International Journal of Engineering & Technology, 7 (4.33) (2018) 83-92

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Optimising Contribution Rate for SOCSO's Invalidity Pension Scheme: Actuarial Present Value (APV)

Mohd Zaki Awang Chek*, Isma Liana Ismail, Nur Faezah Jamal

Faculty of Computer and Mathematical Sciences (FSKM), Universiti Teknologi MARA, Perak Branch, Tapah Campus, Tapah Road, 35400 Perak, Malaysia
**Corresponding author E-mail: mohdz220@perak.uitm.edu.my*

Abstract

This study proposes the optimization of the contribution rate for Social Security Organization (SOCSO)'s Invalidity Pension Scheme (IPS). This study aims to statistically analyses the current situation of the contribution fund collection and the claim benefits payment under SOCSO's IPS. It seeks to develop an actuarial formulation based on the benefits coverage from SOCSO's IPS. It attempts to determine an optimal contribution rate to support the benefits provided under SOCSO's IPS using an actuarial approach. It proposes an appropriate contribution rate to be implemented by SOCSO. Currently, the contribution rate for SOCSO's IPS is 1%, which is shared equally between employer and employee. This contribution rate is directly deducted from the employee's monthly gross salary. This contribution rate needs to be adjusted upwards by SOCSO soon to ensure that all payments of claims are sufficiently covered. Based on the 9th Actuarial Valuation Report issued by the International Labour Organization (ILO), recent statistics show that immediate revision of contribution rate is necessary to achieve the minimum loss ratio (max 20%) in SOCSO's IPS funding systems. In this study, the Actuarial Present Value Approach is applied to all benefits under SOCSO's IPS. SOCSO data from 1985 until 2014 are used in this study. Seven assumptions are made in this study namely mortality rate, salary ceiling, interest rate, retirement age, increment salary rate, age entry, and salary entry. By optimizing the worst-case scenario (single simulation), this study has found that the optimal contribution rate is 2.2% rather than the current 1%. This can be attributed to the fact that since 1969, many changes have occurred in the workplace, working conditions are different and many new jobs have been created. Therefore, an Actuarial Present Value Approach with regards to actuarial modeling was conducted to optimize SOCSO's IPS contribution rate. In conclusion, an optimal contribution rate of 2.2% should be introduced and implemented in the future as part of the efforts to reduce society's burden whilst ensuring that adequate protection is provided to the nation's workforce.

Keywords: *APV; Contribution Rate; Invalidity Pension Scheme; Optimisation; SOCSO.*

1. Introduction

Every family desires to have a comfortable, trouble-free lifestyle, protected and shielded from any unforeseen events and accidents. Typically, families spend millions of dollars to protect themselves against the risk of calamities or accidents occurring [1].

Social security is defined as the protection which society provides for its members, through a series of public measures, against economic and social distress that would be caused by stoppage or substantial reduction of earnings resulting from sickness, maternity, employment injury, unemployment, invalidity, old age and death, and the provision of subsidies for families with children [2]. In [3] reported that nearly 90% of countries worldwide practice social security measures.

Employees are exposed to accidents within the workplace. Each job has its own unique risks and exposure to hazards. Risk management involves creating awareness of uncertainty, qualifying the risks, managing the controllable risks, and minimising the impact of uncontrollable risks by way of risk allocation [4].

In practical terms, this concept can be interpreted as economic protection against losses that may arise on the assets and earnings of employers or employees. For most of the people, insurance is the most practical method to mitigate these risks. Employees who are currently employed are usually covered by their home country's social insurance. The first broad system of social insurance was created by the Government of Germany under Chancellor Bismarck between 1883 and 1889. As far back as the 1850s, several German states helped local governments to set up sickness funds to which workmen could be compelled to contribute [5].

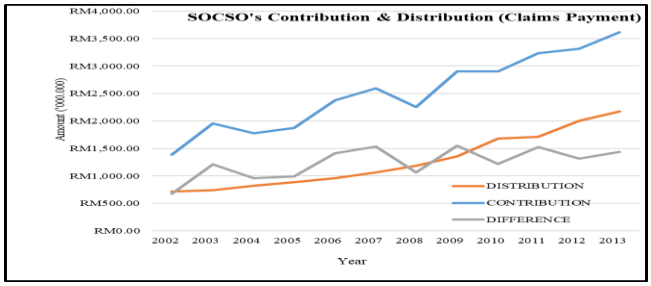

Fig. Error! No text of specified style in document.**:** Statistics Contribution and Distribution of SOCSO, 2002-2014

Figure 1 shows the total amount of contribution collected against benefits and claim payouts made by SOCSO from 2002 to 2013. SOCSO provides compensation to the eligible employees who receive lifetime pensions due to occupational uncertainties. This is one of the factors which has contributed to the drop in the SOCSO fund since 2008. Furthermore, the Minister also stated that

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SOCSO's contribution rate imposed on employers and employees in this country is low at 2.25% as compared to workers in other developing countries such as Thailand, Singapore, and Indonesia who have to contribute between 10 to 20 percent of their monthly incomes towards their social security funds [6].

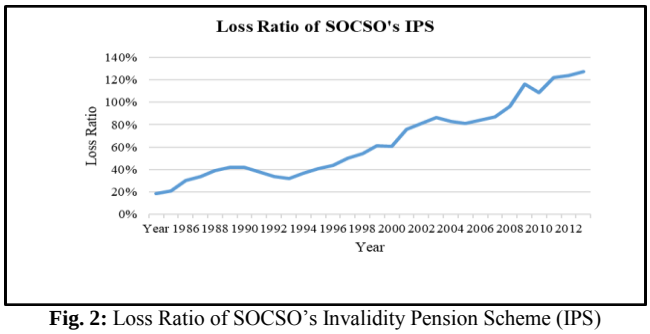

Fig. 2: Loss Ratio of SOCSO's Invalidity Pension Scheme (IPS)

Figure 2 shows the loss ratio, which is the rate of total SOCSO's IPS benefit against SOCSO's IPS main income from 1985 to 2014. The graph shows a fluctuating and increasing trend of this loss ratio throughout. This loss ratio indicates that the contribution is inadequate. Based on the guidance issued by the ILO, the loss ratio should be below 20% [7–9].

