,231,116.098	147,690.4127	10.54312441	1,673,997.703
23	4,486,356.396	147,690.4127	10.51268001	2,933,734.347
24	6,103,887.244	147,690.4127	10.47893290	4,556,249.319
25	8,152,684.810	147,690.4127	10.44134042	6,610,598.934

Normal Attained Age Method
- Actuarial liability at age 20:

$$^{AAN\ r}(AL)_{20} = {}^{60}(PVFB)_{20} - {}^{AAN}(NC)_{20}\frac{D_{20}}{N_{20} - N_{60}}$$
$$= 1,564,885.604 - (147,692.3254)(0.094378992)$$
$$= 1,550,946.551.$$

- Actuarial liability at age 21:

$$^{AAN\ r}(AL)_{21} = {}^{60}(PVFB)_{21} - {}^{AAN}(NC)_{21}\frac{D_{21}}{N_{21} - N_{60}}$$
$$= 2,276,067.825 - (148,041,7.53)(0.094602286)$$
$$= 2,262,062.737.$$

Table 5. Summary of Normal Obligation Calculation Results Normal Attained Age Method with $i = 10\%$

x	$^r(PVFB)_x$	$^{AAN}(NC)_x$	$\dfrac{D_x}{N_x - N_r}$	$^{AAN\,r}(AL)_x$
20	1,564,885.604	147,692.3254	0.094378992	1,550,946.551
21	2,276,067.825	148,041.7553	0.094602286	2,262,062.737
22	3,231,116.098	148,427.1211	0.094848544	3,217,038.002
23	4,486,356.396	148,856.9616	0.095123223	4,472,196.642
24	6,103,887.244	149,336.3512	0.095429564	6,089,636.141
25	8,152,684.810	149,874.0143	0.095773144	8,138,330.904

3.2.6 Calculating Retirement Benefits
The pension benefit will be given at 20% at once when the workers participating in the pension program enter retirement age and the remaining 80% is allocated every month as retirement salary.

Entry Age Normal Method

$$^{EAN}B_{60} = 20\% \left[^{EAN\,60}(AL)_{59} - \sum_{x=20}^{59} {}^{EAN\,60}(NC)_x \right]$$
$$= 20\%[2,195,707,654.522 - 14,381,648.7808]$$
$$= 436,265,201.15.$$

Attained Age Normal Method

$$^{AAN}B_{60} = 20\% \left[^{AAN\,60}(AL)_{59} - \sum_{x=20}^{59} {}^{AAN\,60}(NC)_x \right]$$
$$= 20\%[2,194,290,459.331 - 10,232,276.3380]$$
$$= 436,811,636.60.$$

3.2.7 Comparison of Calculation Results
Pension Contribution
Pension contributions from year to year can increase or decrease. The figure below is a graph that shows the amount of pension contributions from each method.
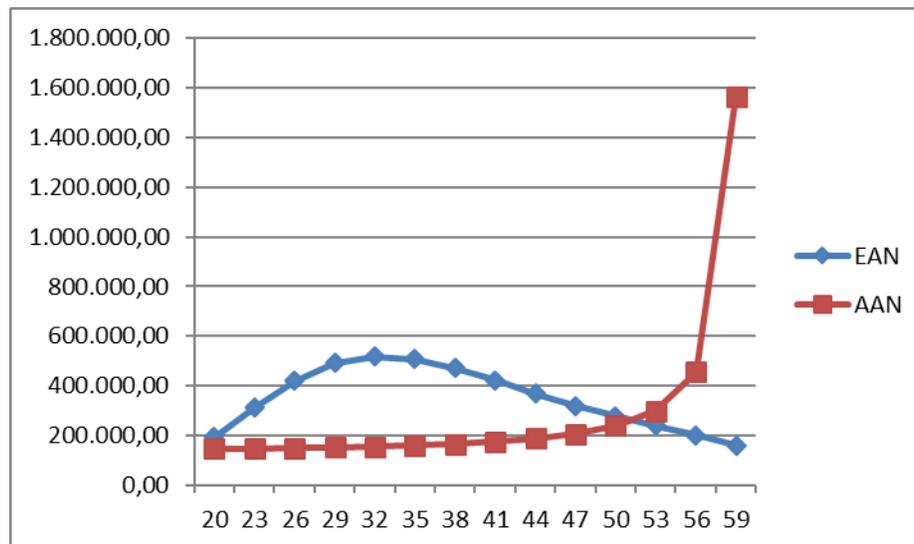

