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Cash Flow Projection Analysis of a Defined Benefit Pension Fund Under Membership Freezing Conditions in Indonesia

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Abstract

Background: Defined Benefit Pension Funds (DPPK PPMP) in Indonesia face funding sustainability risks as frozen membership reduces contribution inflows while long-term pension obligations persist.
Objective: This study evaluates the long-term cash flow sustainability of DPPK PPMP with frozen membership, identifies key funding determinants and deficit points, and proposes mitigation strategies.
Methods: A descriptive-analytical quantitative approach was applied to 18 DPPK PPMP with frozen membership using financial statements, actuarial reports, and OJK audit results from 2023–2025. Cash flows were projected through 2062 under fixed actuarial assumptions and no new participants or operational costs. Funding ratios, net cash flows, and heatmaps were analyzed.
Results: Pension Funds F and P entered negative cash flow in 2027, while B, C, L, and O maintained funding ratios above 100% through 2062. Participants aged 56–75 represented 65% of membership, with retirees reaching 95% in some funds. Only four funds remained financially resilient, while the remainder faced high to very high funding risk. Sustainability was mainly determined by initial asset adequacy, participant demographics, and investment returns.
Conclusion: Most DPPK PPMP with frozen membership face long-term funding deficits. Regular cash flow projections, strengthened Asset Liability Management, and funding recovery plans are essential to ensure sustainable pension payments.

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INTRODUCTION

Pension funds are an important instrument in the social and financial protection system, which guarantees an individual's income after a productive period (Chohan, 2023; Koval et al., 2020; Murari, 2022). Its existence not only has an impact on the welfare of participants, but also acts as a long-term institutional investor that supports infrastructure financing and financial market stability (Weber et al., 2016). Within the framework of the Sustainable Development Goals (SDGs), pension funds contribute directly to SDG 1 (No Poverty) and SDG 8 (Decent Work and Economic Growth) (Syam Budi Bakroh & Hiilamo, 2025).

Globally, defined benefit pension fund systems face mounting pressures from population aging, declining birth rates, and rising life expectancy (Abdul Rahman & Lau, 2024; Amaglobeli et al., 2019; Ring et al., 2024). The OECD (2023) estimates that by 2050, the share of people aged 65 and over in OECD countries will exceed 25%, significantly increasing pension liability burdens. Countries including the United Kingdom, United States, and Japan have witnessed a substantial trend toward membership freezing of defined benefit plans, transitioning toward defined contribution schemes to manage long-term funding risks (Zhao & Sutcliffe, 2024). In emerging economies, including Indonesia, these demographic shifts are compounded by lower coverage

rates and inadequate regulatory frameworks for managing closed pension funds, creating urgent systemic risks for retirement income security (OECD, 2025).

In Indonesia, the pension system is divided into compulsory and voluntary schemes. Voluntary schemes include the Employer Pension Fund (DPPK) and the Financial Institution Pension Fund (DPLK). The Defined Benefit Pension Program (PPMP) can only be run by the DPPK, with predetermined benefits, but contributions may change according to funding conditions. Consequently, if funding is lacking, employers are obliged to cover the shortfall. The funding challenge is even more severe when the pension fund no longer accepts new participants (freezing membership). As explained by Zhao & Sutcliffe (2024), membership freezes fundamentally change the employer's risk profile.

Data from the Financial Services Authority (OJK) shows that the number of PPMP DPPK has decreased from 141 (2021) to 117 (2025). Of these, 61 pension funds have been frozen (OJK, 2026). Despite the decline in numbers, DPPK PPMP assets still dominate the Pension Fund's industrial assets, reaching IDR 1,684.89 trillion as of March 2026, with benefit payments jumping 14.26% (yoy) to IDR 20.79 trillion as of February 2026 (OJK, 2026). The OECD report (2025) also highlights that the funding parameters of the definite benefit scheme in Indonesia are not adequate for long-term solvency. As active participant numbers decline without replacement, contribution income diminishes progressively until cessation, while benefit payment obligations to existing retirees and survivors persist for decades. This structural imbalance between inflows and outflows directly threatens long-term funding sustainability, potentially resulting in benefit payment defaults if corrective actions are not implemented in a timely manner.