This situation is likely to be critical within the next five years (2009- 2013) as SOCSO's contribution rate has not been revised for the last 45 years. The current SOCSO fund may still be adequate for the short-term. Yet, considering that SOCSO also provides long- term coverage such as Temporary Disablement Benefit, Dependents' Benefit, Invalidity Pension Benefit, Survivors Benefit, and Constant Attendant Allowance, the ratio on excess amounts may drop to a seriously low level. Thus, considering the social obligation, within the Malaysian context, this study would form part of the research contribution to optimize SOCSO's contribution rate in order to ensure sufficient funds are available to meet future obligations.

In [4] described social insurance programmes as being programmes which provide individuals with protection against the adverse financial effects of demographic-based hazards (such as greater than expected longevity after retirement, disability, expensive medical treatment, and unemployment). It is thus event-conditioned.

In [4] also stated that in many countries, the benefits provided by the social insurance programmes are based on the current contributions collected. This implementation is necessary to ensure sufficient funds are available to fulfil short-term and long-term obligations as they may be needed to facilitate more effective personal financial planning in the future. In addition, most developing countries, including Malaysia, operate strictly on a Pay-As-You-Go (PAYG) funding system basis, where current contributions pay for today's benefits.

Currently, in Malaysia SOCSO administers two types of protection schemes, namely the Employment Injury Scheme (EIS) and the Invalidity Pension Scheme (IPS). Both schemes are effective once employers make contributions to SOCSO [10]. These contributions are taken from a certain percentage of an employee's monthly gross income.

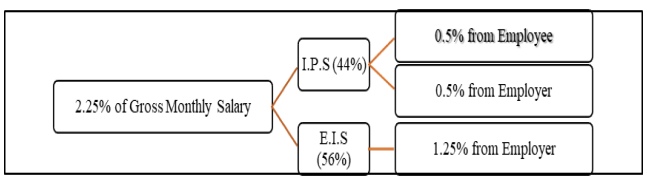

Fig. 3: SOCSO's Contribution Rate

The contribution rate considers the age of employees according to their date of birth. If the employee is less than 60 years old, the contribution rate is 2.25% of the employee's monthly gross income. These contribution rates are distributed into two schemes namely the EIS and the IPS at 1.25% and 1.0% respectively. Based on the contribution rate, payment of contribution is shared between the employer and the employee. Meanwhile, for an employee above the age of 60, the contribution rate is set at 1.25% of the employee's monthly gross income.

In 2013, the excess of claims amounted to RM4.5 billion, which was an increase of 19.7% from the previous year. Yet, the contributions only amounted to RM4.3 billion. Datuk Sri Dr. S. Subramaniam added that the yearly pattern of claims has been trending upwards for the last five years. Since 1969, many significant changes have occurred in the workplace. Working conditions have changed significantly and new jobs have been created due to advancements in technology. In many countries, a social gap has existed between the rich and the poor, between pension fund obligations and pension fund revenues, a gap that is projected to increase dramatically in the decades ahead. There is a general consensus among international pension policy analysts that there is a need to reduce, if not to close, the gap [11].

In fact, the findings of the study by ILO through the 9th Actuarial Valuation suggest that the contribution rate should be increased to offset the amount of claims [9]. SOCSO is still conducting a comprehensive study to determine the appropriate contribution rate.

This study seeks to fill the gap inherent in socio-economic environment for SOCSO's financial protection system within the context of the country's broader social security framework. As a single fund manager of social insurance created for the lower and middle income group in Malaysia, SOCSO is obligated to make sure that all future payments towards employees' claims be made regardless of any current and economic situation, as spelled out in the Employee Social Security Act 1969. To fulfil its obligations on all future claims of employees, SOCSO should have a dynamic and strong financial system. Despite this, the statistics in Figure 1 show that the IPS's fund collection is in deficit as compared to the amount it has paid out for claims.

According to the Risk Theory, if the fund or capital continues to drop, SOCSO will face bankruptcy. Therefore, this study seeks to steer SOCSO away from the risk of bankruptcy. This critical situation can be solved by improving the current SOCSO's IPS funding system. As suggested in this study, the funding system could be made more effective through an increase of the fund collection by raising the current contribution rate. The contribution rate is determined through recent social and economic data, such as current mortality rate and interest rate.

The empirical findings from the study revealed the appropriate contribution rate for SOCSO's IPS by using the Pay as You Go (PAYG) funding system currently utilised by SOCSO. It is also revealed that based on actuarial assessment, the suggested contribution rate would be sufficient for SOCSO to pay all future long-term and short-term claims under SOCSO's IPS. It will be financially favourable to SOCSO if the current IPS contribution collection increases over time in the future.

The empirical findings would be useful for SOCSO as a whole since this study adopts Actuarial Present Value (APV) approach. The estimated APV of Wage and APV of SOCSO's IPS used toward comprehensive contribution rate would serve as a reference or guideline for SOCSO in making future decisions. Based on the above scenarios, this study is conducted to optimise SOCSO's IPS using actuarial modelling through Actuarial Present Value (APV) approach.

2. Literature Review

2.1. Theoretical Framework

Social insurance is a social mechanism that allows individuals and governments to compensate economic losses caused by unfavourable events such as invalidity, death, and accidents. National actuaries develop actuarial models to gain better understanding of the theory involved in social insurance [12].

There exist numerous actuarial models of social insurance activity namely main models such as actuarial aggregate risk model or sometime known as Pay As You Go (PAYG) model [13]. The traditional tasks of actuarial modelling are valuation of social insurance contribution rate, 'ruin' probability, pension schemes, and total amount of claims [14].
In addition, the social insurance actuary must deal with uncertain future events and complex interrelated systems. To predict a possible future scenario for these events, the actuary uses a simplified representation of this reality, which is called a model. An actuarial model can be constructed using data from prior experiments, related phenomena, or judgment [8]. The actuarial model can be validated by comparing its findings to the actual outcomes of the phenomena being modelled. The inputs to a social security actuarial model comprise statistical data and assumptions on the future behaviour of critical variables [15].
The model builder must also consider the available tools to collect the data and run the statistical applications software [16]. The actuary must also consider the timing constraints and the resources available [17].
Prior literature showed that the appropriate contribution rate for long-term social insurance benefits has been structured around the modern risk theory framework introduced by Filip Lundberg in 1907. Whereas, the social insurance starts with lower contribution rate, it is safer to revise the contribution rate based on current working environment risks [8]. The illustrated theoretical framework used in this study are as follows:

