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From Defined Contribution Plan to Defined Benefit Plan: Modelling a Retirement Fund for a Few Case Studies in Malaysia

(Daripada Pelan Caruman Tertakrif kepada Pelan Manfaat Tertakrif: Memodelkan Dana Persaraan untuk Beberapa Kajian Kes di Malaysia)

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ABSTRACT

Defined benefit (government pension) and defined contribution (Employee Provident Fund (EPF)) plans are Malaysia's two main types of mandatory retirement plans. The discontinuation of pension eligibility for newly appointed permanent civil servants has raised concerns about retirement income sustainability. This study models a defined contribution retirement fund for future retirees in Malaysia by estimating the accumulated retirement fund at retirement, projected monthly pension amounts, and the duration of retirement fund adequacy. A financial mathematics approach implemented in RStudio is applied using salary structures for individuals with *Sijil Pelajaran Malaysia* (SPM), diploma, and degree qualifications. The results show that a higher educational background yields larger accumulated retirement funds, estimated at RM701,494, RM910,827, and RM1,273,478 for SPM, diploma, and degree holders, respectively, at the baseline 5% annual return assumption. However, larger retirement funds do not necessarily mean longer sustainability. Degree holders are projected to sustain their funds for only 24.8 years, compared with diploma holders (26.4 years) and SPM holders (28.1 years), due to higher pension withdrawals. Sensitivity analysis indicates that retirement fund adequacy is highly responsive to investment returns. Estimated fund duration ranges from 10.7 to 14.7 years at a 3% return rate but exceeds 100 years under most scenarios at a 7% return rate. Higher lump-sum withdrawals generally reduce fund sustainability, particularly under lower return rates. The results highlight the importance of prudent withdrawal strategies and effective retirement planning to support long-term retirement adequacy.

Keywords: Annuity; defined benefit; defined contribution; pension; retirement fund

ABSTRAK

Pelan manfaat tertakrif (pencen kerajaan) dan caruman tertakrif (Kumpulan Wang Simpanan Pekerja (KWSP)) ialah dua jenis pelan persaraan mandatori utama Malaysia. Pemberhentian kelayakan pencen bagi penjawat awam tetap yang baharu telah menimbulkan kebimbangan mengenai kemampanan pendapatan persaraan. Kajian ini memodelkan dana persaraan caruman tertakrif untuk bakal pesara di Malaysia dengan menganggarkan dana persaraan terkumpul semasa persaraan, unjuran jumlah pencen bulanan dan tempoh kecukupan dana persaraan. Pendekatan matematik kewangan dilaksanakan menggunakan RStudio berdasarkan struktur gaji individu dengan kelayakan Sijil Pelajaran Malaysia (SPM), diploma dan ijazah sarjana muda. Keputusan menunjukkan bahawa latar pendidikan yang lebih tinggi mengumpul dana persaraan yang lebih besar dianggarkan sebanyak RM701,494, RM910,827 dan RM1,273,478 masing-masing bagi pemegang SPM, diploma dan ijazah, pada asas andaian pulangan tahunan 5%. Walau bagaimanapun, dana persaraan yang lebih besar tidak bermakna kemampanan yang lebih lama. Pemegang ijazah diunjurkan mengekalkan dana mereka hanya selama 24.8 tahun, berbanding pemegang diploma (26.4 tahun) dan pemegang SPM (28.1 tahun), berikutan pengeluaran pencen yang lebih tinggi. Analisis sensitiviti menunjukkan bahawa kecukupan dana persaraan sangat responsif terhadap pulangan pelaburan. Anggaran tempoh dana antara 10.7 hingga 14.7 tahun pada kadar pulangan 3% tetapi melebihi 100 tahun di bawah kebanyakan senario pada kadar pulangan 7%. Pengeluaran sekali gus yang lebih tinggi secara amnya mengurangkan kemampanan dana, terutamanya di bawah kadar pulangan yang lebih rendah. Hasil kajian menekankan kepentingan strategi pengeluaran berhemat dan perancangan persaraan yang berkesan untuk menyokong kecukupan persaraan jangka panjang.

Kata kunci: Anuiti; dana persaraan; faedah tertakrif; manfaat tertakrif; pencen

INTRODUCTION

Retirement plans are an important component of individual financial planning, especially for those who plan to retire with economic stability. In Malaysia, defined benefit (DB) and defined contribution (DC) pension plans are the two main mandatory retirement schemes. DB plans, as offered to civil servants, provide guaranteed monthly pension payments based on final salary and years of service. DC plans such as the Employees Provident Fund (EPF) accumulate contributions from employees and employers, which can then be withdrawn as a lump sum to support retirement years. However, the pension amount received cannot be ascertained and depends on investment performance and any withdrawals made by the employee.