Research on the sustainability of pension funds has been conducted with various approaches. Application of Asset Liability Management (ALM) in pension funds to maintain a balance between assets and liabilities (Bernardino et al., 2025; Marcaillou, 2016). Moreira et al. (2026) highlight the importance of optimizing investment portfolios in increasing the resilience of pension funds. Meanwhile, Jang et al. (2024) emphasized the use of liability-driven investment strategies to reduce the risk of asset and liability mismatches. However, most previous research has focused more on investment and asset management aspects, while analysis of long-term cash flow projections in pension funds that have experienced membership freezes is still relatively limited. In addition, previous research has generally not identified specifically when a pension fund begins to experience significant funding pressures and how the demographic characteristics of participants affect the rate of decline in the financial condition of the pension fund. El Moutaki (2026) show that retirement age and demographic structure are very sensitive variables in determining the sustainability of pension funding, but the study has not specifically examined the context of the definite benefit pension fund that has been closed to new participants.

Based on the research gap, this study offers novelty through the integration of long-term cash flow projection analysis with the funding ratio heatmap approach to map the level of funding pressure in the Employer Pension Fund of the Defined Benefit Pension Program that has experienced a membership freeze in Indonesia. In contrast to previous research that focused more on evaluating solvency or investment strategies, this study identifies a tipping point when a pension fund begins to enter negative funding conditions based on projections until 2062. In addition, this study combines the analysis of the demographic structure of participants, investment returns, initial asset adequacy, and the development of cash flows of pension benefits to produce a more comprehensive picture of the sustainability risks of pension funds.

This approach is expected to make a new contribution to the development of risk-based supervision methods in the pension fund industry in Indonesia. Unlike previous studies that primarily evaluate solvency at a fixed point in time or optimize investment portfolios in isolation Moreira et al. (2026), this study integrates deterministic long-term cash flow projections with a funding ratio heatmap to simultaneously visualize temporal funding pressure and identify specific tipping points. This dual-analytical framework enables actionable, time-specific risk identification that static solvency assessments cannot provide.

The urgency of this research is even higher considering the increasing number of pension funds that have experienced membership freezing and the large value of assets managed by the DPPK PPMP. Without a long-term evaluation of the projected cash flow, potential funding deficits can be detected too late, reducing the space for managers and regulators to take corrective actions. In addition, global economic pressures, financial market fluctuations, and changes in the

demographic characteristics of participants can accelerate the deterioration of pension fund funding conditions. Therefore, research is needed that is able to provide an overview of the level of resilience of pension funds in the face of freezing conditions and identify the factors that most affect the sustainability of their funding.

The results of this research are also expected to be the basis for decision-making for pension fund managers, sponsors, and regulators in designing more effective risk mitigation strategies. If funding risks remain undetected, individual participants and retirees face the risk of benefit payment disruptions, directly threatening their income security in old age and undermining progress toward SDG 1 (No Poverty). For sponsoring companies, underfunded pension liabilities may require substantial additional contributions, straining corporate financial capacity. At the industry level, widespread underfunding across multiple frozen pension funds could destabilize the voluntary pension fund sector and erode public trust in pension institutions (Syam Budi Bakroh & Hiilamo, 2025).

