



A Comparative Study of Projected Unit Credit and Attained Age Normal Methods for Actuarial Liability Estimation: A Case Study of PT Taspen

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Abstract

The selection of an appropriate actuarial liability calculation method will help PT Taspen (Persero) to ensure the adequacy of pension funds that must be prepared, optimize pension fund management, and reduce the risk of future underfunding. This study aims to analyze the comparison between the Projected Unit Credit and Attained Age Normal methods in the context of estimating actuarial liabilities at PT Taspen (Persero), and evaluate how the differences in these methods affect pension fund planning and management. Through this analysis, it is expected to find a method that is more suitable for the characteristics of pension participants and the long-term needs of PT Taspen (Persero) in ensuring the sustainability of an efficient pension program. Comparative descriptive research was conducted in this study to describe the comparison of the results of estimating actuarial liabilities from two methods: Projected Unit Value (PUC) and Attained Age Normal (AAN) and assess their impact on funding conditions. In total, the value of actuarial liabilities generated by the PUC method is slightly higher at IDR421,875,241,393.40, compared to the AAN method of IDR420,746,185,877.40. This difference shows that the method used in the calculation greatly affects the amount of liabilities that must be met by the pension fund.

Keywords: Mathematics, Actuarial Liability, Projected Unit Credit, Attained Age Normal

1. Introduction

A pension program is a form of old-age security provided to workers after they enter an unproductive age or stop working for certain reasons. Pension programs are designed to provide income certainty in the future, so that workers can live their old age safely and prosperously without worrying about economic problems. In Indonesia, especially for the State Civil Apparatus (ASN), the pension program is managed by PT Dana Tabungan dan Asuransi Pegawai Negeri Perusahaan Persero or commonly referred to as PT Taspen (Persero). This company is a State-Owned Enterprise that is responsible for managing pension funds and old-age savings. In carrying out its duties, proper planning in managing pension obligations is very important. One of the main components in such planning is the calculation of actuarial liabilities that reflect the amount of funds that must be prepared to meet future pension obligations.

To calculate actuarial liabilities, there are two major methods that can be used, namely the Accrued Benefit Cost Method and the Projected Benefit Cost Method. The Accrued Benefit Cost Method focuses on pension benefits that have been earned and will be paid until a certain date. Meanwhile, the Projected Benefit Cost Method focuses on estimating pension benefits in the future, namely when participants reach retirement age. Projected Unit Credit is one of the approaches included in the Accrued Benefit Cost Method, while Attained Age Normal is part of the Projected Benefit Cost Method.

Projected Unit Credit and Attained Age Normal have different approaches in calculating retirement benefits. Therefore, a deeper understanding of the advantages and disadvantages of each method is required. A comparison between these two methods can make a major contribution to improving the accuracy of estimating actuarial liabilities. The selection of the right method will help PT Taspen (Persero) to ensure the adequacy of pension funds that must be prepared, optimize pension fund management, and reduce the risk of underfunding in the future.

With this background, this study aims to analyze the comparison between the Projected Unit Credit and Attained Age Normal methods in the context of estimating actuarial liabilities at PT Taspen (Persero), and evaluate how the differences in these methods affect pension fund planning and management. Through this analysis, it is expected to

find a method that is more suitable for the characteristics of pension participants and the long-term needs of PT Taspen (Persero) in ensuring the sustainability of an efficient pension program.

2. Literature Review

2.1. Pension

According to Turner and Helms (1987) a pensioner is an individual who does not work full-time during the year and who receives some sort of pension from previous years of work. In the context of modern financial and labor systems, pensions have two main functions. First, as an old-age guarantee that aims to maintain the welfare of a person's life after being economically unproductive. Second, as an appreciation or reward for the dedication and contribution of labor to the institution or state, especially in the context of Civil Servants (PNS) and State Civil Apparatus (ASN). Therefore, the pension program must be managed with the principles of prudence and justice between generations so that its sustainability is maintained in the long term.

2.2. Mortality Table

A mortality table is a statistical tool used to describe the mortality rate in a population group over a period of time, as well as showing survival rates from birth to death (Bowers et al., 1997). Generally, this table lists the probability of a person dying before reaching their next birthday, depending on their current age. In their construction, mortality tables often represent the life history of a hypothetical cohort - a group of individuals who are assumed to be born at the same time and whose numbers gradually shrink due to death over time. This table has an important role in the actuarial world, especially in designing and determining values in life insurance policies.

2.3. Annuity

An annuity is a series of payments of the same amount made periodically in each period of time (Johnson, 1956). In this paper, the annuity used is a life annuity. A life annuity is an annuity that is paid while a person is still alive (Bowers et al., 1997). The use of life annuities in pension programs provides two sides of the challenge. From the participant's side, it provides certainty of income for life. But from the side of the pension fund organizer, it requires careful actuarial calculations so that the funds collected during the working period are sufficient to pay the annuity for the rest of the participant's life, without causing a financial deficit.

2.4. Actuarial Liability

In the Decree of the Minister of Finance of the Republic of Indonesia Number 510/KMK.06/2002 concerning Funding and Solvency of Employer Pension Funds article 1 paragraph 5, it is stated that Actuarial Liability is the financial responsibility of the Pension Fund calculated with the assumption that the Pension Fund will continue to operate until all rights of Participants and Eligible Parties are fully fulfilled. This liability is calculated using a specific actuarial method that considers projected retirement benefits, participant age, length of service, interest rates, and other demographic assumptions. The objective is to ensure that sufficient funds are available to meet all obligations to participants until retirement is complete, thus ensuring the sustainability of the program.