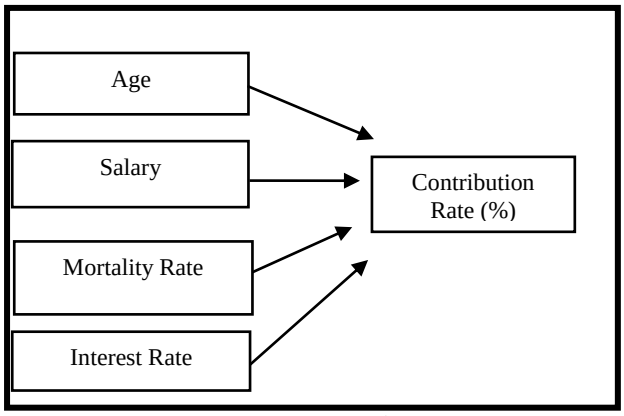

Fig. 4: Theoretical Framework of Contribution Rate

The contribution rate, being a dependent variable, is influenced by four independent variables, namely age, salary, mortality rate, and interest rate. The importance of all four independent variables are explained below, based on past literature. Through the evidence presented in this study, the appropriate contribution rate for SOCSO's IPS is proposed in the next section. A theoretical framework has been outlined in this section that may help to explain the variables that affect the appropriate contribution rate for SOCSO's IPS.

2.1. Dependent Variable

As can be seen in Figure 4, the dependent variable in this study is contribution rate. Theoretically, by increasing the contribution rate of SOCSO's IPS, the financial expenditures will increase simultaneously. For the current study, the contribution rate is chosen based on current practice by SOCSO and some other developed and developing countries [18].
Under an appropriate PAYG financial system, the long-term ensures that financing resources will be available to meet the projected benefits and administrative expenditure. The PAYG financial system determines the way contributions will be collected and accumulated over time. In addition, PAYG financial systems for long-term benefits such as Invalidity Pension Scheme can ensure actuarial equilibrium. Long-term benefits are assumed to be indefinitely in operation and there is generally no risk that the sponsor of the scheme will go bankrupt [19].
However, when the scheme is mature and the demographic structure of the insured population and pensioners is stable, the PAYG cost rate remains indefinitely constant. Despite the financial system being retained for a given scheme, the ultimate level of the PAYG rate is an element that should be known at the onset of the scheme. It is important for SOCSO to be aware of the ultimate cost of the benefit obligations so that the capacity of workers and employers to finance the scheme in the long-term can be estimated [20].
On top of that, the PAYG cost rate represents the ratio of expenditure over insurable earnings. It reveals the contribution rate in the absence of any reserves, just to support the current expenditure especially claims payment made under the scheme. This ratio calculates separately each expenditure of the scheme, both in the short-term and the long-term. A comparison of the PAYG rate with the actual contribution rate of the scheme may glaringly show the need for a rapid increase of the current contribution rate [21].

2.2. Factors Affecting Contribution Rate of Invalidity Pension Scheme

This section discusses the actuarial, social and economic factors leading to a variation in social insurance, identified in computational Actuarial Present Value of Salary and Benefits. These assumptions are the most common variables employed to optimise the contribution rate in previous computational Actuarial Present Value.
These are factors that influence claims payment of social insurance. Therefore, economic and demographic characteristics of the population can be easily measured and provide the most consistent and quantifiable measure on optimising Invalidity Pension Scheme contribution rate [22].

2.2.1. Mortality Rate

Ideally, mortality rate should be built from a scheme's experience. If the data are unavailable, or are not statistically credible, or if the scheme covers a large proportion of the total population of the country under study such as Malaysia, it is then appropriate to use the mortality rates of the general population [23].
According to [24], the general population shows a more stable pattern of mortality rates, although life expectancy is generally higher among the insured population. The only reliable set of mortality rates that can normally be developed from the statistics of a social security scheme relates to pensioners.
The effect on the contribution rate relating to survivors' pensions of a higher force of mortality will be different, and so will the effect on the contribution rate for invalidity pensions of a higher force of invalidity. This produces a mutually compensating effect in a comprehensive social security pension scheme covering all three risks of retirement, invalidity and premature death [1, 25].

2.2.2. Age

Another identifiable factor that drives contribution rate of social insurance is age namely entry age and retirement age. Different age groups in a population have different levels of disability, and therefore different cost of coverage and contribution rate, provided they can contribute based on their occupational risks. The ability to pay contribution is largely dependent on the benefit provisions of the social insurance system. The contribution rate differentials between population subgroups can generally be determined through statistical analysis. The population structure and the capacity of the entry age as well retirement age in the social insurance system are important factors which are likely to influence the claims payment coverage [17].
Moreover, the optimal contribution rate becomes more valid when deterministic actuarial approach based on expected values is used. It considers a pension scheme which operates without any funda-

mental changes such as significant modifications of the benefit provisions or appreciable expansion of its scope of coverage, except for a steady flow of new entrants. It is also assumed, as is generally the case, that persons already over retirement age at the outset of the scheme are not entitled to any benefit. The above assumes the worst case scenario which apply a fixed entry age for new entrants and a fixed retirement age. However, with regards to the complete data, the same reasoning can be applied to any other combination of entry and retirement ages in order for the contribution to be more accurate [26].

2.2.3. Salary

As found in many empirical studies, salary is the most important factor which influences the contribution rate for social insurance. Salary is used in occupational risk classification today irrespective of the nature of the work, especially in Malaysia and other developing countries. However, through actuarial valuation reports conducted by ILO actuary experts, it appears that they may look at the interaction of group salary and other potential social risk classification variables to achieve an optimal contribution rate for social insurance [21, 27].
In [21] discovered a positive link between the contribution rate and salary in both the lower and higher income groups of the USA and Europe.

2.2.4. Interest Rate

Actuarial interest rate is another factor that should be considered in calculating an optimal contribution rate of social insurance. Since actual interest rate fluctuates and changes remarkably over time, the actuarial rate should be assumed prudently, and with adequacy and solvency to support future claims payments [21, 28].
Again, social insurance providers are sensitive to interest rates because contribution collection that is constantly being remitted by contributors need to earn an adequate ROI and solvency has to be maintained to fulfil future claims [29–32].
By having concrete understanding and significant findings from previous literature about the factors affecting contribution rate for social insurance, this study is able to consider the same factors towards theoretical framework as stated in Figure 4, in order to optimize the contribution rate of SOCSO's IPS.

