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Investigating the Sensitivity Effect of Actuarial Assumptions on Pension Liabilities in Malaysia

***Rose Irnawaty Ibrahim*[1*]** ***Norazmir Mohd Nordin*[1]** ***Mohd Zaki Awang Chek*[2]**

[1] Faculty of Science & Technology, Universiti Sains Islam Malaysia (USIM), Nilai, 71800, Malaysia.
[2]Center for Actuarial Studies, Faculty of Computer & Mathematical Sciences, Universiti Teknologi MARA (UiTM), Tapah Campus, Tapah Road, 35400 Tapah, Perak, Malaysia
[*]Corresponding author: rose.irnawaty@usim.edu.my [*], norazmir@usim.edu.my , mohdz220@uitm.edu.my
[*]ORCID ID: https://orcid.org/0000-0002-8393-5455 [*] , https://orcid.org/0000-0003-4488-2482 , https://orcid.org/0000-0003-4271-053X

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Abstract:

Malaysia will be an ageing population by 2030 as the number of those aged 60 years and above has increased drastically from 6.2 percent in 2000 and is expected to reach 13.6 percent by 2030. There are many challenges that will be faced due to the ageing population, one of which is the increasing cost of pensions in the future. In view of that, it is necessary to investigate the effect of actuarial assumptions on pension liabilities under the perspective of ageing. To estimate the pension liabilities, the Projected Unit Credit method is used in the study and commutation functions are employed in the process. Demographic risk and salary risk have been identified as major risks in analyzing pension liabilities in this study. The sensitivity analyses will be conducted in the study to investigate how the pension liabilities will be affected when these major risks changes. This study analyzes nine scenarios under assumptions in the actuarial model, namely age of retirement, rate of mortality and rate of salary growth. The result of this study indicates that the implied mortality experience and salary growth rate assumptions have a significant impact on pension liabilities.

Key words: Actuarial assumptions, Ageing, Pension liabilities, Projected Unit Credit method.

Introduction:

Many countries including Malaysia are facing a rapidly ageing population as the proportion of those aged 60 years and above has increased from 5.2 percent in year 1970 to 5.7 percent in year 1990, and it is expected to increase about 9.8 percent by 2020 and 13.6 percent by 2030. There are many challenges that come with an ageing population, one of which is the increasing cost of pensions in the future. The cost of pensions to be borne by the government is a long-term commitment, where the government has to pay monthly pensions to retirees and their dependents for the rest of their lives. Thus the pensions financial stability becomes priority when the number of retirees and their dependents increases with times (1- 3). Also as the elderly population is growing in many countries, the need to evaluate pension schemes and social security is becoming more urgent as the current pension system is expected to become unsustainable (4).

The ageing population has a significant impact on the survival of the public pension system and it is also a serious problem when associated with the pay-as-you-go (PAYG) pension schemes. Many countries including Malaysia have a public pay-as-you-go (PAYG) pension system. In this sense, PAYG pension schemes are the most sensitive pension schemes to longevity and ageing effects. According to report from the Ministry of Finance Malaysia, the Malaysian government's pension costs have increase drastically from RM4 billion and over in 2000 to RM26 billion in 2019, which is six times higher compared to 20 years ago (5). According to previous studies (6, 7), they point out that the PAYG pension schemes in East-Asian region countries are also expected to face fiscal imbalances in the near future.

In view of this, it is necessary to investigate the effect of actuarial assumptions on pension liabilities under the perspective of ageing. To

proceed with such an assessment, two sets of factors must be considered: demography and economy (8). Pension liabilities represent the present value of future benefit payments that have already been earned by employees.

In order to predict employee turnover and the number of employees who will be eligible for retirement benefits, demographic assumptions should be used. A study by (9) stated that demographic uncertainty would have a significant impact in the long-term benefits. They also concluded that impact of changes in mortality trends on pension sustainability requires in-depth study in the future. In addition, the study by (10) in Germany using demographic assumptions also show that demographic changes have significant impacts on the pension benefit levels in the long-term. To overcome the demographic challenges caused by the ageing population, Engels et al (11) and De Wind et al (12) suggested that to increase the statutory age of retirement in the future, as this will indirectly keep the public PAYG pension system financially strong in the long term.

In addition, economic assumptions are used to forecast growth in the future value of pension benefits and to calculate the present value of those future payments. Economic assumptions include inflation rates, discount rates, and salary growth rates. Kitamura et al. (13) used the Asset-Liability Model (ALM) with stochastic simulation to analyze the Public Employees' Pension Scheme in Japan. The variables used in this model, such as price growth rates, wage growth rates, and pension fund investment return rates to assess the appropriateness of indexing rules, which impact the future benefit levels and financial conditions of the scheme. Therefore, the objective of this study is to investigate the effect of actuarial assumptions on pension liabilities due to ageing using the Projected Unit Credit method.