2.5. Normal Contribution

According to the Decree of the Minister of Finance of the Republic of Indonesia Number 510/KMK.06/2002 concerning Funding and Solvency of Employers' Pension Funds article 1 paragraph 13, Normal Contribution is the annual contribution required to finance part of the present value of the Pension Benefits allocated in that year. The amount is calculated based on the higher value between the Participant's contribution as stipulated in the Pension Fund Regulations, and part of the present value of the current year's Pension Benefits, in accordance with the actuarial method used. Normal contributions are an important aspect in maintaining the solvency of the pension fund. If normal contributions are not calculated appropriately, there could be an underfunding in the future, or conversely, excess contributions that burden participants or employers. Therefore, the determination of normal contributions is highly dependent on the actuarial method chosen.

2.6. Actuarial Calculation Methods

Actuarial calculation methods can be grouped into two major methods, namely the Projected Benefit Cost Method and the Accrued Benefit Cost Method. Each method has different assumptions and approaches in calculating pension

benefits that will be paid to participants. Included in the Projected Benefit Cost Method are Entry Age Normal, Attained Age Normal, Individual Level Premium, and Aggregate Cost. Meanwhile, those included in the Accrued Benefit Cost Method are Traditional Unit Credit and Projected Unit Credit (SPA-DP No. 5.02).

2.6.1. Projected Unit Credit (PUC) Method

The Projected Unit Credit method is part of the Accrued Benefit Cost Method category. This method involves calculating by dividing the total pension benefit at normal retirement age by the entire service period, to obtain a unit pension benefit which is then allocated on an annual basis over the service period (Bowers et al., 1997). The PUC method is widely used in practice as it provides a realistic picture of the liabilities that will arise in the future. This method is also the standard approach used in IFRS-based financial statements. The advantage is that it produces an estimate of liabilities that better reflects the financial reality at retirement, but the disadvantage is that the contribution burden may increase as the retirement age of participants approaches.

2.6.2. Attained Age Normal (AAN) Method

The Attained Age Normal method is part of the Projected Benefit Cost Method category. This method calculates actuarial liabilities based on the total projected pension benefits until retirement, then spreads the financing of these benefits evenly from the current working age to the retirement age of the participant (Bowers et al., 1997). The main feature of this method is that the annual cost (normal cost) is calculated as a fixed amount (percentage of earnings or cash value of benefits) over the participant's remaining working life. This means that even though future pension benefits increase as salary and years of service increase, the cost charged annually is fixed, based on the participant's attained age, not their initial age at joining the pension plan. The advantage is that it provides more stable contributions from year to year and is suitable for long-term financing puIDRoses. However, the disadvantage is that in the early years, this method tends to produce a larger estimated liability than other methods and does not directly reflect the benefits that have been obtained by participants, because the cost is calculated based on an average estimate of the future.

3. Materials and Methods

3.1. Materials

The object of this research is the active retirement participants of PT Taspen (Persero) in 2023, with the type of secondary data obtained from the annual financial statements of PT Taspen. The data analyzed includes actuarial liabilities, pension fund asset values, actuarial assumptions such as discount rates and retirement ages, and retirement benefits. The calculation method is supported by Microsoft Excel software to calculate the value of pension benefits, present value of future benefits (PVFB), and estimation of actuarial liabilities using the Projected Unit Credit (PUC) and Attained Age Normal (AAN) methods.

3.2. Methods

According to Sugiyono (2012: 2) "In general, research methods are defined as scientific ways to obtain data with specific puIDRoses and uses". The type of research used in this research is comparative descriptive research. Sugiyono (2012: 11) explains, "Descriptive research is research conducted to determine the value of independent variables, either one or more variables (independent) without making comparisons, or connecting one with another variable"

While comparative research is explained by Pawito (2007: 108), namely, "comparative analysis seeks a comparison of similar symptoms or realities found in the case with those found in other cases very common in research".

According to Sugiyono (2012: 11) "comparative descriptive method, which is research that compares two or more variables". The implementation of this type of comparative descriptive research in this study is to describe the comparison of the results of estimating actuarial liabilities from two methods: Projected Unit Value (PUC) and Attained Age Normal (AAN) and assess their impact on funding conditions.

3.2.1. Mortality Table

In the mortality table the number of people aged x is expressed in the symbol l_x . While the number of people who die between the ages of x and $x + 1$ is expressed in d_x , where:

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

$${}_nd_x = l_x - l_{x+n} \quad (2)$$

Descriptions:

- d_x : Number of people who died between age x and $x + 1$ years
 l_x : Number of people who live exactly x years
 l_{x+1} : Number of people who live exactly $x + 1$ years of age

The probability that a person aged x will live at least n years, expressed in the symbol ${}_np_x$, where:

$$p_x = \frac{l_{x+n}}{l_x} \quad (3)$$

Descriptions:

- ${}_np_x$: Probability that a participant aged x years will work for $x + n$ years
 l_{x+n} : Number of active participants at age $x + n$ years
 l_x : Number of active participants at age x years

The probability that a person aged x will die before the age of $x + n$ years, expressed in the symbol

$${}_nq_x = \frac{{}_nd_x}{l_x} \quad (4)$$

Descriptions:

- ${}_nq_x$: Probability that a participant aged x years will die before the age of $x + n$ years
 ${}_nd_x$: Jumlah peserta meninggal pada usia $x + n$ tahun
 l_x : Jumlah peserta meninggal pada usia x tahun

3.2.2. Actuarial Basic Functions

The actuarial basic functions used in the formulation of pension determination include the survival function, interest rate function, salary function, benefit function and annuity function (Winklevoss, 1993). The survival function is a function that shows the life chances of an employee will continue to work during the active working period until the time allowed for retirement. The life expectancy is ${}_np_x$, with formula (3). The interest function is used to discount a future payment to the present. If i is the assumed interest rate for year t , with $t = 1, 2, \dots, n$, the present value of a unit of money in n years is indicated by:

$$v^n = \frac{1}{(1+i)^n} \quad (5)$$

Descriptions:

- v^n : Discount factor
 i : Interest rate

The current salary for a participant aged x is denoted by s_x , and S_x is the accumulated amount of salary from entry age e to age $x - 1$, where $x - 1$, or can be indicated by:

$$S_x = \sum_{t=e}^{x-1} s_t \quad (6)$$

If the participant earns a salary increase of s per year, the amount of the participant's salary at age $x + t$, based on the salary at age is:

$$s_{x+t} = s_x(1+s)^t \quad (7)$$

Descriptions:

- S_x : Accumulated salary from entry age e to age $x - 1$ year
 s : Salary increase rate (%)

The benefit function is used to determine the amount of benefits paid at the time of retirement, personal termination, disability, and death. According to (Mitchell, 1991), there are three types of benefit formulas that are often used in defined benefit pension plans to determine the amount of retirement benefits at age r (B_r), namely based on the last salary, average salary during work and average salary for the last n years.

Final salary:

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

Descriptions:

- s_{r-1} : Participant's salary at age $r - 1$
 r : Retirement age
 y : Age of starting work
 k : Proportion of salary set aside for retirement benefits

The average salary during employment:

$$B_r = ks_{r-1} \quad (9)$$

Descriptions:

- S_{r-1} : Total salary of the participant at age $r - 1$

The average salary over n years:

$$B_r = k(r - e) \frac{1}{n} \sum_{t=r-n-x}^{r-x-1} s_x (1 + s)^t \quad (10)$$

Descriptions:

- t : Time (year)
 n : Period of employment

From pension benefits, the present value of pension benefits can be calculated. The amount is:

$${}^r(PVFB)_x = B_r \ddot{a}_r v^{r-x} {}_{r-x}p_x \quad (11)$$

3.2.3. Normal Contributions

According to Anderson (1985), the normal contribution of Attained Age Normal method is formulated by:

$${}^{AANr}(NC)_x = \frac{{}^r(PVFB)_e}{\frac{N_x - N_r}{D_x}} \quad (12)$$

Descriptions:

- ${}^{AANr}(NC)_x$: Pension contributions for participants at age x using the Attained Age Normal method
 ${}^r(PVFB)_e$: Present Value of Future Benefit when participant is x years old
 e : Age at which the participant starts the pension program
 r : Retirement age
 N_x : Pension annuity value at age x
 N_r : Pension annuity value at retirement age r
 D_x : Discount factor at age x

According to Winklevoss (1993), normal contributions using the Projected Unit method are formulated as:

$${}^{PUCr}(NC)_x = \frac{{}^r(PVFB)_x}{r - e} \quad (13)$$

Descriptions:

- ${}^{PUCr}(NC)_x$: Pension contributions for participants at age x using the Projected Unit Credit method
 r : Retirement age
 e : Age at which the participant starts the pension program

3.2.4. Actuarial Liability

According to Anderson (1985), the calculation of actuarial liabilities of a person aged x with the Attained Age Normal method can be found by:

$${}^{AANr}(AL)_x = {}^r(PVFB)_x - NC \frac{N_x - N_r}{D_x} \quad (14)$$

Descriptions:

${}^{AAN}r(AL)_x$	: Value of actuarial liabilities at age x using the AAN method
${}^r(PVFB)_x$	: Present value of pension benefits at age x
NC	: Normal annual fee
N_x	: Pension annuity value at age x
N_r	: Pension annuity value at retirement age r
D_x	: Discount factor at age x

According to Winklevoss (1993), the calculation of actuarial liabilities using the Projected Unit Credit method can be written as:

$${}^{PUC}r(AL)_x = \frac{x - e}{(r - e)} {}^r(PVFB)_x \quad (15)$$

Descriptions:

${}^{PUC}r(AL)_x$	: Value of actuarial liabilities at age x using the PUC method
e	: Age at which the participant starts the pension program
r	: Retirement age
${}^r(PVFB)_x$	: Present value of pension benefits at age x

3.2.5. Final Value of Normal Contributions

In pension program financing to find out which method is recommended for participants, it is necessary to calculate the final value of normal contributions. If a participant enters the pension program at the age of e years and is still alive when entering the age of r years, according to Amalia (2024) the final value of the total normal contribution paid by the participant at the age of r years is denoted as ${}^r(NA)_e$:

$${}^r(NA)_e = \sum_{x=e}^{r-1} (NC)_x (1 + i)^{r-x} \quad (16)$$

Descriptions:

${}^r(NA)_e$	: The final value of the total normal contribution of participants who enter at age e and retire at age r
$(NC)_x$	: Normal cost paid in the x th year
i	: Interest rate
$(1 + i)^{r-x}$	: Accumulated interest factor from year x to retirement age r
e	: Age at which the participant starts the pension program
r	: Retirement age