2.3. Actuarial Present Value Approach

The initial amount of the present value is less than the total amount of money paid back to the lender. Present value and future value calculations are used to value loans, mortgages, annuities, sinking funds, perpetuities, bonds, and many more financial instruments [33]. These calculations are used to compare between cash flows that do not occur at simultaneous times [34].
However, in actuarial science, the Actuarial Present Value of random variables is the expected value of the present value of the payments. Equivalently, it is also the present value of their expected values of incomes [1].
In addition, Actuarial Present Values are calculated for the payment or series of payments associated with life insurance and life annuities. In this case, the probability of a future payment is based on assumptions about a person's future mortality, taking into account the person's age and assumed life table, yet the present value of those future assumed payments depend upon the interest rate used to discount them in the passage of time [35–37].
Moreover, in [38] stated that the internal rate of return of a contract is the rate of return for which the Actuarial Present Value of all cash flows is zero. To calculate the Actuarial Present Value, we need to calculate the expected value of this random variable Z. For someone aged *x*, this is denoted as $\overline{A}_x$ in actuarial notation. It can be calculated as:

$$\overline{A}_x = E\left(v^T\right) = \int_0^\infty v^t \, f_T(t)dt = \int_0^\infty v^t \cdot {}_t P_x \cdot \mu_{x+t} \quad (1)$$

where f_T is the probability density function of T, ${}_t P_x$ is the probability of a life age x surviving to age $x+t$, and μ denotes force of mortality.
In [8], an expert actuary in social security from ILO, identified that the Actuarial Present Value technique is naturally suited to the valuation of occupational pension and insurance scheme. Nevertheless, this technique can provide additional financial insights and can therefore be a useful tool towards achieving better prediction. This technique will consider one cohort of insured persons at time and computes the probable present value of the insured salaries. On the other hand, it includes benefits payable to the members of the cohort as well as to their survivors.
By having a concrete understanding of the significant outcomes from previous literature about the Actuarial Present Value Approach, this study uses the same approach towards optimizing the contribution rate of SOCSO's IPS.

3. Methodology

3.1 General Model Formulation

Contributions to social health insurance systems are generally calculated on the basis of the principle of collective annual equivalence. In order to achieve the four objectives, the PAYG method has been used in this study, where the value is calculated by dividing the Actuarial Present Value of Benefits with Actuarial Present Value of Salary [8]. Based on the formulation of the model adopted in this study, the following general definitions were applied. Additional definition was presented as and when necessary. Let us assume:

(x) = A person aged x
j = Decrement cause, where j can assume the following:
1 – Invalidity
2 - Mortality (Death)
τ - All causes of decrement
Bj = Benefit for decrement cause j
${}_tPx^{(\tau)}$ = Probability (x) survives to time t
$tqx^{(\tau)}$ = Probability (x) will become a decrement due to cause j before time t
$\mu x+t^{(j)}$ = Force of decrement at time t due to cause j
(NC) = Number of contribution

All the above general definitions are used in this study. The Actuarial Present Value approach is used to optimise the contribution portion [39]. The portion of the Actuarial Present Value which is allocated to a valuation year is called the aggregate cost methods. Aggregate cost methods determine the time-related contribution rate function on a collective basis. The time-related contribution rate is the level rate which would ensure that the closed fund financial equilibrium of the scheme is achieved at the time [8, 40].

General Formula

$$C_i(t) = \frac{APVB_i(t)}{APVS_i(t)} \quad (2)$$

where
$C_i(t)$ = Time- related contribution rate function
$APVB_i(t)$ = Actuarial Present Value of Future Benefits of Existing Active Members.

$APVS_i(t)$ = Actuarial Present Value of Future Salaries of Existing Active Members

i_1 = Invalidity Pension Scheme (IPS)

3.2. Assumption Used in Calculations

The study adopts the Uniform Distribution of Death assumption and Mid-Point Rule throughout for all its calculations [41].
According to [1], this facilitates tedious calculations which allow simplified calculations and the calculations of contributions. The following assumptions were applied in this study:

1. employees include those aged 16 years old whose starting salary is RM 900.00;
2. there are no changes in the stipulated benefit coverage and stipulated eligibility conditions;
3. there are no natural disasters, epidemics and so on that can cause significant deviation in the simulation;
4. the retirement age is based on current practice, which is 60 years old;
5. the final gross monthly salary is RM3,000.00;
6. interest rate of 3 % is used in the calculation during the period of study;
7. constant salary increment is set at 6% per annum. In [37] stated that most actuarial calculations are based on simplifying assumptions, which determines that the discount function is constant over time; and

Benefit is excluded as this benefit is provided in loan terms. In the general formula, it is already considered as the amount which is part of the accumulated reserve fund. In addition, the amounts of loan are taken from the technical reserves [42].

3.2.1. Entry Age and Salary Assumptions

Based on SOCSO's dataset, the entry age of the youngest contributor is 16 years old. Therefore, the research assumes the entry age of 16 years throughout the study. In addition, the minimum wage is a measure for the financial well-being of a country's inhabitants. The minimum wages are adjusted to living expenses [43].
The wage distribution is right-skewed; most people earn less than the average wage. As an alternative measure, the Median household income apply the measurement of median instead of average. In the Malaysian context, the minimum wage for workers in Peninsular Malaysia has been set at RM900.00 a month or RM4.33 per hour while for Sarawak, Sabah and Labuan, the quantum is RM800.00 per month or RM3.85 an hour [44, 45].

3.2.2. Mortality Assumption

This study utilises the Malaysian Mortality Table, the M9903 (the 1999-2003 populations) instead of those currently used by insurance companies, namely the M8388 (the1983-1988 populations). It is the most updated data available and thus can produce greater accuracy. However, the M9903 is not utilised by insurance companies because the table is yet to be registered.

3.2.3. Interest Rate Assumption

In Malaysia's Pension Trust Fund, interest rate of 3% is used in the calculation of pension liabilities. With reference to Malaysia's Insurance Act 1996, interest rate of 5% is used to calculate insurance premiums and interest rate of 4% is used to calculate annuitant premiums [46].

3.2.4. Retirement Age Assumption

In line with the recent retirement age policy implemented by the Malaysian Government, SOCSO extended all long-term benefits and coverages as well as IPS to be applicable up to 60 years of ager [47]. Hence, for this study, the retirement age is set at 60 years old.

3.2.5. Increment Salary Rate Assumption

In [48] carried out a research to study the total rewards amongst non-executives in Malaysia. The average salary increment rate in Malaysia is estimated to be 6% percent per annum [49]. This percentage of average salary increment rate is used as a constant in this research.