Method of Study:

There are several funding methods, with all having the same ultimate goal of guaranteeing that there will be enough funds to pay the pension benefits when they come due. There are six actuarial methods that are normally used in determining retirement benefits liability which are Method of Projected Unit Credit, Method of Aggregate, Method of Entry Age, Method of Frozen Entry Age, Method of Attained Age, and Method of Frozen Attained Age (14).

However, this study will focus only on the Projected Unit Credit method. This method attempts to fund the "true" present value of the benefits, as they accrue, no spreading of costs. This method considers the pensionable salary projected to the retirement age and depends on the years of service of the participant at the assumed retirement age. The Projected Unit Credit (PUC) method divides the total pension benefits at the normal retirement age by the total length of service into a unit of pension benefit unit which is then allocated to each year during the period of employment (15).

To estimate the pension liability, the Projected Unit Credit method will be used in the study. According to Aitken (16) and Kotamaki (17), the benefits of retirement at age r can be expressed as follows:

$$B_r = k' \, S_{r-1}' \left(r - e\right)$$

Given the assumption of last salary as $S_{r-1} = \left(\frac{S_{r-1}}{s_x}\right) S_x$, so that:

$$\begin{aligned} B_r &= k \, S_{r-1}\left(r - e\right) \\ &= k\left(\frac{S_{r-1}}{s_x}\right) S_x \left(r - e\right) \\ &= k \times \left(1+S\right)^{r-1-x} S_x \times \left(r - e\right) \end{aligned}$$

While the retirement benefits of individual age x can be expressed as follows:

$$\begin{aligned} B_x &= k \, S_{r-1}\left(x - e\right) \\ &= k\left(\frac{S_{r-1}}{s_x}\right) S_x \left(x - e\right) \\ &= k \times \left(1+S\right)^{r-1-x} S_x \times \left(x - e\right) \end{aligned}$$

where;
= Standard age of retirement;
x = Age at the time of valuation;
e = Participant's entry age;
k = Percentage of retirement benefits;
S = Percentage of salary increases.

Then, the Pension Liability calculation for individual age x who started working at age e can be written as follows:

$${}^{r}\left(PL\right)_x = k\left(1+S\right)^{r-1-x} S_x \left(x-e\right) \frac{D_r^{(\tau)}}{D_x^{(\tau)}} \, \ddot{a}_r^{(12)}$$

where;
$\ddot{a}_r^{(12)}$ = The present value of 1 payable 12 times at the beginning of each year to a life aged x;
$D_r^{(t)}$ and $D_x^{(t)}$ are the commutation functions.

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In this study, the commutation functions for single life are defined as:

$$D_x = v^x l_x \quad \text{and} \quad N_x = \sum_{t=0}^{\omega} D_{x+t}$$

By assuming a participant's actual salary at age x is S_x with increases of 6% each year, and the plan provides a retirement benefits of 2% of final salary for each year of service, the formula of Pension Liability for individual age x who started working at age 25 years is estimated as follows:

$$PL_x = 0.02 \times (1.06)^{r-1-x} S_x (x-25) \frac{D_r^{(\tau)}}{D_x^{(\tau)}} \ddot{a}_r^{(12)}$$

Then, to investigate how the pension liabilities will change when the relevant variable changes, the sensitivity analysis has been conducted in this study. The details of the sensitivity analysis are discussed in the next section. Finally, to investigate the sensitivity effect of relevant variable changes, the percentage reduction in Pension Liabilities for each scenario is calculated as follows:

$$PR_i = \left(\frac{PL_i - PL_{baseline}}{PL_{baseline}} \right) \times 100$$

where;

$PL_{baseline}$ = Pension Liabilities for scenario 1 (baseline);

PL_i = Pension Liabilities for scenario i;

$i = 2, 3, 4, \ldots, 9$.

Sensitivity Analysis:

There are many risks involved in pension plan, but these risks can be reduced or avoided with taking into account in the pension plan (18). In this study, the demographic risk and salary risk have been identified as major risks in analyzing pension liabilities. There are several sensitivity scenarios under various assumptions in the actuarial model such as retirement age; mortality rate and salary growth rate. These will be utilized in the study.

This study used the PUC method to estimate the pension liability under nine scenarios. The eight subsequent scenarios are involved with the changes for variables (retirement age, mortality improvement and salary growth). Summary of sensitivity tests is presented in Table 1.