Previous research has examined asset allocation and Asset Liability Management (ALM) in pension funds Bernardino et al. (2025), but is still partial and has not integrated long-term cash flow projections to the last participant, especially in closed pension funds. Zaki Khorasanee (2002) Introduced a cash flow approach for pension funding, but it has not been applied comprehensively in the context of freezing in Indonesia. Nádasi (2026) show that retirement age and recruitment patterns are the most dominant parameters in retirement sustainability. Alirzayev (2025) emphasizes the need to improve long-term forecasting methodologies. Each of these studies has notable limitations: Bernardino et al. (2025) apply ALM primarily to open Brazilian pension funds and do not address closed membership scenarios; Moreira et al. (2026) focus on portfolio optimization without integrating demographic projection into the cash flow model; Zaki Khorasanee (2002) introduced the cash flow framework conceptually but did not apply it to the specific Indonesian regulatory context or to frozen pension funds with multi-decade projection horizons. These gaps collectively justify the present study's integrated methodological approach.

Three principal research gaps are identified: First, from the perspective of variable scope, existing studies largely overlook the interaction between participant demographic aging and asset depletion trajectories in frozen pension funds, focusing instead on general investment optimization or solvency at a single point in time. Second, from a methodological standpoint, prior studies do not integrate long-term deterministic cash flow projections with heatmap-based visualization to identify the timing of funding tipping points. Third, from a contextual dimension, comprehensive empirical analysis of frozen DPPK PPMP in the Indonesian regulatory environment, particularly covering the 40-year projection horizon required to account for all current beneficiaries, remains absent from the literature.

Based on these gaps, this study aims to: (1) map the projected cash flow in and out of the freezing PPMP DPPK; (2) identify key variables that affect funding conditions; (3) determining the tipping point of the funding deficit; (4) formulate mitigation recommendations. The research hypothesis: in a membership freezing scenario, an ageing demographic structure and a high proportion of retirees significantly accelerate the decline in funding ratios, and only pension funds with sufficient initial assets and adequate investment returns can last for a period of up to 20 years. These objectives collectively guide the methodological design and analytical framework elaborated in the following section.

METHOD

This study used a descriptive-analytical quantitative approach. The objects of the study were 18 DPPK PPMPs that had frozen their membership, selected through purposive sampling based on the following criteria: (a) having been established for at least 10 years; (b) having total assets representing more than 50% of the total assets of all DPPK PPMPs that had frozen their membership; and (c) having been inspected by the OJK during the 2022–2026 period. The sample covered 30% of each asset group (categories ranging from ≥Rp5T to <Rp100M) and represented various business sectors of the Pension Fund Founders, including banking, mining, manufacturing, telecommunications, and others. The selection of 18 pension funds was justified by their collective representation of more than 50% of the total DPPK PPMP assets under management, thereby ensuring macroeconomic representativeness.

The minimum asset coverage criterion (>50%) followed the stratified coverage principle used in pension fund supervisory research Jang et al. (2024), ensuring that the sample captured the financial scale necessary for meaningful industry-level inferences. The 30% proportional representation across each asset category followed stratified purposive sampling conventions in financial institution research Miles Matthew et al. (2014), ensuring variation across fund sizes. The minimum establishment period of 10 years ensured the availability of sufficient actuarial data for reliable projection modeling (Zaki Khorasanee, 2002).

Secondary data were obtained from: (1) audited Annual Financial Statements, including statements of changes in net assets, cash flow statements, and investment portfolio reports; (2) Actuarial Reports, including the valuation date, actuarial liabilities, solvency, initial funding ratio, and interest rate assumptions; and (3) OJK audit results, including demographic data, Basic Pension Income, and pension benefits. The projection period covered 2023–2062.

Projections were carried out deterministically under the following assumptions: (a) there were no new participants; (b) actuarial assumptions and investment returns were based on the latest available reports; (c) benefit payments were made only to normal retirees, widows/widowers, and eligible children; and (d) operational and investment costs were assumed to be negligible. The basic equation used represented the change in net assets:

$$A_{t+1} = A_t + (I_t + C_t) - B_t$$

where:

- A_t= total assets at the end of year t
- I_t= investment income during year t
- C_t= contribution income during year t
- B_t= pension benefit payments during year t

Funding ratio is calculated as

$$FRt = (At/Vt) \times 100\%$$

FR_t= funding ratio at year t
A_t= total assets at the end of year t
V_t= actuarial liability at year t

Projections were conducted using Microsoft Excel with parameter data obtained from actuarial reports. The analysis included: (1) descriptive analysis of demographic characteristics and initial funding positions; (2) projection of cash inflows (contributions and investment returns) and cash outflows (benefit payments); (3) calculation of net cash flow; and (4) preparation of a funding ratio heatmap to visualize funding pressure points. Funding risks were classified based on the value of the funding ratio and the year in which the funding position first became negative.