3.2.6. Total Actuarial Liability

The total actuarial liability is the amount of financial obligations that must be prepared by the company or pension fund to fulfill the payment of retirement benefits to participants in the future, based on actuarial calculations. (Daulay et al., 2022). The formula for total actuarial liability is:

$$Total\ AL = \sum_{i=1}^n AL_i \times k_i \quad (17)$$

Descriptions:

AL_i	: Actuarial liability of the i -th person
k_i	: Number of i -th people

3.3. Stages of Analysis

The stages of analysis carried out to achieve the objectives of writing this final project are described as follows:

- 1) Compile a calculation table, based on the 1971 Group Annuity Table Male with an interest rate assumption of 7%
- 2) Calculate the amount of pension benefits for each participant based on PhDP, with the participant's entry age, retirement age, PhDP base salary and the proportion of salary prepared for retirement benefits k of 2.5%
- 3) Calculate the present value of pension benefits based on pension benefits at retirement age, discount factor, initial lifetime annuity at retirement age, and the probability that a person will live to n years
- 4) Calculating normal contributions and actuarial liabilities using the Attained Age Normal Cost and Projected Unit Credit methods

- 5) Calculating the final value of normal contributions using the Attained Age Normal Cost and Projected Unit Credit methods
- 6) Calculating the total actuarial liability by multiplying the actuarial liability per age by the number of participants at that age to obtain the aggregate total liability.

4. Results and Discussion

4.1.1. Benefit Amount Calculation

The following table shows the amount of participant benefits that depend on the PhDP with the participant's starting age, interest rate, pension age, and the PhDP of each participant.

Table 1: Benefit amount of PT TASPEN participants as of August 31, 2023

k	e	r	$(r - e)$	PhDP	Br
2.5%	25	56	31	IDR31,455,557	IDR24,378,056.5
2.5%	20	56	36	IDR31,455,557	IDR28,310,001.1
2.5%	30	56	26	IDR37,499,138	IDR24,374,439.5
2.5%	25	56	31	IDR37,499,138	IDR29,061,831.7
2.5%	20	56	36	IDR37,499,138	IDR33,749,224.0
2.5%	35	56	21	IDR53,424,110	IDR28,047,657.8
2.5%	25	56	31	IDR53,424,110	IDR41,403,685.3
2.5%	20	56	36	IDR53,424,110	IDR48,081,699.1
2.5%	35	56	21	IDR65,392,552	IDR34,331,089.7
2.5%	30	56	26	IDR65,392,552	IDR42,505,158.6
2.5%	25	56	31	IDR65,392,552	IDR50,679,227.6
2.5%	35	56	21	IDR82,696,800	IDR43,415,820.0
2.5%	30	56	26	IDR82,696,800	IDR53,752,920.0
2.5%	35	56	21	IDR69,579,963	IDR36,529,480.7
2.5%	30	56	26	IDR69,579,963	IDR45,226,976.1
2.5%	22	56	34	IDR69,579,963	IDR59,142,968.8
2.5%	19	56	37	IDR69,579,963	IDR64,361,466.1
2.5%	24	56	32	IDR69,896,400	IDR55,917,120.0
2.5%	19	56	37	IDR69,896,400	IDR64,654,170.0

From the results of the benefit calculation above, it can be concluded that the employment benefit increases with the length of service and the amount of PhDP. For participants with a longer service period and higher PhDP, the pension benefits received will be greater.

4.1.2. Present Value of Pension Benefits Calculation

In the calculation of the present value of the benefit value is divided into two, namely, the value of pension benefits at the age of entry and the present value of pension benefits at the calculation age.

The following is a table of pension benefit values at entry age:

Table 2: Pension benefit outcome at entry age

Br	$\ddot{a}_r$	v^{r-e}	$r-e p_e$	$r(PVFB)_e$
IDR24,378,056.5	11.08887	0.12277301	0.91844656	IDR30,481,968.0
IDR28,310,001.1	11.08887	0.08753546	0.9159456	IDR25,169,854.7
IDR24,374,439.5	11.08887	0.17219549	0.92161072	IDR42,893,459.2
IDR29,061,831.7	11.08887	0.12277301	0.91844656	IDR36,338,492.5
IDR33,749,224.0	11.08887	0.08753546	0.9159456	IDR30,005,758.7
IDR28,047,657.8	11.08887	0.24151309	0.9258702	IDR69,546,377.6
IDR41,403,685.3	11.08887	0.12277301	0.91844656	IDR51,770,567.1
IDR48,081,699.1	11.08887	0.08753546	0.9159456	IDR42,748,475.2
IDR34,331,089.7	11.08887	0.24151309	0.9258702	IDR85,126,642.0
IDR42,505,158.6	11.08887	0.17219549	0.92161072	IDR74,799,393.3