3.3. Salary Model Formulation

In [50] stated that the employee's monthly contribution have being taken from a percentage of his monthly wages. The monthly wage itself is a function of time as the wage is adjusted yearly based on the salary's incremental rate. The employee's basic salary is derived from assumptions which are composed of the following:

C_i = Contribution rate as a percentage of an assumed monthly wage

MW = Monthly Wage, (Basic salary) $(1+r)^t$

t = the number of years employed

r = Salary increment rate

i_1 = Invalidity Pension Scheme (I. P. S)

Present Value of Future Salaries Active Members

$$12C_i \sum_{t=0}^{59-x} (MW)_{x+t} v^t {}_t p_x \tag{3}$$

3.4. Benefits Model Formulation

The proposed benefit model formulation is based on the regulations under from Act 4 Employees' Social Security (ESSA 1969), the legislation that has been enforced by SOCSO since 1971. According to [50], Invalidity Pension Schemes provide several types of protection, such as:

1. Invalidity Pension and Grant;
2. Survivors' Pension;
3. Constant Attendance Allowance;
4. Rehabilitation Benefit;
5. Funeral Benefit; and
6. Education Benefit.

Actuarial formulation of the above benefits is proposed accordingly in later sub-topics.

3.4.1. Invalidity Pension with Medical and Rehabilitation

In [50] stated that the Invalidity Pension is payable to an insured employee who suffers from permanent invalidity which causes him or her to be incapable of engaging in any significantly gainful employment and who has fulfilled certain contribution provisions. There are several conditions that should be satisfied to make a claim under this scheme, as listed below:

1. Invalid: as assessed by the Medical Board duly constituted under the legislation with loss of earning capacity between 90% and 100%;
2. Age of claimant is less than 60 years old; and
3. Fulfilled the qualifying number of contribution, either full or reduced (at least 24 continuous contributions within 40 months).

From the above information, the Invalidity Pension Model is created below.

Let
y = Claim by case
P(y) = Probability of the Loss of Earning Capacity
G(y) = Probability that Invalidity Pension at that Loss of Earning Capacity Require Rehabilitation
e = Rehabilitation benefit, expressed as a percentage of Invalidity Pension benefits
(NC) = Number of Contribution
$\ddot{a}$ = Actuarial Present Value factor for Invalidity Pension benefit

Benefit Function, B_1 :

B_1 = Benefit Function for Invalidity Pension + Benefit Function for Rehabilitation

= (NC) * y * P (y) * $\ddot{a}$ + e * G (y) * (NC) * y * P(y) * $\ddot{a}_x$

$= (NC) * y * P(y) * \ddot{a}_x * (1 + [e * G(y)])$

Conditions:
1. *NC* < 24: Invalidity Grant (contributions made with medical and rehabilitation benefits)
2. *NC* $\geq$ 24: gets benefit between 50% and 65% from the monthly salary

For each y,

$$\textit{Actuarial Present Value} = \int_0^{60-x} (B_1) v^t \, {}_t p_x \mu^2_{x+t} \, dt \quad (4)$$

$$\text{Let } t = k + s = \sum_{k=0}^{59-x} (B_1) \int_k^{k+1} v^{k+s} \, {}_{k+s} p_x^{\tau} \mu^2_{x+k+s} \, ds \quad (4a)$$

$$= \sum_{k=0}^{59-x} (B_1) \int_k^{k+1} v^{k+s} \, {}_k p_x^{\tau} v^s \, {}_s p_{x+k}^{\tau} \mu^2_{x+k+s} \, ds \quad (4b)$$

Assuming

$$1.\ \text{Uniform Distribution of Death} = \sum_{k=0}^{59-x} (B_1) v^k \, {}_k p_x^{\tau} \, q^2_{x+k} \int_0^1 v^s \, ds$$

$$2.\ \text{Mid Point Rule} = \sum_{k=0}^{59-x} (B_1) v^{k+\frac{1}{2}} \, {}_k p_x^{\tau} q^2_{x+k}$$

$$= \left[(each; y) \sum_{k=0}^{59-x} ((1 + \ell G(y)) y P(y) (NC)_{x+k} \ddot{a}_{x+k}) v^{k+\frac{1}{2}} \, {}_k p_x^{\tau} q \right]$$

; $NC \geq 24$

3.4.2. Constant Attendance Allowance

In [50] stated that the Constant Attendance Allowance is provided when an employee experienced an invalidity that has severely incapacitated him/her, leading him/her to require personal attendance of another person. The allowance is equal to 40% of the rate of the pension, subject to a maximum of RM500.00. For those experiencing at least 90% Loss of Earning Capacity due to Invalidity Pension, there may be a requirement for the personal attendance of another person. As such, for this benefit, a probability assumption of *P(c)* that the person requires constant attendance allowance is applied. Let

P(c) = Probability that a person who experiences 90% Loss of Earning Capacity due to Invalidity Pension require Constant Attendance

Benefit Function, B_2 = 40 %*(90 % Loss of Earning Capacity Invalidity)**P(c)*.

$$\text{Actuarial Present Value} = 0.36 B_2 \sum_{k=0}^{59-x} (NC)_{x+k} \ddot{a}_{x+k} v^{k+\frac{1}{2}} \, {}_k p_x^{\tau} q^2_{x+k} \quad (5)$$

3.4.3. Survivor Pension

In [50] stated that the Survivor Pension is payable to the primary or secondary dependents of an insured person who dies from whatever cause while in receipt of the invalidity pension, or who dies from whatever cause before attaining the age of 60 years but has satisfied the conditions of qualifying number of contribution either in full or reduced state (at least 24 continuous contributions within 40 months). The modelling of Survivors Benefit largely makes use of the family model assumption. The simplification resulting from the family model yields the following formulation:

Let
(NC) = Number of Contribution
$\ddot{a}$ = Actuarial Present Value factor for survivor benefit
Benefit function = $NC * \ddot{a}_x$

$$\text{Actuarial Present Value} = \sum_{k=0}^{59-x} (NC)_{x+k} \ddot{a}_{x+k} v^{k+\frac{1}{2}} \, {}_k p_x^{\tau} q^3_{x+k} \; ; NC \geq 24 \quad (6)$$

3.4.4. Funeral Fees

In [50] stated that Funeral Benefit is payable for the funeral of an insured employee who dies of an employment injury or while in receipt of disablement benefit or invalidity pension, or who dies before attaining the age of 60 years old but has satisfied the qualifying conditions. The amount given for funeral benefit is RM1,500.00. Modelling the funeral benefit involves the summing up of the Actuarial Present Value over the amount provided by SOCSO.