This research used secondary data obtained from various official documents issued by pension funds and regulatory authorities. The data included audited annual financial statements, actuarial reports, reports on audit results issued by the Financial Services Authority (OJK), and supporting publications related to the condition of the national pension fund industry. Financial statements were used to obtain information on net assets, investment portfolios, cash flows, and pension benefit payments. Actuarial reports were used to obtain data on actuarial liabilities, interest rate assumptions, funding ratios, and participant structures. Meanwhile, OJK audit reports were used to provide additional information on the operational conditions and risk profiles of each pension fund. Multiple data sources were used to enhance the validity of the analysis and provide a more comprehensive understanding of pension fund funding conditions (OJK, 2026).

This research covered several key aspects related to pension fund sustainability. The first aspect was cash inflows, consisting of investment returns and contribution receipts. The second aspect was cash outflows, consisting of pension benefit payments to retirees, widows or widowers, and children entitled to receive benefits. The third aspect was the demographic structure of participants, including the ages of active participants, retirees, and other beneficiaries. The fourth aspect was the funding condition, represented by the funding ratio and

changes in net assets. The final aspect was the identification of critical funding points, indicated by a decline in the funding ratio into the negative zone. These variables were selected because previous studies have shown that demographic structure, asset adequacy, and investment returns are among the primary factors affecting the sustainability of defined benefit pension funds (Shim et al., 2022).

Data analysis was conducted through several interconnected stages. The first stage involved descriptive analysis to describe the characteristics of the pension funds, the demographic structure of participants, asset conditions, and initial funding levels. The second stage involved preparing long-term cash flow projections by considering cash inflows and cash outflows throughout the research period. The third stage involved calculating net cash flow to identify funding surpluses or deficits in each period. The fourth stage involved evaluating funding ratios to assess the adequacy of assets in meeting actuarial obligations. The final stage involved preparing a funding heatmap, which was used as a visualization tool to identify the level of funding pressure and the timing of the tipping point. This approach referred to the concept of cash-flow-based pension funding, which emphasizes the importance of cash flow projections as a basis for decision-making in pension fund management (Zaki Khorasanee, 2002)

RESULTS AND DISCUSSION

Results

Overview and Demographics

Of the 18 sample pension funds, the total number of participants was 119,423 people. The age structure was dominated by the 56–65 years (34%) and 66–75 years (31%) groups, so that 65% of participants were at the age before or after retirement. About 76% of participants were 46–75 years old. The proportion of retirees averages 74%, with Pension Funds A and L reaching 95%. The gender composition is dominated by men (mining, manufacturing), except for the banking sector which tends to be balanced. The beneficiaries consist of retired employees (dominant), widows/widowers (up to 41% in Dapen P), and children (<5%).

These findings are in line with El Moutaki (2026) who stated that the retirement age profile is the most dominant parameter in financial sustainability. A mature structure indicates *front-loaded* pressure on cash outflows.

Projected Cash Flow Inflows and Outflows

Table 1 summarizes cash inflows (investment results + contributions) in 2023 and the projection period.