Br	$\ddot{a}_r$	v^{r-e}	$r-e p_e$	$r(PVFB)_e$
IDR50,679,227.6	11.08887	0.12277301	0.91844656	IDR63,368,570.5
IDR43,415,820.0	11.08887	0.24151309	0.9258702	IDR107,652,946.8
IDR53,752,920.0	11.08887	0.17219549	0.92161072	IDR94,592,890.3
IDR36,529,480.7	11.08887	0.24151309	0.9258702	IDR90,577,725.9
IDR45,226,976.1	11.08887	0.17219549	0.92161072	IDR79,589,171.9
IDR59,142,968.8	11.08887	0.10021934	0.91688517	IDR60,263,835.0
IDR64,361,466.1	11.08887	0.08180884	0.91550045	IDR53,452,971.7
IDR55,917,120.0	11.08887	0.11474113	0.91790376	IDR65,305,264.9
IDR64,654,170.0	11.08887	0.08180884	0.91550045	IDR53,696,065.9

Next is the table of the present value of pension benefits at the calculation age:

Table 3: Pension benefit outcome at calculation age

Br	$\ddot{a}_r$	v^{r-x}	$r-x p_x$	$r(PVFB)_x$
IDR24,378,057	11.088866	0.1405628	0.919613179	IDR34,943,134
IDR28,310,001	11.088866	0.1405628	0.919613179	IDR40,579,123
IDR24,374,440	11.088866	0.1971466	0.923150804	IDR49,190,786
IDR29,061,832	11.088866	0.1971466	0.923150804	IDR58,650,553
IDR33,749,224	11.088866	0.1971466	0.923150804	IDR68,110,319
IDR28,047,658	11.088866	0.2765083	0.928027543	IDR79,809,176
IDR41,403,685	11.088866	0.2765083	0.928027543	IDR117,813,546
IDR48,081,699	11.088866	0.2765083	0.928027543	IDR136,815,731
IDR34,331,090	11.088866	0.3878172	0.935134435	IDR138,062,549
IDR42,505,159	11.088866	0.3878172	0.935134435	IDR170,934,585
IDR50,679,228	11.088866	0.3878172	0.935134435	IDR203,806,620
IDR43,415,820	11.088866	0.4750928	0.94154973	IDR215,355,940
IDR53,752,920	11.088866	0.5439337	0.947452653	IDR307,179,845
IDR36,529,481	11.088866	0.7628952	0.970401166	IDR299,879,540
IDR45,226,976	11.088866	0.7628952	0.970401166	IDR371,279,430
IDR59,142,969	11.088866	0.8734387	0.983741499	IDR563,512,685
IDR64,361,466	11.088866	0.8734387	0.983741499	IDR613,234,392
IDR55,917,120	11.088866	1	1	IDR620,057,455
IDR64,654,170	11.088866	1	1	IDR716,941,432

Based on the two tables above, it can be concluded that the present value of pension benefits (PVFB) will increase as the participant's age increases and the participant gets closer to retirement age. The first table shows the calculation of the value of retirement benefits calculated from the entry age, while the second table is calculated from the current age (valuation age). It can be seen that the PVFB value calculated from the current age (Table 3) tends to be larger because the time to retirement is shorter, so the discount factor is smaller and the chance of living to retirement is higher. In contrast, the PVFB value from the entry age (Table 2) is lower because the benefits are still far in the future and need to be discounted for longer. This comparison shows the importance of timing in the valuation of retirement benefits: the closer to retirement, the greater the liability burden reflected.

4.1.3. Normal Contributions Calculation

Before determining the amount of pension fund liabilities that must be prepared, it is important to first calculate the normal contributions paid annually by participants. In this section, we will compare the results of calculating normal contributions using two methods, namely the Attained Age Normal (AAN) and Projected Unit Credit (PUC) methods, to see the differences more clearly.

Table 4: Normal contributions using the Attained Age Normal method

$r(PVFB)_e$	x	r	N_x	N_r	$N_x - N_r$	D_x	$r(NC)_x$
IDR30,481,968.0	27	56	22942.4524	2282.9325	20659.5199	1592.6866	IDR2,349,920.1
IDR25,169,854.7	27	56	22942.4524	2282.9325	20659.5199	1592.6866	IDR1,940,398.0
IDR42,893,459.2	32	56	15964.4056	2282.9325	13681.4731	1131.2119	IDR3,546,518.1
IDR36,338,492.5	32	56	15964.4056	2282.9325	13681.4731	1131.2119	IDR3,004,540.1
IDR30,005,758.7	32	56	15964.4056	2282.9325	13681.4731	1131.2119	IDR2,480,936.9
IDR69,546,377.6	37	56	11010.591	2282.9325	8727.6585	802.3002	IDR6,393,132.0
IDR51,770,567.1	37	56	11010.591	2282.9325	8727.6585	802.3002	IDR4,759,069.8
IDR42,748,475.2	37	56	11010.591	2282.9325	8727.6585	802.3002	IDR3,929,703.5
IDR85,126,642.0	42	56	7499.8973	2282.9325	5216.9648	567.6816	IDR9,263,016.0
IDR74,799,393.3	42	56	7499.8973	2282.9325	5216.9648	567.6816	IDR8,139,261.2
IDR63,368,570.5	42	56	7499.8973	2282.9325	5216.9648	567.6816	IDR6,895,421.5
IDR107,652,946.8	45	56	5909.0081	2282.9325	3626.0756	460.2399	IDR13,663,857.8
IDR94,592,890.3	47	56	5019.8942	2282.9325	2736.9617	399.4869	IDR13,806,777.2
IDR90,577,725.9	52	56	3281.0245	2282.9325	998.092	278.0929	IDR25,237,175.0
IDR79,589,171.9	52	56	3281.0245	2282.9325	998.092	278.0929	IDR22,175,494.5
IDR60,263,835.0	54	56	2744.7159	2282.9325	461.7834	239.6032	IDR31,268,789.0
IDR53,452,971.7	54	56	2744.7159	2282.9325	461.7834	239.6032	IDR27,734,871.1
IDR65,305,264.9	56	56	2282.9325	2282.9325	0	205.8761	IDR0.0
IDR53,696,065.9	56	56	2282.9325	2282.9325	0	205.8761	IDR0.0

Next is the normal contribution calculation table using the Projected Unit Credit method.