Table 1. Summary of the sensitivity tests

Variable	Baseline value	Modified value
Retirement age	60	62 and 65
Mortality rate	Mortality rates for Malaysian population in year 2019	Reduced by 2% and 4%
Salary growth rate	6%	5% and 7%

Scenario 1 (baseline): Retirement age is 60 years; mortality rates for Malaysian population in year 2019 and salary growth rate of 6% will be used in this study.

Scenario 2: Retirement age increased to 62 years, mortality rates reduced by 2% and salary growth rate remains 6%.

Scenario 3: Retirement age increased to 65 years, mortality rates reduced by 2% and salary growth rate remains 6%.

Scenario 4: Retirement age increased to 62 years, mortality rates reduced by 4% and salary growth rate remains 6%.

Scenario 5: Retirement age increased to 65 years, mortality rates reduced by 4% and salary growth rate remains 6%.

Scenario 6: Retirement age increased to 62 years, mortality rates year 2019 and salary growth rate reduced to 5%.

Scenario 7: Retirement age increased to 65 years, mortality rates year 2019 and salary growth rate reduced to 5%.

Scenario 8: Retirement age increased to 62 years, mortality rates year 2019 and salary growth rate increased to 7%.

Scenario 9: Retirement age increased to 65 years, mortality rates year 2019 and salary growth rate increased to 7%.

Results and Discussion:

This section discusses the sensitivity effect of changes to the age of retirement, rate of mortality and rate of salary growth. By changing the mortality rate variable and holding the salary growth rate at 6%, the percentage reduction in Pension Liabilities are computed. Table 2 presents the results of

percentage reduction in Pension Liabilities for scenario 2 – scenario 5.

Table 2. Summary percentage reduction in pension liabilities of changing the mortality rate assumption

	Males		Females	
	***r* = 62**	***r* = 65**	***r* = 62**	***r* = 65**
reduced 2%	5.89	15.58	2.91	8.18
reduced 4%	5.79	15.33	2.86	8.04

Source: Authors' Computation

As shown in Table 2, reducing the mortality rate by 2% and increasing the retirement age to 62 reduces the Pension Liabilities to around 5.89% and 2.91% for males and females respectively. While reducing the mortality rate by 4% and increasing the retirement age to 62 reduces the Pension Liabilities to around 5.79% and 2.86% for males and females respectively.

Also, it was found that reducing the mortality rate by 2% and increase the age of retirement to 65 reduces Pension Liabilities to around 15.58% and 8.18% for males and females respectively. While reducing the mortality rate by 4% and increase the age of retirement to 65 reduces Pension Liabilities to around 15.33% and 8.04% for males and females respectively.

Comparing the age retirement of 62 and 65 together, results indicate that the effect of mortality rate on age retirement 65 is significantly larger than of age retirement 62. The results imply that increasing the retirement age will reduce the Pension Liabilities more significantly.

In addition, the mortality assumption used in the calculation should be dynamic, including provision for future improvement in life expectancy. This is especially relevant in the case of pension plan estimates, which are carried out over periods of 50 years or more.

Aside from the mortality rate, the salary growth rate also plays key roles in adjusting pension liability. This study considers the impact on pension liability when the salary growth rate are reduced by 1% and increased by 1%. By changing the salary growth rate variable, and holding the mortality rate, the percentage reduction in Actuarial Liabilities for scenario 6 – scenario 9 is presented in Table 3.

Table 3. Summary percentage reduction in pension liabilities of changing the salary growth rate assumption

	Males		Females	
	***r* = 62**	***r* = 65**	***r* = 62**	***r* = 65**
***s* = 5%**	7.76	19.73	4.79	12.56
***s* = 7%**	4.21	11.79	1.13	3.91

Source: Authors' Computation

From Table 3, it was found that when the salary growth rate is decreased to 5%, and increase the age of retirement to 62, the percentage reduction in Pension Liabilities are 7.76% and 4.79% for males and females respectively. On the other hand, when the salary growth rate is increased to 7%, and increase the age of retirement to 62, the percentage reduction in Pension Liabilities are 4.21% and 1.13% for males and females respectively. This result shows that the effect of changes on salary growth rate is greater when it reduced by 1% instead of being increased by 1%.

And at retirement age 65, it was found that when the salary growth rate is decreased to 5%, the percentage reduction in Pension Liabilities are 19.73% and 12.56% for males and females respectively. While if the salary growth rate is increased to 7%, the percentage reduction in Pension Liabilities are 11.79% and 3.91% for males and females respectively.