Table 1
Total Cash Flow (IDR billion)

Pension Fund	2023		Total Cash Flow	
	Investment Returns	Total Cash Flow	2023–2042	2043–2062
Pension Fund A	1.165,24	1.165,24	12.930,54	(12.899,73)
Pension Fund B	1.141,43	1.141,43	16.099,34	9.397,38
C Pension Fund	119,51	119,51	2.265,60	3.786,14
D Pension Fund	140,41	140,41	1.222,80	(1.329,28)
Pension Fund E	108,7	108,7	1.256,32	(338,93)
F Pension Fund	5,92	5,92	(428,85)	(3.418,30)
G Pension Fund	54,11	54,11	594,97	(967,98)
H Pension Fund	45,9	45,9	199,94	(3.357,55)
Pension Fund I	77,75	77,75	610,01	(3.507,46)
J Pension Fund	20,94	20,94	271,6	(100,48)
K Pension Fund	30,65	30,65	22,55	(2.002,70)
L Pension Fund	35,27	35,27	447,99	562,27
M Pension Fund	14,79	14,79	199,19	(28,27)
N Pension Fund	5,96	5,96	76,87	(103,03)
O Pension Fund	2,26	2,26	32,38	25,62
P Pension Fund	1,48	1,48	(73,16)	(593,69)

Q Pension Fund	0,06	0,06	0,98	(5,09)
R Pension Fund	0,26	0,26	3,18	3,18

Source: Data processed (2026), Note: numbers in parentheses show negative values.

Only Dapen B, C, L, O has positive cash inflows until 2062. Most of them (Dapen A, D, F, H, I, K, P, Q) showed negative in the period 2043–2062, indicating a decline in productive assets.

Cash outflows (benefit payments) reached a peak in 2023 (IDR 4,461.81 billion in total) and gradually declined. The total outflow in 2023–2042 amounted to IDR 70,377.20 billion, the 2043–2062 period decreased to IDR 20,764.45 billion. This front-loaded pattern is consistent with the freezing characteristics because there are no new participants.

Net cash flow (Table 2) was entirely negative in 2023 (total -IDR 1,486.64 billion) and the 2023–2042 period (total -IDR 34,629.72 billion). In 2043–2062, Dapen B, C, L, O recorded positive, but the majority remained negative. This shows that the cash flow deficit is structural and accumulative, which if not addressed will accelerate the decline of assets.

Table 2
Net Cash Flow (IDR billion)

Pension Fund	**Peak Statistics**			**Projected Total Retirement Benefits**	
	2023 Payment*)	Peak Year	Peak Value	2023–2042	2043–2062
Pension Fund A	1.743,4	2023	1.743,4	28.179,1	6.392,0
Pension Fund B	1.623,9	2023	1.623,9	24.997,8	8.650,8
C Pension Fund	132,8	2023	132,8	2.344,4	927,9
D Pension Fund	267,1	2023	267,1	3.487,0	547,2
Pension Fund E	180,2	2023	180,2	2.709,7	576,4
F Pension Fund	30,9	2023	30,9	601,0	420,1
G Pension Fund	78,7	2023	78,7	1.431,0	700,5
H Pension Fund	81,6	2023	81,6	1.484,2	728,2
Pension Fund I	123,5	2023	123,5	2.198,9	954,6
J Pension Fund	29,8	2023	29,8	493,4	207,8
K Pension Fund	70,7	2023	70,7	1.078,8	316,7
L Pension Fund	60,5	2023	60,5	729,1	97,1
M Pension Fund	20,3	2023	20,3	338,2	126,5
N Pension Fund	8,0	2023	8,0	147,2	78,1
O Pension Fund	3,5	2023	3,5	52,1	12,5
P Pension Fund	6,4	2023	6,4	92,8	20,3
Q Pension Fund	0,1	2023	0,1	2,4	2,7
R Pension Fund	0,4	2023	0,4	7,0	4,2

Source: Data processed 2026
*) shows projections based on certain actuarial assumptions.