The differences between DC and DB plans create a dilemma for individuals planning their retirement. The Malaysian government's announcement that new and permanent civil servants are no longer eligible for the pension scheme (Parzi 2024) has raised concerns among future retirees, particularly regarding the absence of a stable monthly pension. Unlike DC plans, in which retirement savings can be depleted over time through withdrawals and investment risks, DB plans provide lifelong financial security (Bovenberg & Nijman 2019; Iyengar & Ma 2016). This situation calls for a deeper study of DC plans' implications for the finances of future retirees in Malaysia.

This study aims to model DC retirement funds for future retirees in Malaysia by focusing on several case studies, including service gratuity and monthly pension. The study develops an integrated financial modelling framework to estimate retirement fund accumulation, pension payments, lump-sum withdrawals, and sustainability under a DC scheme. A financial mathematical approach is applied to calculate the retirement fund at retirement age, determine the monthly pension amount that may be obtained, and estimate how long the funds can last to support retirement years, focusing on three educational backgrounds, namely *Sijil Pelajaran Malaysia* (SPM), diploma, and degree.

RETIREMENT SYSTEM

The context of retirement financial planning studies often compares DB and DC systems due to their differing approaches to risk management and pension provision. Extensive studies have examined the pros and cons of both plans to improve retirement systems and ensure income stability for retirees. Some countries have developed comprehensive retirement systems that serve as useful benchmarks for others. This section reviews past studies comparing DB and DC plans and highlights some of the best retirement systems adopted in other countries.

DEFINED BENEFIT AND DEFINED CONTRIBUTION PLANS

The shift from DB to DC pension systems has been a significant global trend as populations age and financial sustainability among future retirees becomes a concern. Past studies highlight that this transition affects retirement age, pension adequacy, and cost efficiency. Sweeting (2018) notes that DB plans have become increasingly costly for employers in the United Kingdom (UK) due to longer life expectancy and lower discount rates. In contrast, the absence of age-related incentives in DC plans may lead to later retirement (Friedberg & Webb 2005; Hurd & Rohwedder 2011) and shift greater responsibility for retirement savings to employees (Bond & Doonan 2020; Webber 2019).

Previous studies have also discussed the impact of pension systems on retirement age. Tyrowicz, Makarski and Bielecki (2016) find that gradual increases in retirement age do not significantly reduce welfare in DB or DC systems. Makarski and Tyrowicz (2019) discuss that although the welfare effects of raising the retirement age differ between DB and DC plans, they are generally comparable. Manchester (2010) further found that differences in pension wealth accumulation between DB and DC plans contribute only modestly to differences in expected retirement age and retirement behaviour. This implies that failing to account for such mechanisms may lead to overestimation of the impact of pension plan changes on retirement decisions.

Some studies suggested combining DC and DB plans to improve retirement savings. Alonso-García, Boado-Penas and Devolder (2018) and Moeis et al. (2022) suggest combining DB and DC elements to balance pension adequacy, fairness, and sustainability. Bovenberg and Nijman (2009) further propose collective pension schemes that share risks and manage costs more efficiently, while Lachance, Mitchell and Smelters (2003) propose a buy-back option for employees to revert to a DB structure. However, further research is necessary to evaluate how such hybrid models could be effectively implemented. In pension reform, key factors such as portability and asset price risks that influence the comparative attractiveness of DB versus DC schemes (Chen & Uzelac 2015), along with employee behaviour, must be identified to prevent negative outcomes like reduced public employment attractiveness (Clark, Hanson & Mitchell 2016).

INTERNATIONAL BEST PRACTICES IN PENSION DESIGN

The Netherlands ranked first in the Mercer CFA Institute Global Pension Index 2024 for having the best retirement system, due to its balance of adequacy, sustainability, and integrity (Mercer 2024). Its system consists of three pillars. The first pillar, the General Old-Age Pensions

Act (AOW) is a state pension funded by tax revenues based on social welfare principles and acts as a basic income (Pension Federation 2025). The second pillar consists of mandatory employer contributions to employees' pension funds. Private pension, as the third pillar, is voluntary savings to supplement retirement income. Although most of the Dutch pension system is a DB system, it is not a pure DB system, but a hybrid system combining DB up to a certain salary level and DC to secure pension income above that level (Sibylle J.M. Reichert n.d.). The state retirement age is 67 this year and will gradually increase to keep pace with rising life expectancy, which currently stands at nearly 82 years (CBS 2024).

Similarly, Iceland applies a three-pillar approach consisting of social insurance, occupational pension, and supplementary savings (Government of Iceland n.d.). The social insurance system is a means-tested tax-financed public pension that provides supplementary pensions, where the benefits can reach 70% of average earnings (Gudmundsson 2003). The occupational pension is a compulsory system funded by a total contribution of 15.5% of wages (11.5% employers and 4% employees) (OECD 2023) to replace 50-60% of pre-retirement income (PFO 2024). The third pillar offers additional financial security to individuals' retirement savings. The retirement age is 67, with flexibility to receive monthly pension payments earlier or later under certain conditions (Nordic Co-operation n.d.).