Table 5: Normal contributions using the Projected Unit Credit method

$r(PVFB)_x$	r	e	$r - e$	$r(NC)_x$
IDR34,943,134	56	25	31	IDR1,127,198
IDR40,579,123	56	20	36	IDR1,127,198
IDR49,190,786	56	30	26	IDR1,891,953
IDR58,650,553	56	25	31	IDR1,891,953
IDR68,110,319	56	20	36	IDR1,891,953
IDR79,809,176	56	35	21	IDR3,800,437
IDR117,813,546	56	25	31	IDR3,800,437
IDR136,815,731	56	20	36	IDR3,800,437
IDR138,062,549	56	35	21	IDR6,574,407
IDR170,934,585	56	30	26	IDR6,574,407
IDR203,806,620	56	25	31	IDR6,574,407
IDR215,355,940	56	35	21	IDR10,255,045
IDR307,179,845	56	30	26	IDR11,814,609
IDR299,879,540	56	35	21	IDR14,279,978
IDR371,279,430	56	30	26	IDR14,279,978
IDR563,512,685	56	22	34	IDR16,573,902
IDR613,234,392	56	19	37	IDR16,573,902
IDR620,057,455	56	24	32	IDR19,376,795
IDR716,941,432	56	19	37	IDR19,376,795

From the two tables above, it can be seen that the calculation of normal contributions using the Attained Age Normal (AAN) method tends to produce larger and more variable annual contribution values than the Projected Unit Credit (PUC) method. The AAN method considers age and years of service until retirement, so contributions are divided equally over the remaining working life, while the PUC method calculates contributions based on projected pension benefits for each year of service, which makes them more stable and tends to be smaller at the beginning of the working life. This comparison shows that the choice of method greatly affects the number of contributions that participants have to pay.

4.1.4. Actuarial Liability Calculation

After knowing the amount of normal contributions per year, the next step is to calculate the actuarial liability (AL). This calculation shows the total obligation of the company to participants who have worked until a certain age, calculated based on the same AAN and PUC methods as in the previous normal contribution calculation.

Table 6: Value of actuarial liabilities using Attained Age Normal method

$r(PVFB)_x$	x	r	N_x	N_r	$N_x - N_r$	D_x	$r(NC)_x$	$r(AL)_x$
IDR34,943,134	27	56	22942.45	2282.933	20659.52	1592.687	IDR2,349,920.1	IDR4,461,165.8
IDR40,579,123	27	56	22942.45	2282.933	20659.52	1592.687	IDR1,940,398.0	IDR15,409,268.5
IDR49,190,786	32	56	15964.41	2282.933	13681.47	1131.212	IDR3,546,518.1	IDR6,297,327.0
IDR58,650,553	32	56	15964.41	2282.933	13681.47	1131.212	IDR3,004,540.1	IDR22,312,060.3
IDR68,110,319	32	56	15964.41	2282.933	13681.47	1131.212	IDR2,480,936.9	IDR38,104,560.7
IDR79,809,176	37	56	11010.59	2282.933	8727.659	802.3002	IDR6,393,132.0	IDR10,262,798.7
IDR117,813,546	37	56	11010.59	2282.933	8727.659	802.3002	IDR4,759,069.8	IDR66,042,978.8
IDR136,815,731	37	56	11010.59	2282.933	8727.659	802.3002	IDR3,929,703.5	IDR94,067,255.6
IDR138,062,549	42	56	7499.897	2282.933	5216.965	567.6816	IDR9,263,016.0	IDR52,935,907.2
IDR170,934,585	42	56	7499.897	2282.933	5216.965	567.6816	IDR8,139,261.2	IDR96,135,191.5
IDR203,806,620	42	56	7499.897	2282.933	5216.965	567.6816	IDR6,895,421.5	IDR140,438,049.8
IDR215,355,940	45	56	5909.008	2282.933	3626.076	460.2399	IDR13,663,857.8	IDR107,702,993.0
IDR307,179,845	47	56	5019.894	2282.933	2736.962	399.4869	IDR13,806,777.2	IDR212,586,954.6
IDR299,879,540	52	56	3281.025	2282.933	998.092	278.0929	IDR25,237,175.0	IDR209,301,814.0
IDR371,279,430	52	56	3281.025	2282.933	998.092	278.0929	IDR22,175,494.5	IDR291,690,258.5
IDR563,512,685	54	56	2744.716	2282.933	461.7834	239.6032	IDR31,268,789.0	IDR503,248,849.6
IDR613,234,392	54	56	2744.716	2282.933	461.7834	239.6032	IDR27,734,871.1	IDR559,781,420.4
IDR620,057,455	56	56	2282.933	2282.933	0	205.8761	IDR0.0	IDR620,057,454.7
IDR716,941,432	56	56	2282.933	2282.933	0	205.8761	IDR0.0	IDR716,941,432.0

Next is the table of calculation of actuarial liabilities using the Projected Unit Credit method.