Projected Cash Flow Inflows and Outflows

Initial funding ratios vary: Dapen R (136%), L (108%), O (115%), C (116%); lowest Dapen P (37%), F (25%). During the projection, only 4 pension funds (B, C, L, O) maintain FR >100% until 2062. Meanwhile, 14 other pension funds are in the negative zone (FR <0%) between 2027–2053. *The* Summary Heatmap (Table 3) shows the negative starting point:

- Rapid pressure (2027): Dapen F and P
- Medium pressure (2034–2042): Dapen K (2034), H (2036), I (2038), D and Q (2041)
- Long-term pressure (2043–2053): Pressure A, G, R, N, E, J, M

Table 3
Funding Pressure Classification

Pressure Groups	**Pension Fund**	**Year Start Negative**	**Remarks**

Quick pressure	F and P Pension Funds	2027	Being negative in the first five years of the projection period
Medium pressure	K, H, I, Q, and D Pension Funds	2034–2042	Become negative before the end of the 2023–2042 period
Early long-term stress	Pension Funds A, G, R, N, E, and J	2043–2049	Starts negative at the beginning of the period 2043–2062
Further long-term stress	M Pension Fund	2051	It only becomes negative in the middle of the long-term period
Relatively safe	Pension Funds B, C, L, and O	-	Stays above 100% throughout the projection period

Discussion

Demographic Structure of Participants as the Main Factor in Pension Fund Funding Pressure

The results of the study showed that the majority of participants in the 18 Employer Pension Funds of the Defined Benefit Pension Program (DPPK PPMP) that were the research sample were in the age group of 56-75 years with a proportion of around 65% of the total participants. In addition, the average proportion of retirees has reached 74% of the overall participants, and some pension funds even have a proportion of retirees of up to 95%. These findings indicate that most pension funds that have experienced membership freezing are in a very high maturity phase. In these conditions, the obligation to pay pension benefits becomes increasingly dominant compared to the ability of pension funds to generate new cash flows from active participant contributions.

The variation in demographic maturity across pension funds in this study is not incidental but reflects the diverse industrial origins of fund founders: banking sector funds (e.g., Pension Funds B and C), which historically absorbed younger employees and maintained more balanced age structures, demonstrate better funding resilience. Conversely, mining and manufacturing sector funds (e.g., Pension Funds A and P), which achieved workforce stability earlier and stopped hiring, exhibit the most severe demographic aging. This sectoral differentiation has important regulatory implications: risk-based supervision frameworks should incorporate industry-sector-specific demographic benchmarks rather than applying uniform thresholds.

This phenomenon explains why most pension funds in the study are under increasing funding pressure year after year. When the number of active participants continues to decrease due to retirement and there are no new participants entering, the source of income derived from contributions becomes smaller and smaller until it eventually stops. On the contrary, the number of beneficiaries continues to grow as the age of the participants increases. This condition creates a structural imbalance between cash inflows and cash outflows that gradually erode the ability to fund pension funds. These findings are in line with the research of El Moutaki (2026) which states that retirement age and demographic structure are the most sensitive factors in determining the sustainability of the long-term pension system.

From an actuarial perspective, the structure of participants dominated by the elderly group causes the obligation to pay benefits to be front-loaded or concentrated in the initial period of the projection. This can be seen from the high benefit payments in the 2023-2042 period compared to the next period. This condition shows that the greatest pressure on pension fund liquidity actually occurred in the first two decades after the membership freeze was implemented. These findings strengthen the argument that pension fund management cannot rely solely on current solvency measurements, but must consider changes in the composition of participants that will affect future benefit payment needs (Shim et al., 2022).

Cash Flow Deficit as a Direct Result of Membership Freezing

The projection results show that all pension funds in the study experienced negative net

cash flow in the initial period of the projection. Even in aggregate, total net cash flow during the 2023-2042 period remains in a deficit position. These findings show that freezing membership creates funding pressure that is systematic and accumulative.

These conditions can be explained through the basic characteristics of a definite benefit pension program. In this scheme, retirement benefits have been determined in advance so that benefit payments must still be made regardless of investment conditions or funding capabilities at that time. When no new participants enter, the pension fund loses one of the main sources of income in the form of normal contributions. As a result, the sustainability of funding becomes highly dependent on investment returns and the adequacy of previously formed assets.