Likewise, Denmark's retirement system ranks third due to its three-pillar approach (Mercer 2024). The public old-age pension, as the first pillar, offers a universal basic income, financed through tax and administered on a pay-as-you-go (PAYG) basis to address economic gaps among pensioners. The second pillar, the labor market pension, is a mandatory DC scheme that covers all employees through fund-specific contribution rates, depending on the wage agreement (Danish Ministry of Finance 2020). The third pillar is voluntary private pensions to encourage additional retirement savings among employees through tax incentives. The monthly amount received under the state pension depends on factors such as retirement age, marital status, and work status, and is adjusted annually. The public retirement age gradually increased between 2019 and 2022, alongside rising life expectancy (DSV 2022). Denmark's pension assets, exceeding 200% of Gross Domestic Product (GDP), are among the highest internationally, underscoring its ability to minimize income disparity in retirement and reflecting effective fund management practices (OECD 2024).

Singapore's Central Provident Fund (CPF) ranked first in Asia and consists of three main accounts. The Ordinary Account (OA) is set up for retirement, housing, insurance, and investment. The Special Account (SA) is focused on old age and investments in financial products for retirement. The third account, the MediSave Account (MA), is intended for hospital costs and recognized health insurance. Another account, the Retirement Account (RA), will be created when the employee reaches age 55 for monthly pension payouts. The contribution rate from the monthly wages differs based on the employee's age, ranging from 12.5% for employees above 70 to 37% for those aged 55 and below (CPFB 2024). The current minimum retirement age is 63, while the re-employment age is up to age 68 (MOM 2024). Meanwhile, the life expectancy is 83 in 2023 (DOS 2024).

COMPARATIVE INSIGHTS FOR MALAYSIA'S PENSION SYSTEM

The Netherlands, Iceland, Denmark, and Singapore represent exemplary retirement system models. They employ a multi-pillar system that combines public pensions, mandatory occupational contributions, and voluntary private savings. Their goal of providing high replacement rates can serve as a benchmark for Malaysia to create a more sustainable and equitable pension framework while reducing reliance on a single scheme.

The Dutch hybrid retirement system of DC and DB elements ensures adequacy through tax-funded state pensions and mandatory employer contributions. The retirement age linked to life expectancy exemplifies adaptability to demographic changes. On the other hand, Iceland's pension fund, financed by joint contributions of employers and employees, supplemented by means-tested public pension, emphasizes a strong occupational pension in addition to helping all workers, especially low-income earners, receive at least a minimum amount of pension benefits. Denmark demonstrates effective fund management and equitable retirement outcomes with its universal basic income and highest pension asset-to-GDP ratios globally. Singapore's CPF excels in retirement schemes in Asia by offering a financial approach to fulfil an individual's basic living expenses and financial security in old age.

Comparatively, Malaysia's EPF aligns most closely with the second pillar of these countries as it focuses on mandatory contributions from employers and employees. Most Malaysian retirees heavily rely on their accumulated EPF savings since Malaysia lacks a robust first-pillar system equivalent to a universal state pension. Additionally, the EPF's adequacy is a concern as over 90% of the EPF members under 30 do not have basic savings of RM240,000 by retirement age (KRI 2024), and 48% of the members aged under 55 have less than RM10,000 (Bernama 2023), which caused the depletion of their retirement savings within a decade of retirement (EPF 2021). Malaysia's EPF, which focuses on a DC model, lacks the guaranteed income characteristics of DB plans as seen in the previous four countries discussed. A feature that can be incorporated into Malaysia's EPF is annuitization or a higher contribution rate like Singapore's CPF to ensure lifelong retirement income, or inflation-indexed benefits

like Iceland to ensure stable purchasing power among retirees throughout retirement time. Besides, Malaysia can implement policies by giving additional tax incentives to encourage delayed retirement, mandating supplementary contribution schemes, or fostering private savings to boost financial readiness. Thus, this study will model DC funds into DB funds that can offer lump-sum withdrawals and monthly retirement benefits for retirees in Malaysia.

METHODOLOGY

This study applies a financial mathematics approach to model defined contribution retirement funds for future retirees in Malaysia using RStudio. The model will focus on several cases, viz., service gratuity and monthly pension, by calculating the retirement fund amount at retirement age, determining the monthly pension amounts, and estimating the duration for which the fund can sustain pensioners' retirement period. The data used for modelling includes the initial salary based on the average starting salaries for individuals with *Sijil Pelajaran Malaysia* (SPM), diploma, and degree qualifications in Malaysia, and annual salary increments for each educational category based on the Malaysian remuneration system for public service sector members, also known as *Sistem Saraan Malaysia* (SSM), as specified in the *Pekeliling Perkhidmatan Bilangan 1 Tahun 2016 Jabatan Perkhidmatan Malaysia* (JPA 2016).