Table 7: Value of actuarial liabilities using the Projected Unit Credit method

$r(PVFB)_x$	x	r	e	$x - e$	$r - e$	$r(NC)_x$	$r(AL)_x$
IDR34,943,134	27	56	25	2	31	IDR1,127,198	IDR2,254,396
IDR40,579,123	27	56	20	7	36	IDR1,127,198	IDR7,890,385
IDR49,190,786	32	56	30	2	26	IDR1,891,953	IDR3,783,907
IDR58,650,553	32	56	25	7	31	IDR1,891,953	IDR13,243,673
IDR68,110,319	32	56	20	12	36	IDR1,891,953	IDR22,703,440
IDR79,809,176	37	56	35	2	21	IDR3,800,437	IDR7,600,874
IDR117,813,546	37	56	25	12	31	IDR3,800,437	IDR45,605,244
IDR136,815,731	37	56	20	17	36	IDR3,800,437	IDR64,607,428
IDR138,062,549	42	56	35	7	21	IDR6,574,407	IDR46,020,850
IDR170,934,585	42	56	30	12	26	IDR6,574,407	IDR78,892,885
IDR203,806,620	42	56	25	17	31	IDR6,574,407	IDR111,764,921
IDR215,355,940	45	56	35	10	21	IDR10,255,045	IDR102,550,448
IDR307,179,845	47	56	30	17	26	IDR11,814,609	IDR200,848,360
IDR299,879,540	52	56	35	17	21	IDR14,279,978	IDR242,759,628
IDR371,279,430	52	56	30	22	26	IDR14,279,978	IDR314,159,518
IDR563,512,685	54	56	22	32	34	IDR16,573,902	IDR530,364,880
IDR613,234,392	54	56	19	35	37	IDR16,573,902	IDR580,086,587
IDR620,057,455	56	56	24	32	32	IDR19,376,795	IDR620,057,455
IDR716,941,432	56	56	19	37	37	IDR19,376,795	IDR716,941,432

From the two actuarial liability tables above, it can be concluded that the Attained Age Normal (AAN) and Projected Unit Credit (PUC) methods provide different results in calculating the company's responsibility to pension participants. In general, the PUC method tends to produce a larger liability figure for participants with a longer working age, because the contribution burden is calculated based on the length of service each year. The AAN method, on the other hand, is more equitable and consistent as it divides the liability proportionally until retirement age. This shows that the method chosen will greatly affect how much coverage the company must prepare. Next, we will discuss the final value of normal contributions to see the total pension fund burden as a whole.

4.1.5. Final Value of Normal Contributions

In addition to actuarial liabilities, the final value of normal contributions is also calculated to see the total contributions accumulated until retirement age. This calculation is important to determine whether the contributions paid during the working period are sufficient to finance the retirement benefits that participants will receive.

Table 8: Final value of normal contributions using the Attained Age Normal method

e	$r(PVFB)_e$	v	$r(NA)_e$
25	IDR30,481,968.0	1.07	IDR377,577,478.086
20	IDR25,169,854.7	1.07	IDR404,469,711.222
30	IDR42,893,459.2	1.07	IDR413,216,318.111
25	IDR36,338,492.5	1.07	IDR450,121,736.786
20	IDR30,005,758.7	1.07	IDR482,180,795.888
35	IDR69,546,377.6	1.07	IDR523,562,549.819
25	IDR51,770,567.1	1.07	IDR641,277,498.096
20	IDR42,748,475.2	1.07	IDR686,951,260.396
35	IDR85,126,642.0	1.07	IDR640,854,682.672
30	IDR74,799,393.3	1.07	IDR720,583,754.587
25	IDR63,368,570.5	1.07	IDR784,940,954.408
35	IDR107,652,946.8	1.07	IDR810,438,346.948
30	IDR94,592,890.3	1.07	IDR911,265,412.729
35	IDR90,577,725.9	1.07	IDR681,891,807.661
30	IDR79,589,171.9	1.07	IDR766,726,330.121
22	IDR60,263,835.0	1.07	IDR871,602,292.112
19	IDR53,452,971.7	1.07	IDR905,993,151.676
24	IDR65,305,264.9	1.07	IDR851,483,077.120
19	IDR53,696,065.9	1.07	IDR910,113,439.573

Next is the table of the final value of normal contributions using the Projected Unit Credit method.

Table 9: Final value of normal contributions using the Projected Unit Credit method

e	$r(PVFB)_x$	v	$r(NA)_e$
25	IDR34,943,134	1.07	IDR283,549,901
20	IDR40,579,123	1.07	IDR388,967,089
30	IDR49,190,786	1.07	IDR338,688,478
25	IDR58,650,553	1.07	IDR334,031,945
20	IDR68,110,319	1.07	IDR652,864,591
35	IDR79,809,176	1.07	IDR464,960,601
25	IDR117,813,546	1.07	IDR956,010,972
20	IDR136,815,731	1.07	IDR1,311,433,376
35	IDR138,062,549	1.07	IDR804,339,161
30	IDR170,934,585	1.07	IDR1,176,919,071
25	IDR203,806,620	1.07	IDR1,653,811,229
35	IDR215,355,940	1.07	IDR1,254,643,035
30	IDR307,179,845	1.07	IDR1,184,000,050
35	IDR299,879,540	1.07	IDR1,747,069,418

e	$r(PVFB)_x$	v	$r(NA)_e$
30	IDR371,279,430	1.07	IDR2,556,333,717
22	IDR563,512,685	1.07	IDR5,050,776,669
19	IDR613,234,392	1.07	IDR6,080,689,417
24	IDR620,057,455	1.07	IDR5,200,398,410
19	IDR716,941,432	1.07	IDR7,109,024,273