Benefit = RM1,500

$$\textit{Actuarial Present Value} = 1500 \sum_{k=0}^{59-x} v^{k+\frac{1}{2}} \, {}_k p_x^{\tau} q^3_{x+k} \quad (7)$$

3.4.5. Invalidity Grant

In [50] stated that the Invalidity Grant is paid to a member who does not meet the criteria for Invalidity Pension, particularly when the contribution qualifying condition of 24 months is not fulfilled, but has made at least 12 monthly contributions which are paid by the member and the employer for the IPS, including the interest thereof. The benefit formulation is as follows:

$$\text{Actuarial Present Value} = \sum_{k=0}^{59-x} (MW) \ddot{a}_{x+k} V^n \, {}_k P_x^{(\tau)} q^{(1)}_{x+k} \quad (8)$$

4. Results and Discussion

4.1. Computation Actuarial Present Value of Wage

In the computation of Actuarial Present Value of Wage, the following assumptions were used:
1. The employee is a male whose starting salary is RM900.00 at the age of 16;
2. The employee retires at the age of 60;
3. The employee is married with children; and
4. The employee receives a constant salary increment of 6% per annum.

Based on the above assumptions, the model below was applied to obtain the computation of Actuarial Present Value of Wage.

$$\text{Actuarial Present Value of Contributions} = 12C \sum_{k=0}^{59-x} (MW)_{x+k} v^k \, {}_k p_x$$

where *MW* = Monthly Wage
The computation of Actuarial Present Value of wage according to age. The calculation is based on salary increment of 6% from age 16 up to 60 years old.

4.2. Computation Actuarial Present Value (APV) of Invalidity Pension with Rehabilitation

The model below was used for computation of Actuarial Present Value (APV) of Invalidity Pension with Rehabilitation and the result is also included below:

$$APV = \left[(y) \sum_{k=0}^{59-x} \left((1+\ell G(y)) y P(y) (AMW)_{x+k} \ddot{a}_{x+k} \right) v^{k+\frac{1}{2}} {}_k p_x^{\tau} q \right]; NC \geq 24$$

where *P(y)* is the probability distribution for loss of earning capacity due to invalidity and *G (y)* is loss of earning capacity and with rehabilitation expenses, with (e) being a ceiling of RM1500 applied in this study as shown below. The rates given below were extracted from SOCSO's Office.

Table 1: Invalidity loss of earning capacity

Invalid Case	y	P(y)	G(y)	e
100%	1	0.0005	0.01	1500
90%	0.9	0.0007	0.008	1500
80%	0.8	0.0009	0.009	1500

y = Percentage of Loss of Earning Capacity due to Invalidity
P(y) = Probability Distribution for Loss of Earning Capacity due to Invalidity
G(y) = Loss of Earning Capacity with Rehabilitation.
e = Expected Expenses Amount

The adopted model used *AMW*, which is Assumed Monthly Wage. This AMW is imposed by the ESSAt 1969 enforced by SOCSO. For example, if the claimant's monthly salary is RM3000.00, the assumed monthly wage applied in the calculation is RM2950. This amount is the median value of monthly wage between the intervals of those who are earning a monthly salary of above RM2900.00. The SOCSO schemes, whether the Employment Injury Insurance or the IPS, will only cover up to a ceiling monthly salary of RM3000 [10].
Additionally, $\ddot{a}_{x+k}$ is the Actuarial Present Value annuity factor for Invalidity Pension. The amounts payable vary according to age groups, which are categorized in groups of five. For example, if the insured person's age is within the range of 16 to 19 years old, the Actuarial Present Value Annuity Factor is 8973 and this applies for every subsequent age group until the age of 60. Additionally, for the younger insured person who becomes invalid, the higher Actuarial Present Value Annuity Factor of SOCSO will be used in the calculation to pay the benefit. These values are derived and imposed by SOCSO through the enactment of the ESSA 1969.
Furthermore, the symbol $v^{k+\frac{1}{2}}$ is used to denote the present value. The present value of an accumulated sum due *k* plus 0.5 years is used in the calculation throughout the study. This refers to the initial amount, for instance 100% of loss of earning capacity case at age 40 or the death of an insured person at an interest rate of 3% per annum used in the calculation, which will amount to RM 954,301.40, at the end of each year. The amount is given under the Actuarial Present Value of Invalidity Pension with Rehabilitation.
Moreover, ${}_k p_x{}^{\tau}$ represents the probability that an insured person at age *x* survives to reach *k* years of age. In this study, *x* starts at the age of 16 and *k* starts at integer 1 until 45. The results show that the probability of an insured person at age 16 surviving to the end of year 1 is 1. The probability of the insured person surviving decreases every year. However, ${q^3}_{x+k}$ is the probability of a person aged *x* becoming decrement due to causes of invalidity and die before *k* years of age. The probability of an insured person becoming invalid increases gradually every day [51].
The benefit of the IPS should be paid to the insured person who is declared invalid by the Medical Board. Based on current practice, the majority have probably exceeded 80% loss of capacity and placed under the IPS. In summary, the calculation for Actuarial Present Value for Invalidity Pension with Rehabilitation benefit applies the following assumptions:

1. 6% salary increment yearly;
2. At least 80% of loss capacity; and
3. Being declared invalid by the appointed Medical Board.

4.3 Computation Actuarial Present Value (APV) of Survivors' Pension

The model below is used in calculation of computation of Actuarial Present Value of Survivors' Pension:

$$APV = \sum_{k=0}^{59-x} (AMW)_{x+k} \ddot{a}_{x+k} v^{k+\frac{1}{2}} {}_k p_x^{\tau} q_{x+k}^3 \; ; NC \geq 24$$