The modelling in this study employs several assumptions and limitations. First, the employment and retirement periods are assumed to be 35 years and 25 years, respectively. The employment period is chosen with the expectation that individuals in Malaysia will begin their careers at age 25 and retire 35 years later, according to the current mandatory retirement age of 60. Meanwhile, the retirement period of 25 years is assumed to be reasonable, given the average life expectancy of Malaysians at approximately 75 years (DOSM 2024). Thus, an estimated retirement period of 25 years is deemed reasonable to reflect financial needs throughout post-retirement life, considering potential increases in future life expectancy.

Next, the individual is assumed to be promoted three times during employment in the eighth, sixteenth, and twenty-second years. This assumption of career progression is based on the structured and time-based promotion system observed in the Malaysian public education sector under the Ministry of Education Malaysia. In this system, teachers advance through established grades (e.g., DG41, DG44, DG48, and DG52), where progression is determined by years of service and performance evaluation (Ministry of Education Malaysia 2025). These promotion points are adopted as a simplified yet representative trajectory to reflect a realistic pattern of career advancement, given the teaching profession's consistency and transparency compared to other public sector occupations. Consequently, annual salary increments are assumed to vary according to the individual's current grade level. Nevertheless, the proposed modelling framework can be applied to other occupations by adjusting the relevant parameters.

For the monthly pension, it is assumed that retirees will receive 60% of their final monthly salary as the first-year monthly pension, reflecting the maximum pension replacement rate in the Malaysian public sector (JPA 2022), with a 2% increment annually. The increment is used as a modest adjustment to account for inflation and cost of living over time, as adopted by the Organisation for Economic Co-operation and Development (OECD 2025). In addition, a lump sum of money is assumed to be withdrawn from the total accumulated contribution at the time of retirement to reflect the 7.5% service gratuity received by government servants (JPA 2022). To account for variations in individual financial needs and withdrawal behaviour at retirement, withdrawal rates ranging from 5% to 20% are considered. This range is adopted to capture conservative and higher withdrawal patterns for purposes such as immediate consumption, debt settlement, or unforeseen expenses, while remaining within a reasonable and realistic range for retirement withdrawals. These assumptions enable a more comprehensive analysis of retirement fund adequacy and the projected pension outcomes.

CONTRIBUTION MODEL WITH SALARY INCREMENT

The total accumulated amount of the retirement fund at the time of retirement is denoted as H and calculated based on the total contribution rate of 24% (13% from the employer and 11% from the employee) from the monthly salary, B and salary increment, D where n_i represents the years the employee has been in the particular salary grade. Since the employee is assumed to be promoted three times during employment, in the eighth, sixteenth, and twenty-second employment years, thus, $n_1 = 8$, $n_2 = 8$, $n_3 = 6$, $n_4 = 13$, where the total employment year is denoted by $n = 35$. The value of t refers to the number of times the individual remains in the particular salary grade. For example, in this study, the individual is promoted three times, thus $t = 4$ (including the time before promotion). The monthly salary, B increases by the salary increment amount, D forms an annuity with varying payments in arithmetic progression, $B_i s_{\overline{n_i}|} + D_i \frac{s_{\overline{n_i}|} - n_i}{f}$ as in Equation (1). The accumulated value for each salary grade must be calculated separately and multiplied with $(1+f)^{n-\sum_{j=1}^{i} n_j}$ for compounding to the time of retirement. The variable f represents the annual interest rate set at 5%, which is considered reasonable as it aligns with the EPF's average dividend rate (EPF 2024). The values will be summed up and multiplied by 12 to denote the annual contribution as shown in Equation (1).

TABLE 1. Total contribution amount accumulated during retirement

Educational background	Initial monthly salary (RM)	Yearly salary increment (RM)	Final monthly salary (RM)	Total contribution (RM)	Initial monthly pension (RM)
SPM	1,352	100	5,242	701,494	3,145
	2,252	115			
	3,057	125			
	3,682	130			
Diploma	1,698	145	7,098	910,827	4,259
	2,848	155			
	3,933	165			
	4,758	195			
Degree	2,188	225	10,343	1,273,478	6,206
	3,763	250			
	5,513	270			
	6,863	290			

Whereas Equation (2) represents the accumulated value of the monthly salary and salary increment used in Equation (1).