The findings of the study show that only a small percentage of pension funds are able to maintain positive cash flow until the end of the projection period. On the other hand, the majority of pension funds have experienced a decline in their ability to generate sufficient investment income to cover their benefit payment obligations. This condition is in line with the view of Khorasanee (2002) who stated that the cash flow approach is the most effective instrument to identify the sustainability risks of pension funds because it is able to show when funding imbalances begin to occur.

In terms of risk management, the condition of the continuous cash flow deficit will put pressure on the liquidity of pension funds. Managers may be forced to sell investment assets before maturity or cash out long-term investment instruments to meet benefit payment needs. This decision has the potential to reduce long-term investment returns and accelerate the decline in pension fund funding conditions.

The Role of Funding Ratio in Determining the Resilience of Pension Funds

Evidence from the projection data indicates that pension funds with a high initial funding ratio tend to be able to maintain better funding conditions than pension funds with low funding ratios. Pension funds that have a funding ratio above 100% at the beginning of the projection period show a better ability to deal with the pressure of benefit payments than pension funds that have been underfunded since the beginning.

These findings show that the adequacy of initial assets is one of the factors that most determine the success of pension funds in dealing with membership freezing conditions. Pension funds that have adequate assets have greater room to develop investments and absorb the pressure of benefit payments in the long run. On the other hand, pension funds that have experienced funding shortages from the beginning tend to enter critical conditions faster.

The results of this study support the findings of the OECD (2025) which highlights that one of the main challenges of the pension fund system in Indonesia is the low quality of long-term funding in some definite benefit pension funds. In addition, the results of the study also strengthen the argument of Zhao & Sutcliffe (2024) who explain that freezing membership changes the risk profile of pension funds because all future liabilities must be supported by assets that are already available at the time of the freeze.

These findings have important implications for pension fund managers and corporate sponsors. The decision to freeze membership should not only consider short-term financial conditions, but should also be based on an evaluation of the adequacy of assets in the long term. Without adequate asset reserves, freezing can actually accelerate funding pressure.

Investment Returns as the Main Sustainer of Funding Sustainability

Research shows that the ability to generate investment income is the main differentiating factor between pension funds that are able to survive and pension funds that experience a significant decline in funding conditions. In a relatively healthy pension fund, investment results are still able to generate sufficient cash flow to support benefit payments. On the other hand, pension funds that are under funding pressure show a decrease in the contribution of investment returns to the total income of pension funds. This finding has a critical implication: investment performance functions as a substitute source of funding income once contribution flows cease, fundamentally shifting the character of investment management from a growth function to a liability-matching function. The relative performance differences between pension funds in this study can be partly attributed to differences in portfolio allocation strategies—funds with higher fixed-income allocations demonstrated more stable but lower returns, while equity-heavier

portfolios showed higher variance, creating potential liquidity risks during market downturns.

These findings show that in the condition of membership freezing, the investment function changes from just an asset development instrument to the main source of funding sustainability. Therefore, investment strategy is very important in determining the future of retirement funds.

The results of this study are consistent with the research of Bernardino et al. (2025) which affirms the importance of integrating asset management and liabilities in maintaining the sustainability of pension funds. In addition, Moreira et al. (2026) stated that optimizing an investment portfolio can improve the ability of pension funds to face long-term obligations.

However, the results of this study also show that a good investment strategy is not always enough if the pension fund already has an overmature participant structure and limited initial assets. In other words, optimal investment must be supported by adequate assets and a healthy funding structure in order to have a significant impact on the sustainability of pension funds.

Identifying Tipping Points as New Research Contributions

One of the important findings in this study is the ability to identify tipping points when pension funds begin to enter negative funding conditions. The projection results show that the timing of the critical point varies from 2027 to 2053.