where (AMW) is the Assumed Monthly Wage.
The AMW value is imposed by the Employees Social Security Act 1969 and enforced by SOCSO, for instance if the claimant is earning monthly salary of RM3000, the assumed monthly wage used in the calculation is RM2950. This amount is the median value of the monthly wage between the intervals for those who are earning a monthly salary of RM2900. Both the SOCSO schemes, namely the Employment Injury Insurance and the Invalidity Pension Scheme will only cover up to the ceiling salary of RM3000.
Additionally, $\ddot{a}_{x+k}$ is the Actuarial Present Annuity Value Factor for Survivors' Pension. These values are payable at different amounts according to the age groups. These are grouped by 5 years to the next 5 years. For example, if the insured person's age is between 16 to 22, the Actuarial Present Value Annuity Factor is 9756 and so on so forth until 60 years. In other words, the younger an insured person dies, the higher the amount of Actuarial Present Value Annuity Factor which will be used by SOCSO in the calculation to pay the benefit. These values were derived by SOCSO through the ESSA 1969 [52].
Furthermore, the symbol $v^{k+\frac{1}{2}}$ is used to denote the present value. The present value of an accumulated sum due, being *k* plus 0.5 years, is used in the calculation throughout the study. This refers to the initial amount which, for instance at the age 40, or the death of an insured person at an interest rate of 3% per annum used in the calculation will amount to RM 1917.50, at the end of each year. The amount is given under the Actuarial Present Value of Survivors' Pension. Moreover, ${}_k p_x{}^{\tau}$ is the probability that an insured person at age *x* survives to *k*. In this study *x* starts at the age of 16 and *k* starts at integer 1 until 45. It showed that the probability insured person at age 16 survives to year 1 is 1. The probability of the insured person surviving decreases every year. However, ${q^3}_{x+k}$ is the probability of a person age *x* will become decrement due to causes of invalidity and die before *k* year. The probability of the insured person invalid every year increased gradually every day. The calculations for both probabilities are demonstrated in Appendix C [51].
In [44-46] stated that under the eligibility of Survivors' Pension, the benefit, *B* will be paid to the beneficiary a maximum amount of RM 1917.50 if the insured person dies before the age of 60 and at least 24 months' contribution. The calculation of the Actuarial Present Value of Survivors' Pension is the increasing every year. In summary the calculation for Actuarial Present Value for Survivors' Pension benefit uses the assumption of 6% salary increment yearly [54].

4.4 Computation Actuarial Present Value (APV) of Constant Attendance Allowance (CAA)

The Actuarial Present Value Constant Attendance Allowance Benefit is applicable for pensioners with serious physical condition or at least 80% loss of earning capacity who are provided this benefit. The model below is used in the calculation:

$$\text{APV}=0.36B_3\sum_{k=0}^{59-x}(AMW)_{x+k}\,\ddot{a}_{x+k}v^{k+\frac{1}{2}}{}_k p_x{}^{\tau}q^2{}_{x+k}$$

where *(AMW)* is Assumed Monthly Wage.
This AMW is imposed by the Employees Social Security Act 1969 and enforced by SOCSO. For example, if the claimant's monthly salary is RM3000, the assumed monthly wage used in the calculation is RM2950. This amount is the median value of the monthly wage between the intervals of those who are earning a monthly salary above RM2900.00. As mentioned, both the SOCSO schemes, being the Employment Injury Insurance and IPS will only cover up to a ceiling monthly salary of RM3000.00 [54]. Additionally, $\ddot{a}_{x+k}$ is the Actuarial Present Value annuity factor for Invalidity Pension. These values are payable at various different amounts according to the age groups. Each age group covers 5 years. For example, if the insured person's age is between 16 to 19, the Actuarial Present Value Annuity Factor is 8973 and so on and so forth until 60 years of age. Additionally, the younger the insured person who becomes invalid, the higher the amount of Actuarial Present Value Annuity Factor which will be used in the calculation to pay the benefit. These values are imposed and enforced by SOCSO through the ESSA 1969. Furthermore, the symbol $v^{k+\frac{1}{2}}$ is used to denote the present value.
The present value of an accumulated sum due *k* plus 0.5 years is used in the calculation throughout the study. This refers to the initial amount, for instance 90% of loss of earning capacity at age 40, or the death of an insured person at an interest rate of 3% per annum used in the calculation will amount to RM180, at the end of each year. Tt is given under the Actuarial Present Value of Constant Attendance Allowance.

Moreover, ${}_k p_x{}^{\tau}$ is the probability that an insured person at age *x* survives to be age *k*. In this study, *x* starts at the age of 16 and *k* starts at integer 1 until 45. It shows that the probability of insured person at age 16 surviving to the end of year 1 is 1. The probability of the insured person surviving decreases every year. However, $q^3{}_{x+k}$ is the probability of a person age *x* will become decrement due to causes of invalidity and die before *k* year. The probability of the insured person becoming invalid increases gradually every day.
The benefit of IPS should be paid to the beneficiary, being a maximum amount of RM500. In the current practice the majority have probably exceeded more than 80% loss of capacity and were put under this Constant Attendance Allowance (CAA) benefit. In summary, the calculation for Actuarial Present Value for Invalidity Pension with Rehabilitation benefit uses the following assumption:

1. Salary increment of 6% yearly;
2. At least 80% loss of capacity; and
3. Being declared invalid by the appointed Medical Board.

4.5 Computation Actuarial Present Value (APV) of Funeral Fees

The model below was used to facilitate the calculation of Actuarial Present Value of Funeral Fees:

$$\text{APV}=1500\sum_{k=0}^{59-x}v^{k+\frac{1}{2}}{}_k p_x{}^{\tau}q^3{}_{x+k}$$

where ${}_k p_x{}^{\tau}$ is the probability that an insured person at age *x* survives to be age *k*. In this study, *x* starts at the age of 16 and *k* starts at integer 1 until 45. It shows that the probability that an insured person at age 16 survives to complete the first year is 1. The probability of the insured person surviving decreases every year. However, $q^3{}_{x+k}$ is the probability of a person of age *x* will become decrement due to causes of invalidity and die before *k* year. The probability of the insured person becoming invalid increases gradually every day.
Furthermore, the symbol $v^{k+\frac{1}{2}}$ is used to denote the present value. The present value of an accumulated sum due *k* plus 0.5 years is used in the calculation throughout the study. This refers to the initial amount where the death of the insured person with an interest rate of 3% per annum used in the calculation will amount to RM1500 at the end of each year and it is given under the Actuarial Present Value of Constant Attendance Allowance.
SOCSO stated that under the eligibility of Funeral Fees, the benefit will be paid if the insured person dies before the age of 60 and has made at least 24 months' worth of contribution. The maximum amount of this benefit is RM1,500.00. The amount of the Actuarial Present Value of the Funeral Fees increases every year.
As stated in the previous section, should an insured person die before the age of 60 due to any reason or upon the death of any pensioner covered under the IPS, the beneficiary is entitled to make this claim.

4.6 Explanation of Actuarial Present Value (APV)

The computation of the Actuarial Present Value Invalidity Pension is divided into 3 types of cases, being:

1. 100 % loss of earning capacity due to invalidity with rehabilitation;
2. 90 % loss of earning capacity due to invalidity with rehabilitation; and
3. 80 % loss of earning capacity due to invalidity with rehabilitation.