$$H = 12 \times 0.24 \times \sum_{i=1}^{t} \left[B_i s_{\overline{n_i}|} + D_i \frac{s_{\overline{n_i}|} - n_i}{f} \right] (1+f)^{n - \sum_{j=1}^{t} n_j} \quad (1)$$

where

$$s_{\overline{n_i}|} = \frac{(1+f)^n - 1}{f} \quad (2)$$

RETIREMENT FUND BALANCE WITH PENSION FUND INCREMENT PER YEAR

The accumulated amount of the retirement fund after m retirement years is calculated using Equation (3), factoring an annual investment rate of return of r earns from H during the retirement period. The value of r is assumed to be equal to f (5%) since both values represent the interest earned as the dividend from the EPF. The amount will be calculated for each 5-year retirement gap, in which m is equal to 5, 10, 15, 20, and 25.

$$H(1+r)^m \quad (3)$$

Assuming that the monthly pension fund, C increased by an annual rate of pension increment, k which is assumed to be 2% each year during the retirement period, the amount of the pension fund, P consumed after m year is:

$$P = 12C \frac{R^m - 1}{\mathrm{R} - 1} \quad (4)$$

where

$$R = \frac{1+k}{1+r} \quad (5)$$

At the end of each m retirement years, the remaining balance of the retirement fund can be determined by deducting the amount of pension fund used by the retiree, P (as calculated from Equation (4)) from the retirement fund amount accumulated at m retirement years calculated in Equation (3). This leads to Equation (6).

$$H(1+r)^m - P \quad (6)$$

Instead, if the retiree withdraws a lump sum of q from the amount of H at the time of retirement, the new fund balance will be calculated using Equation (7). The lump sum withdrawal rate q is assumed to take the value of 5%, 10%, 15%, and 20%.

$$(H - qH)(1+r)^m - P \quad (7)$$

ESTIMATED DURATION OF RETIREMENT FUND ADEQUACY

Instead of calculating the fund balance after a certain year of retirement, Equation (8) can estimate the expected time frame of the retirement fund adequacy from the accumulated contribution fund at the time of retirement throughout the employment period.

$$H = \frac{12C}{1+r}\left(\frac{1-R^m}{1-R}\right) \quad (8)$$

Rearranging Equation (8) to ease the calculation of the estimated duration will result in Equation (9).

$$m = \begin{cases} \dfrac{\ln\left[\left(1-\dfrac{H(1+r)}{12C}\right)(1-R)\right]}{\ln R}, & if\ 1-\dfrac{H(1+r)}{12C}(1-R) > 0 \\ > M, & if\ 1-\dfrac{H(1+r)}{12C}(1-R) \le 0 \end{cases} \quad (9)$$

Equation (9) estimates how long the retirement fund can sustain pension payments before depletion. In cases where the fund remains positive under certain combinations of retirement savings, withdrawal rates, and annual return assumptions, an extended projection horizon of M = 100 years is adopted. Durations exceeding this horizon are reported as >100, indicating that the fund is not depleted within the projection period under the model assumptions. For lump-sum withdrawals, H in Equation (9) is replaced by $H(1 - q)$. Sensitivity analyses using return rates of 3% and 7% were also conducted to test the robustness of results under conservative and optimistic investment scenarios, respectively.

RESULTS AND DISCUSSION

This section presents and discusses the results, focusing on the effects of educational backgrounds, salary increments, and lump-sum withdrawals on retirement fund adequacy. All monetary values are reported to the nearest Ringgit Malaysia (RM).

CONTRIBUTION AMOUNT WITH SALARY INCREMENT

Table 1 presents the total contribution accumulated over 35 years of employment for individuals with SPM, diploma, and degree qualifications, based on Equation (1). The accumulation reflects differences in initial salary, annual salary increments based on the SSM salary scale (JPA 2016), and the estimated final salary. The initial monthly pension is assumed to be 60% of the expected final salary, which will be increased by k = 2% annually.

Individuals with SPM, diploma, and degree qualifications are estimated to accumulate RM701,494, RM910,827, and RM1,273,478, respectively. The results indicate that higher educational attainment leads to higher lifetime earnings and, consequently, larger retirement fund accumulation. This proves that education plays an important role in shaping financial capacity during retirement, although other factors, such as expenditure and healthcare costs, may also influence fund adequacy.

RETIREMENT FUND BALANCE WITH PENSION FUND INCREMENT PER YEAR

The retirement fund balance is calculated at five-year intervals, assuming a 25-year retirement period under two scenarios: (a) no lump-sum withdrawal and (b) lump-sum withdrawal rates ranging from 5% to 20% of the accumulated retirement fund at retirement. Scenario (a) is calculated using Equations (4) to (6) or Equation (7) when q = 0%, while scenario (b) is calculated using Equation (7).

The results in Table 2 show that higher withdrawal rates significantly reduce retirement fund balances across all educational backgrounds. The fund remains sufficient for up to 25 years without withdrawals for SPM holders, but turns negative under higher withdrawal rates. Similar patterns are observed for diploma and degree holders, where larger initial balances do not prevent earlier depletion when withdrawals are applied. In particular, withdrawal rates of 15%-20% result in substantial deficits before the end of the retirement period.