In comparison of age retirement 62 and 65, results indicate that the effect of salary growth rate on age retirement 65 to be significantly larger than age retirement 62. The results imply that increasing the retirement age will reduce Pension Liabilities more significantly. Therefore, to reduce Pension Liabilities in the future due to ageing population, the Malaysian Government may consider an increase in the retirement age in the future.

Conclusion:

Demographic risk and salary risk have been identified as major risks in analyzing pension liabilities. The analysis of sensitivity was conducted in this study to investigate how the pension liabilities are affected when these major risks changes. There are nine sensitivity scenarios under various assumptions in the actuarial model such as retirement age; mortality rate and salary growth rate, which were analyzed in this study. The study indicates that the effect of mortality rate and salary growth rate on the age retirement of 65 is significantly larger than age retirement 62. The results imply that increasing the retirement age will reduce Pension Liabilities for all scenarios more significantly.

The results demonstrate that the government needs to extend the retirement age in the future following to ageing population. Based on the results, it is suggested that to improve the current scheme of pension, increasing the age of retirement is a mandatory requirement for newly appointed government employees.

Currently, the contribution rate of the Malaysia Government Pension is 17.5 %. This appears to be high given the future capacity of the financial support of the scheme. The current retirement age of the scheme (60) is relatively low compared to international standards. This does not take into account the fact that life expectancy is expected to increase significantly in the future.

From the age of 60, the estimated life expectancy for males and females are 15.9 and 18.8 years respectively for which is expected to rise to 19.4 and 22.3 years for males and females by 2050, respectively. It is a significant aspect that has led to an increase in the rate of the PAYG system over the years. It should then be rational to incorporate an aspect of uncertainty into the system by relating the retirement age to the estimated period of time an individual is likely to live, on average, the moment the individual retires.

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Authors' declaration:

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are mine ours. Besides, the Figures and images, which are not mine ours, have been given the permission for re-publication attached with the manuscript.
- Ethical Clearance: The project was approved by the local ethical committee in Universiti Sains Islam Malaysia.

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التحقق من تأثير الحساسية للافتراضات الاكتوارية على التزامات التقاعد في ماليزيا

روز ارناواتي ابراهيم نورزمير محمد نور الدين محمد زكي اوانج تشيك

[1]كلية العلوم والتكنولوجيا ، يونيفرسيتي سينس إسلام ماليزيا (USIM) ، نيلاي ، 71800 ، ماليزيا.
[2]مركز الدراسات الاكتوارية، كلية علوم الحاسب والرياضيات، جامعة مارا للتكنولوجيا(UITM) ، تاباه الحرم الجامعي، تاباه الطريق، 35400 تاباه، بيراك، ماليزيا

الخلاصة:

ستشهد ماليزيا شيخوخة السكان بحلول عام 2030 حيث زاد عدد الأشخاص الذين تبلغ أعمارهم 60 عامًا فما فوق بشكل كبير من 6.2 في المائة في عام 2000 ومن المتوقع أن يصل إلى 13.6 في المائة بحلول عام 2030. وهناك العديد من التحديات التي ستواجهها بسبب شيخوخة السكان أحدها التكلفة المتزايدة للمعاشات التقاعدية في المستقبل. في ضوء ذلك ، من الضروري التحقق في تأثير الافتراضات الاكتوارية على التزامات المعاشات التقاعدية من منظور الشيخوخة. ومن اجل تقدير مطلوبات المعاشات التقاعدية ، يتم استخدام طريقة انتمان الوحدة المتوقعة في الدراسة ويتم استخدام وظائف الاستبدال في العملية. تم تحديد المخاطر الديموغرافية ومخاطر الرواتب على أنها مخاطر رئيسية في تحليل التزامات المعاشات التقاعدية في هذه الدراسة. سيتم إجراء تحليلات الحساسية في الدراسة للتحقق في كيفية تأثر التزامات المعاشات التقاعدية عندما تتغير هذه المخاطر الرئيسية. تحلل هذه الدراسة تسعة سيناريوهات تحت افتراضات في النموذج الاكتواري وهي سن التقاعد ومعدل الوفيات ومعدل نمو الرواتب. تشير نتيجة هذه الدراسة إلى أن تجربة الوفيات الضمنية وافتراضات معدل نمو الرواتب لها تأثير كبير على التزامات المعاشات التقاعدية.

الكلمات المفتاحية: الافتراضات الاكتوارية، الشيخوخة، التزامات التقاعد، طريقة وحدة الائتمان المتوقعة.