For this assumption family model the entitlement to make the claims arise after the 2nd year of contribution because the first condition that must be met is that the insured person must have made at least 24 months' worth of contribution within a period of 40 months [54].
The number of contributions (NC) made is an important factor that must be taken into consideration. This is because it influences the percentage of benefit received by the insured person. Normally, the amount of pension to be paid will be within 50% to 65% of the amount of the average salary of the last two years but subject to a ceiling of RM2950.00, where the percentage comes from the years of service of the insured person himself or herself.
Both the SOCSO schemes, being the Employment Injury Insurance or IPS, will only cover up to a ceiling of RM3000.00. Additionally, in this study, as mentioned earlier by age 40 the insured person would have already reached the ceiling for future wage.
The Actuarial Present Value annuity factor for invalidity benefit is payable differently according to the age groups. Each of them are grouped by 5 years to next 5 years. For example, for insured person aged 16 to 24, the value is 8793, for ages 20 to 24 it is 8530, for ages 25 to 29 it is 8029 and so on and so forth until age 60. In other words, the younger the insured person, the higher the Actuarial Present Value annuity factor will be.
Therefore, based on findings on the Actuarial Present Value of Invalidity Pension and Grant with Rehabilitation, it can be concluded that an optimized contribution rate will give sufficient funding to SOCSO. This is because the IPS could have enough

amount of money to cover invalid pensioners in the near future if they introduce the suggested optimal contribution rate.
For deaths occurring before 60 years of age regardless of the reason, the beneficiary will be eligible to make a claim. On top of that, the insured person should have at least made 24 months' worth of contributions within a period of 40 months.
As explained above in the computational Actuarial Present Value of Invalidity Pension and Grant with Rehabilitation benefit, the number of contributions (NC) is an important factor taken into consideration, as it affects the percentage of benefit received by the beneficiary. Normally, pension will be paid at an amount of within 50% to 65 % of last 2 years' assumed average monthly wage (AMW). Yet, there is a ceiling of monthly assumed monthly wage (AMW) amounting to RM2950.00. The percentage actually comes from insured person's years of service [54].

4.7 Optimizing the Contribute Rate

This study already explored the calculation of contributions and benefits based on worst case scenario. All assumptions to be used in this study, as described in the previous chapter, are also based on worst case scenario. For example, the employee is a male aged 16 whose starting salary is RM900.00, the employee retires at age 60, is married with children, and receives a constant salary increment of 6 % per annum, and the Decrement Table M9903 applies. The Contribution Rate of SOCSO's Invalidity Pension Scheme, C, is:

$$C = \frac{\text{Actuarial Present Value of Benefits}}{\text{Actuarial Present Value Wage}} = \frac{998{,}578.16}{448{,}011.31} = 2.2\%$$

The findings above show that the current rate of contribution for IPS is insufficient to support the benefits. This study excludes overhead expenses and Invalidity Grant. As mentioned in the previous chapter, the Invalidity Grant was excluded because the contribution made will be returned to the insured person in full.
This is because the first condition of the claim is not met where the insured person has not made enough number of contributions. The number of contributions made should be 24 within a period of 40 months [55]. Since 1969, the IPS contribution rate is 0.5%.
The contribution is deducted from employees' gross monthly wages. Conversely, with certain assumptions made and Actuarial Present Value Approach applied, this study concretely shows that the adequate contribution rate is 2.2% [9].

Table 2: Result summaries

Benefits		Actuarial Present Value (APV)
IVP	$(ADW)*y*P(y)*\ddot{a}_x*(1+[e*G(y)])$	$\left[(\text{eachly})\sum_{k=0}^{59-x}((1+\ell G(y))yP(y)(NC)_{x+k}\ddot{a}_{x+k})v^{k+\frac{1}{2}}{}_kp_x{}^\tau q\right]$
IVP:80%	44,002,483.92	349.19
IVP:90%	39,450,502.82	313.07
IVP:100%	33,718,378.48	267.58
SUR	$MV * \ddot{a}_x$	$\sum_{k=0}^{59-x}(MV)_{x+k}\ddot{a}_{x+k}v^{k+\frac{1}{2}}{}_kp_x{}^\tau q^3{}_{x+k}$
SUR:100%	68,371.50	395532.94
CAA	40 %*(90 % LECI)*P(c)	$0.36B_3\sum_{k=0}^{59-x}(MV)_{x+k}\ddot{a}_{x+k}v^{k+\frac{1}{2}}{}_kp_x{}^\tau q^2{}_{x+k}$
CAA:100%	7,740.00	602059.86
FUNERAL	1,500.00	$1500\sum_{k=0}^{59-x}v^{k+\frac{1}{2}}{}_kp_x{}^\tau q^3{}_{x+k}$
FUN: 0.05%	67,500.00	55.51
WAGES		$12C\sum_{k=0}^{59-x}(MW)_{x+k}v^k{}_kp_x$
		448,011.31
Rate		2.2%

5. Conclusion

This study is beneficial for future researchers, SOCSO management, and the Malaysian government. This study has gathered more knowledge about the products' features, as well as contribution determination, and pricing procedures in the effort to understand the real practice of social security insurance. It can also provide a guideline for creating new products for future implementations in SOCSO [56].
The SOCSO management could also use the findings from this study to define sufficient funding through optimal contribution rate charged to employees and employers. This study was able to clearly show the factors that are influencing SOCSO's fund collections and distributions payable to the insured person [8].
Furthermore, this study had only concentrated on the Invalidity Pension Scheme. Therefore, it is strongly recommended that future studies consider another benefit and coverage, which is the Employment Injury Insurance Scheme, in which could provide very useful information to SOCSO's management. It is also recommended that future studies on this subject apply other sophisticated analyses, such as the actuarial cost methods, the unit-credit method, and the economic model [17].
Subsequently, the calculation can be used to advance computer software that are currently in the market such as Visual Basic, C++, SAS, and R. All these concepts and advanced approaches will help in generating more accurate results [57].
Moreover, the findings and analyses conducted in this study had shown that it can benefit the government too. By using the suggested adequate rate of contribution for SOCSO's Invalidity Pension Scheme, the government can reduce some allocations from their financial obligations that were implemented for the last 45 years. In which case, some allocation from these particular expenses could be distributed to other important national development programs towards achieving National Vision 2020 [53].

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