Although individuals with higher educational backgrounds begin with larger retirement funds, these balances still become negative under higher withdrawal rates. For diploma holders, the fund depletes more quickly even at a 5% withdrawal rate, while higher rates (15%-20%) lead to substantial deficits, with balances reaching -RM352,332 and -RM506,551 after 25 years, respectively. A similar trend is observed for degree holders, despite having the highest initial fund (RM1,273,478). The larger contributions from higher salaries are insufficient to offset the effects of lump-sum withdrawals, with fund balances depleting more rapidly and turning negative in less than 20 years under a 20% withdrawal rate.

Figure 1 illustrates the retirement fund balance without lump-sum withdrawal, showing a positive correlation between education level and fund balance during the first 20 years of retirement. Individuals with higher education levels maintain larger balances due to higher salaries and annual increments. However, the final five years indicate a higher risk of fund depletion, particularly among degree holders. Despite their larger initial balances, higher spending levels may accelerate the depletion of retirement savings and reduce fund adequacy. This is consistent with evidence that higher-income individuals tend to exhibit higher expenditure patterns (DOSM 2022) as higher disposable income and favourable income expectations generally support stronger household spending patterns (Immordino, Jappelli & Oliviero 2023; Mustafa 2025). Besides, retirees typically require 70% to 80% of pre-retirement income to maintain a comparable standard of living (Binswanger & Schunk 2012; Tur-Sinai & Spivak 2022), while expenditure patterns are also shaped by individual perceptions, which may result in either higher or consistent spending levels (Crawford, Karjalainen & Sturrock 2022).

These findings highlight the importance of effective retirement financial planning. Without adequate planning, individuals, particularly those with higher education, may face a depletion of funds before the end of their retirement period. This also suggests that individuals with lower income levels should be equally aware of the need for careful retirement planning.

A consistent decline in retirement fund balances is also observed in Figure 2 across all educational categories with varying lump-sum withdrawals. As withdrawal rates increase from 5% to 20%, fund balances decline more rapidly, indicating that the withdrawal strategy plays a critical role in determining fund longevity. While higher withdrawals may provide immediate financial relief, they significantly shorten the retirement fund's lifespan. Although higher education contributes to a larger retirement fund, lump-sum withdrawals weaken long-term sustainability. Hence, more comprehensive retirement planning, such as increasing contributions, diversifying investments, and limiting early withdrawals, is important to reduce the risk of fund depletion.

ESTIMATED DURATION OF RETIREMENT FUND ADEQUACY

The analysis of retirement fund adequacy duration was conducted using Equation (9), under two scenarios: (a) without a lump-sum withdrawal and (b) with a lump-sum withdrawal rate ranging from 5% to 20% of the accumulated contribution at retirement. As shown in Table 3, individuals with higher educational attainment exhibit shorter fund-adequacy durations despite having larger accumulated retirement funds. Under the baseline annual return rate of 5%, the estimated duration without lump-sum withdrawals is 28.1 years for SPM holders, compared with 26.4 and 24.8 years for diploma and degree holders, respectively.

This outcome can be attributed to higher pension withdrawals associated with higher income levels. Since monthly pensions are assumed to be a fixed proportion of final salary, individuals with higher levels of education receive larger pensions, resulting in faster depletion of retirement savings. Although degree holders accumulate larger retirement funds, their higher pension replacement amounts accelerate fund drawdown. This is consistent with the life-cycle consumption framework, which links spending patterns to income trajectories, particularly under stable pension income in retirement (Blanchett & Finke 2025; Immordino, Jappelli & Oliviero 2023).

The sensitivity analysis shows that retirement fund adequacy is highly responsive to the assumed annual return rate. At a 3% return, the estimated duration ranges from 10.7 to 14.7 years, increasing to between 18.2 and 28.1 years under the baseline 5% scenario. This improvement reflects the compounding effect of higher returns, which increases both the accumulated retirement

TABLE 2. Retirement fund balance

Educational background	Initial retirement fund (RM)	Lump-sum withdrawal (%)	Retirement fund balance after *m* years (RM)				
			5	10	15	20	25
SPM	701,494	0	678,675	627,005	536,166	392,746	179,355
		5	633,910	569,872	463,249	299,682	60,580
		10	589,145	512,739	390,331	206,618	-58,195
		15	544,380	455,606	317,413	113,555	-176,971
		20	499,615	398,473	244,495	20,491	-295,746
Diploma	910,827	0	869,110	785,335	644,703	427,997	110,326
		5	810,987	711,153	550,026	307,162	-43,894
		10	752,863	636,971	455,349	186,328	-198,113
		15	694,740	562,789	360,672	65,493	-352,332
		20	636,616	488,607	265,994	-55,342	-506,551
Degree	1,273,478	0	1,197,845	1,056,825	827,722	481,086	-21,199
		5	1,116,580	953,107	695,348	312,140	-236,821
		10	1,035,314	849,389	562,975	143,194	-452,444
		15	954,048	745,671	430,601	-25,752	-668,066
		20	872,782	641,953	298,228	-194,697	-883,688