Based on the results of the calculation of the final value of normal contributions using the Attained Age Normal (AAN) and Projected Unit Credit (PUC) methods, it can be seen that although both calculate pension contributions, the final results can differ quite significantly. Generally, the final value of normal contributions from the AAN method tends to be smaller than the PUC method, especially for participants with a younger entry age and longer service period. This is because the AAN spreads the contribution burden evenly from the beginning of the working period until retirement, while the PUC focuses more on liabilities that increase with age and working period. In other words, the PUC method tends to produce a larger final contribution value because it assumes a gradual increase in pension liability.

4.1.6. Total Actuarial Liability

The total actuarial liability is calculated as the present value of pension benefits that have been recognized up to the participant's current age. This value is multiplied by the number of participants (k) in each age category or data group to get the total liability. In the Attained Age Normal method, the obligation is calculated based on the full pension benefit multiplied by the proportion of the service period that has been served. The following table shows the calculation of total actuarial liabilities using the Attained Age Normal method.

Table 10: Total actuarial liabilities with the Attained Age Normal method

AL	k	$Al \times k$
IDR4,461,165.8	361	IDR1,610,480,865.0
IDR15,409,268.5	361	IDR5,562,745,913.1
IDR6,297,327.0	334	IDR2,103,307,215.1
IDR22,312,060.3	334	IDR7,452,228,126.8
IDR38,104,560.7	334	IDR12,726,923,260.5
IDR10,262,798.7	109	IDR1,118,645,053.3
IDR66,042,978.8	109	IDR7,198,684,688.6
IDR94,067,255.6	109	IDR10,253,330,857.4
IDR52,935,907.2	58	IDR3,070,282,619.2
IDR96,135,191.5	58	IDR5,575,841,105.3
IDR140,438,049.8	58	IDR8,145,406,888.1
IDR107,702,993.0	5	IDR538,514,965.0
IDR212,586,954.6	5	IDR1,062,934,772.9
IDR209,301,814.0	218	IDR45,627,795,462.4
IDR291,690,258.5	218	IDR63,588,476,357.7
IDR503,248,849.6	218	IDR109,708,249,214.8
IDR559,781,420.4	218	IDR122,032,349,644.9
IDR620,057,454.7	10	IDR6,200,574,547.2
IDR716,941,432.0	10	IDR7,169,414,320.2
Total		IDR420,746,185,877.4

In the Projected Unit Credit method, the liability is calculated based on the proportion of pension benefits that have been recognized up to the time of evaluation. The following is a table calculating the total actuarial liability using the Projected Unit Credit method.

Table 11: Total actuarial liabilities with the Projected Unit Credit method

AL	k	$Al \times k$
IDR2,254,396	361	IDR813,836,859
IDR7,890,385	361	IDR2,848,429,005
IDR3,783,907	334	IDR1,263,824,815
IDR13,243,673	334	IDR4,423,386,853
IDR22,703,440	334	IDR7,582,948,892
IDR7,600,874	109	IDR828,495,258
IDR45,605,244	109	IDR4,970,971,550
IDR64,607,428	109	IDR7,042,209,696
IDR46,020,850	58	IDR2,669,209,285
IDR78,892,885	58	IDR4,575,787,346
IDR111,764,921	58	IDR6,482,365,407
IDR102,550,448	5	IDR512,752,238
IDR200,848,360	5	IDR1,004,241,800
IDR242,759,628	218	IDR52,921,598,816
IDR314,159,518	218	IDR68,486,774,938
IDR530,364,880	218	IDR115,619,543,769
IDR580,086,587	218	IDR126,458,875,997
IDR620,057,455	10	IDR6,200,574,547
IDR716,941,432	10	IDR7,169,414,320
Total		IDR421,875,241,393.4

Based on the results of the calculation of the total actuarial liabilities of the two methods, it is found that the total value of actuarial liabilities with the PUC method is slightly greater than the AAN method. The AAN method produces a total liability of IDR420,746,185,877.40, while the PUC method produces a total liability of IDR421,875,241,393.40. This difference shows that the PUC method tends to provide a higher estimate of liabilities because it takes into account the proportion of years of service linearly to the total pension benefits to be received.

5. Conclusion

This study compares two actuarial methods, namely Attained Age Normal (AAN) and Projected Unit Credit (PUC), in estimating actuarial liabilities and pension fund financing at PT Taspen. Based on the calculation of the value of benefits, the present value of pension benefits, normal contributions, the final value of normal contributions, and total actuarial liabilities, it is found that each method produces different estimates. The AAN method tends to produce larger but more stable and equitable annual contributions, while the PUC method produces liabilities that increase as the length of service increases, so it tends to better reflect the actual conditions of participants with long service periods.

In total, the actuarial liability value generated by the PUC method is slightly higher at IDR421,875,241,393.40, compared to the AAN method of IDR420,746,185,877.40. This difference shows that the method used in the calculation greatly affects the number of obligations that must be fulfilled by the pension fund. The results of this analysis are expected to be taken into consideration for PT Taspen in choosing the method of calculating actuarial liabilities that best suits the characteristics of participants and the company's long-term goals.

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