These findings make a different contribution than most previous studies that focused more on solvency evaluation or investment strategies. Previous research has generally described funding conditions in a given period without indicating when funding risks begin to emerge in real terms (Bernardino et al., 2025). Instead, the study was able to pinpoint specific periods when pension funds began to experience significant pressure.

The existence of information about tipping points is very important for regulators and pension fund managers because it allows the preparation of mitigation strategies before critical conditions actually occur. Thus, corrective action can be taken earlier and more directed.

Implications of Mitigation Policies and Strategies

Based on the results of the research, there are several strategies that can be done to improve the sustainability of pension funds that have experienced membership freezing. First, pension fund managers need to make regular cash flow projections to identify potential funding pressures early on. Second, the implementation of Asset Liability Management (ALM) needs to be strengthened so that investment strategies can be aligned with the characteristics of retirement benefit obligations (Jang et al., 2024).

Third, pension fund sponsors need to increase additional funding commitments in pension funds that show indications of a significant decrease in funding ratio. This step is important to prevent underfunded conditions that can interfere with the payment of benefits to participants. Fourth, regulators need to develop a risk-based surveillance system that utilizes cash flow projection indicators and funding ratio development as part of the Early Warning System (EWS) mechanism.

If these recommendations are implemented, the benefits that can be obtained are not only in the form of increasing the stability of pension funds, but also protecting the welfare of participants and retirees. The sustainability of pension benefit payments will support the achievement of sustainable development goals, especially reducing the risk of poverty in old age and improving the social welfare of the community as stated by (Syam Budi Bakroh & Hiilamo, 2025).

Overall, this study shows that the sustainability of definite benefit pension funds in conditions of membership freezing is determined by the interaction between the demographic structure of participants, the adequacy of initial assets, and the ability of investments to generate long-term income. Therefore, pension fund management in the future needs to adopt a more proactive, projection-based, and integrated approach so that funding risks can be anticipated before they develop into problems that threaten the sustainability of pension benefit payments.

CONCLUSION

This study analyzed the funding sustainability of Employer Pension Funds with Defined Benefit Pension Programs (DPPK PPMP) experiencing membership freezing by employing long-

term cash flow projections, funding ratio analysis, and funding pressure mapping. The findings demonstrate that membership freezing fundamentally weakens funding sustainability because contribution inflows continue to decline while long-term pension benefit obligations remain. Funding resilience is determined not only by the adequacy of initial assets but also by participant demographics, pension fund maturity, and the ability of investment returns to support future liabilities. Pension funds with a high proportion of retirees and limited asset capacity reached critical funding conditions much earlier than those with stronger financial positions. Methodologically, this study contributes by integrating deterministic cash flow projections with funding ratio heatmapping, providing an anticipatory framework for identifying funding risks beyond conventional point-in-time solvency assessments.

The results imply that evaluating pension fund sustainability requires a long-term perspective rather than relying solely on current solvency indicators. The proposed analytical framework can support risk-based supervision and strategic decision-making by enabling earlier identification of funding deterioration and facilitating timely mitigation measures, including strengthened Asset Liability Management, periodic cash flow projections, and funding recovery planning. Although the study provides practical insights for pension fund governance, its findings are limited by deterministic assumptions and the exclusion of stochastic market dynamics, operational costs, and potential changes in benefit policies. Future research should incorporate sensitivity analysis, stress testing, and stochastic simulation models to produce a more comprehensive assessment of long-term funding sustainability and financial resilience.

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AUTHOR CONTRIBUTION STATEMENT

Conceptualization, F.P. and Z.A.H.; Methodology, F.P. and Z.A.H.; Formal Analysis, F.P. and Z.A.H,; Investigation, F.P. and Z.A.H.; Resources, F.P.; Data Curation, F.P.; Writing – Original Draft Preparation, F.P. and Z.A.H.; Writing – Review & Editing, F.P. and Z.A.H.; Visualization, F.P. and Z.A.H.; Supervision, Z.A.H.; Project Administration, F.P.

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