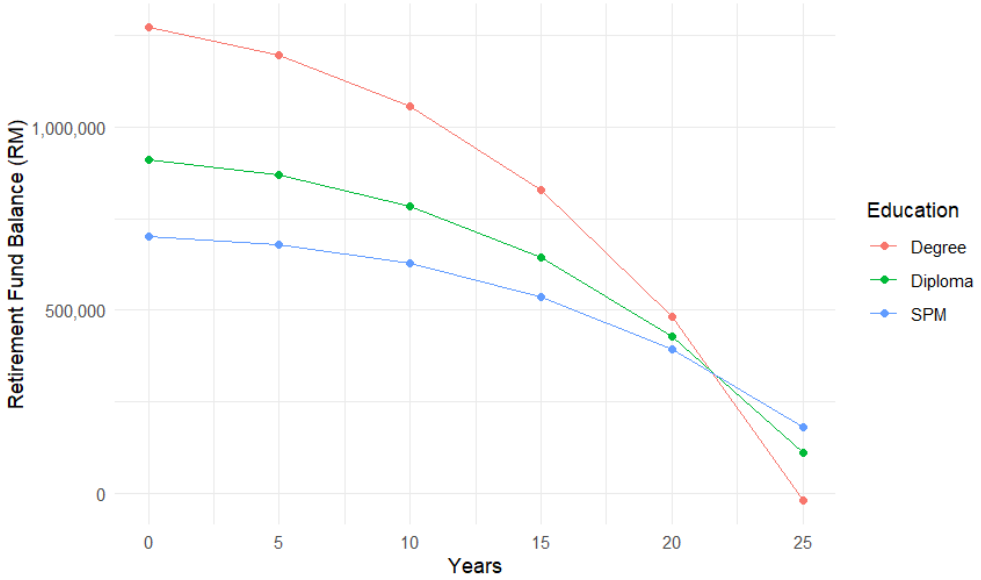
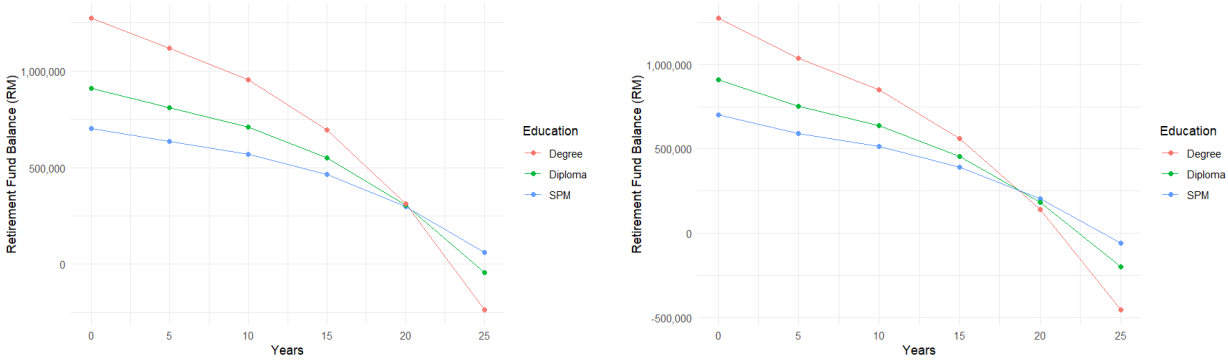
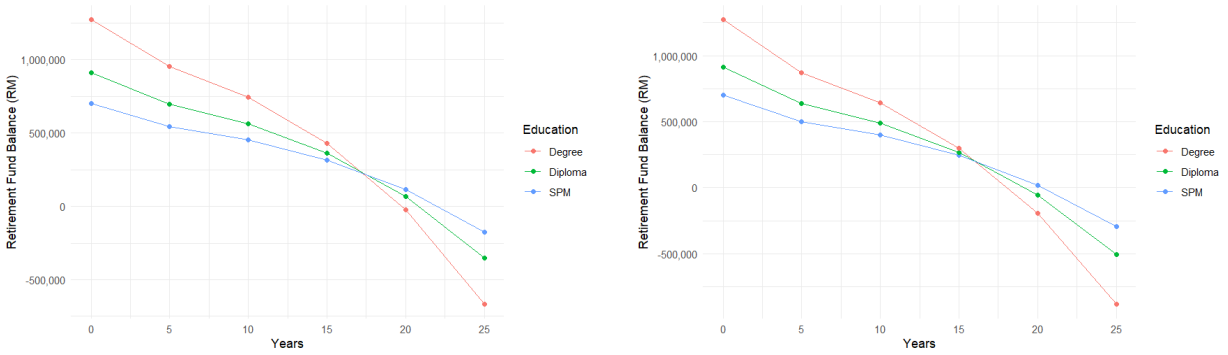