Figure 1. Graph of Increase and Decrease in Pension Contributions for the EAN and AAN Methods

The graph shows that with the Entry Age Normal method, pension contributions increase from age 20 to 33 years and decrease from age 34 to retirement age, while with the Attained Age Normal method, pension contributions continue to increase every year with the most significant increase occurring in several years. the last before

retirement. This greater increase carries the risk of reducing salary increases, therefore, the Attained Age Normal method is more detrimental to participants.

Benefits of Retirement at Once
The lump-sum pension benefit that participants receive upon entering retirement age is 20% of the difference between actuarial obligations and pension contributions. The pension benefits obtained using the Entry Age Normal and Attained Age Normal methods are IDR 436,265,201.15 and IDR 436,811,636.60, respectively. The proportion of salary for pension benefits is IDR 296,775,985.84. If the proportion of salary for pension benefits is used as a comparison to see the size of the pension benefit, then it is obtained that the pension benefit with the Entry Age Normal method is 1.470 times greater than the proportion of salary for pension benefits and the pension benefit with the Attained Age Normal method is 1.472 times greater than the proportion of salary for retirement benefits. The following table compares the two methods.

Table 6. Comparison of Normal and Attained Age Normal Entry Age Methods

Methods	Benefits of Retirement at Once	Large Retirement Contribution Rate
Entry Age Normal	436,265,201.15	Increase-Decrease
Attained Age Normal	436,811,636.60	Increase

4. Conclusion

This paper discusses the calculation of pension funds using the Entry Age Normal and Attained Age Normal methods which are part of the Projected Benefit-Cost method. Based on the calculation results, it is obtained that the normal contribution of the Attained Age Normal method has increased every year, while the Entry Age Normal method of pension contributions at the entry age to the age of 33 years has increased and then decreased every year until retirement age. The lump-sum pension benefit with the Entry Age Normal method is smaller than the Attained Age Normal method, but both are worth more than the proportion of salary for retirement benefits. Therefore, the Normal Entry Age method is more profitable for participants.

Acknowledgments

References

Anita, Saptaningtyas, Y., Yuli, F., and Tuharto, *Perhitungan Manfaat dan Iuran Peserta Program Dana Pensiun dengan Metode Projected Unit Credit dan Individual Level Premium pada PT. Taspen (Persero) Cabang Yogyakarta*, Universitas Negeri Yogyakarta, 2016.

Friedler, L. M., *Actuarial Mathematics*, by Newton L. Bowers, Jr., Hans U. Gerber, James C. Hickman, Donald A. Jones, Cecil J. Nesbitt., in *The American Mathematical Monthly*, vol. 93, no. 6, pp. 489–491, 1986. https://doi.org/10.1080/00029890.1986.11971867

Islam, M. E. N., Wilandari, Y., and Suparti, Perhitungan Pembiayaan Dana Pensiun dengan Metode Attained Age Normal dan Projected Unit Credit (Studi Kasus: PT. Taspen (Persero) Kantor Cabang Utama Semarang), *Jurnal Gaussian*, vol. 5, no. 3, pp. 505-514, 2016.

Kieso, Weygandt, and Warfield, *Akuntansi Intermediate*, Erlangga, 2008.

Promislow, S. D., *Fundamentals of Actuarial Mathematics*, second edition, 2011. https://doi.org/10.1002/9781119971528

Sukono, Suyudi, M., Sari, W. N., Hidayat, Y., and Bon, A. T., Comparison of pension fund calculations using actuarial methods of projected Unit Credit and Pay-As-You-Go, *Proceedings of the International Conference on Industrial Engineering and Operations Management*, Paris, France, July 26-27, 2018, pp. 2929-2937.

Winklevoss, H. E., *Pension Mathematics with Numerical Illustrations Second Edition*, University of Pennsylvania Press, 1993.

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