FIGURE 1. Retirement fund balance without lump sum withdrawal



a) 5% withdrawal

b) 10% withdrawal



c) 15% withdrawal

d) 20% withdrawal

FIGURE 2. Retirement fund balance with lump sum withdrawal

TABLE 3. Estimated duration of fund adequacy

Educational background	Annual return rate (%)	Total retirement fund (RM)	Lump-sum withdrawal rate (%)				
			Estimated fund duration (years)				
			0	5	10	15	20
SPM	3	504,515	14.7	13.9	13.1	12.4	11.6
	5	701,494	28.1	26.0	24.0	22.2	20.4
	7	1,003,163	>100	>100	>100	>100	>100
Diploma	3	656,873	14.1	13.3	12.6	11.9	11.1
	5	910,827	26.4	24.5	22.6	20.9	19.3
	7	1,299,403	>100	>100	>100	>100	>100
Degree	3	924,044	13.6	12.9	12.1	11.4	10.7
	5	1,273,478	24.8	23.1	21.4	19.8	18.2
	7	1,805,770	>100	>100	>100	>100	73.2

fund at retirement and investment income during retirement. For example, the accumulated retirement fund for SPM holders increases from RM504,515 at 3% to RM701,494 at 5%, and RM1,003,163 at 7%. As pension payments increase at only 2% annually, higher return rates widen the gap between investment income and pension growth, slowing fund depletion.

The effect of compounding is most evident under the 7% return scenario, where the retirement fund remains positive throughout the 100-year projection period for most educational categories and withdrawal scenarios. The only exception is degree holders at a 20% lump-sum withdrawal, where the estimated duration is 73.2 years. These findings suggest that retirement sustainability depends not only on the size of the accumulated retirement fund but also on long-term investment performance. Higher return rates increase the fund's capacity to support withdrawals and partially offset the adverse effects of early lump-sum withdrawals.

Consistent with previous studies (Anarkulova et al. 2025; Leggio, Lien & Dai 2024), higher lump-sum withdrawals generally shorten retirement fund adequacy duration. Under the baseline 5% return, a 20% withdrawal reduces the duration by approximately 4 to 8 years compared with the no-withdrawal scenario. This highlights the trade-off between immediate liquidity needs and long-term financial sustainability, underscoring the importance of prudent withdrawal decisions and realistic return assumptions in retirement planning.

The findings are subject to certain limitations, as factors such as healthcare costs, household expenditure patterns, and economic uncertainties were not incorporated into the model and may influence fund adequacy in practice. Future studies are encouraged to examine these variables to provide a more comprehensive assessment of retirement sustainability. Nevertheless, the results emphasize the need for more strategic retirement planning approaches to address rising living costs and fluctuations in investment returns. In this regard, financial literacy programmes, effective planning strategies, and supportive government policies may play a crucial role in extending the adequacy and sustainability of retirement funds.

CONCLUSION

This study showed that educational level plays a significant role in determining retirement fund accumulation and the duration of adequacy. Individuals with higher educational qualifications generally earn higher salaries and accumulate larger retirement funds, but they also experience shorter adequacy periods due to higher pension withdrawals. Sensitivity analysis further demonstrates that retirement fund adequacy is highly responsive to investment performance, with substantially shorter fund duration at 3% return rate and considerably improved sustainability at 7% return rate.

Lump-sum withdrawals generally reduce retirement fund sustainability, particularly under lower-return assumptions. These findings highlight the importance of prudent withdrawal decisions, realistic return assumptions, and early financial planning to support long-term retirement adequacy. They also suggest that current contribution structures and investment returns may be insufficient to meet future retirement needs under less favourable investment conditions. This calls for enhanced strategies, including increasing contribution rates, improving investment incentives, and educating the public about the importance of managing retirement funds as early as possible during career years.

The findings also carry important policy implications. Policymakers and relevant authorities, such as the EPF and the Ministry of Finance are encouraged to review contribution structures and consider more flexible or

tiered mechanisms aligned with income levels and demographic changes. In addition, efforts to promote sustainable withdrawal strategies, expand access to diversified investment options, and discourage premature lump-sum withdrawals via incentive-based mechanisms should be strengthened. Employers may further support these initiatives through workplace financial literacy programmes.

Future studies should incorporate additional factors such as inflation, healthcare costs, and retirees' spending behaviour to provide a more comprehensive assessment of retirement adequacy. The impact of policy changes, such as increasing contribution rates or mandatory pension age, could also be explored to assess their implications on retirement fund sustainability. Further studies focusing on specific demographic groups, including women, low-income earners, and informal sector workers, would also help to identify gaps in the retirement system and propose more targeted solutions.

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