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Full Length Research Paper

Management flight simulator of pension expenditure

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Salary risk and demographic risk have been identified as main risks in analyzing pension expenditure particularly in defined benefit pension plan. Thus, this paper described the development of management flight simulator for pension expenditure (with particular case on a Malaysia Defined Benefit pension plan). Public pension plan in Malaysia is studied to analyze pension expenditure due to salary and demographic risk. Through the literature review and interview session with several officers in public sector, factors affecting pension expenditure are determined. Then, the inter-relationships between these factors are analyzed through causal loop diagram. The System Dynamics model is later developed using iThink software to show how demographic and salary changes affect pension expenditure. Then, by using actual data, the impact of different policy scenarios on pension expenditure is analyzed. It is shown that dynamics simulation model of pension expenditure is useful to evaluate the impact of changes and policy decisions on risk particularly involving demographic and salary risk.

Key words: Demographic and salary risk, pension expenditure, public policy, system dynamics.

INTRODUCTION

Pension is a fixed income received by a worker after retirement. Pension is usually a stream payment made in form of annuity to a retired employee. There is also retirement plan where the benefits in form of accumulations can be withdrawn in lump-sum upon retirement. Generally, there are two types of pension plans; Defined Benefit (DB) plan and Defined Contribution (DC) plan. Defined Benefit plan is a pension plan where the retirement benefit is calculated based on last salary, years of employment, retirement age and other factors. Usually in this pension plan, the benefit is paid in form of annuity. Meanwhile, Defined Contribution plan is a retirement plan where each worker possesses own individual account and the retirement benefit is based on employer's contribution and investment return. Generally, a worker in this plan can withdraw their retirement benefit in form of lump-sum of cash.

Due to demographic changes and increasing pension spending, pension systems around the world are in flux conditions (Disney and Johnson, 2001). This condition is caused by uncertainties or inherent risk that affects the pension scheme. The existence of risk will also affect the pension expenditure. Among the risk that the sponsor of pension plan particularly in DB plan is exposed to, are demographic risk and salary risk (Chang, 2000). Demographic risk is defined as the increasing risk due to population aging while salary risk refers to the salary growth affecting the cost of providing pension benefits (Chang, 2000). The increasing exposure to risk introduces the world of pension risk management that all sponsors have to realize and investigate properly. Therefore, is the sponsor of pension plan aware of the exposure of the increasing risk involved? Most importantly, how will the risk influence the pension plan? The complex phenolmenon

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of demographic and salary changes in a pension plan involves numerous factors which are interconnected in different directions. Hence, this study attempts to develop a policy design model which analyzes pension expendi-ture as a result of demographic risk and salary risk. Also, this paper describes the development of decision making tool which is also known as management flight simulator. Management flight simulator is a user's interface that acts as a decision making tool to simulate policy changes in system dynamics model of pension expenditure. The management flight simulator, also known as SD-PEX, is user's interface product which is developed in this study. This paper started with a discussion on the characteristics of the management flight simulator of SD-PEX and then different scenarios was illustrated as a prototype model.

MANAGEMENT FLIGHT SIMULATOR

Nowadays, there is a need in tools, theories and methods that is easier and effective for decision makers (Maier and Strohhecker, 1996). Management Flight Simulator which also described as corporate planning games in Milling (1997), is a comprehensive tool to assist decision makers in planning their corporate strategies. Management flight simulator was designed to allow easy access to a specified developed model, also as a tool to help decision makers to learn and improve their understanding about dynamics and complex systems (Maier and Strohhecker, 1996). Also, Ford (1999) describes Management Flight Simulator as a learning tool through interactive experimentation. Management Flight Simulator, also known as Micro-world is a live model of real world situation, which is built to provide a managerial-friendly interface with computer model (Maani and Cavana, 2000). Decision makers can use the management flight simulator to experiment the consequences of their actions, policies and strategies (Cheng, 2010). Literatures show there are few attempts on the development of management flight simulator in several areas in order to assist decision making. For example, management flight simulator have been constructed and have proven useful for business planning and development (Maier and Strohhecker, 1996; Milling, 1997; Thompson, 2004), education strategic planning (Barlas and Dicker, 2000), business and industrial marketing (Woodside, 2006), human resource planning (Maani and Cavana, 2000), terminal container management (Cheng, 2010), global climate control, healthcare, airlines, insurance, real estate, project management (Ford, 1999), etc. Since management flight simulator or micro-world in the pension area has not been in existence, in this study, management flight simulator for pension expenditure (SD-PEX-with particular case on a Malaysia Defined Benefit pension plan) was constructed to simulate policy changes in system dynamics model of pension expenditure.

Management flight simulator of SD-PEX

Management flight simulator is like an airplane flight simulator which is an electromechanical model of a plane designed for a pilot to improve their flying instincts with the simulated airplane. However, management flight simulator is designed to assist decision makers to improve their strategic planning instincts (Milling, 1997). Therefore, based on developed system dynamics model of pension expenditure, a management flight simulator of pension expenditure was constructed. Management flight simulator has a user's interface that acts as a decision making tool for policy-maker to simulate interactive experimentation of policy changes. Management flight simulator of pension expenditure is also known as SD-PEX, which includes the element of risk, complexity and dynamics. It is originally based on system dynamics model that has been developed in this study. It is also acts as a presentation device to decision makers which consist of three main components which are the component of background, component of parameters and variables and component of simulations outputs.

Background component (Figure 1) describes a short overview of this study. It contains six sections which are background section, parameter section and simulation output section (indicated as a button). While the others three sections consist of research's objective button, the study's framework and researches' button that is involved in this research. The first three buttons (background, parameter and simulation) only acts as a dummy button. It only navigates to the desired position (and display information) when the user clicked the buttons. While, the next three buttons contain an explanation about the research's objective and methodology, and the list of researches involved in this research. When the user click to objective button, an information regarding objectives of the research will be displayed (Figure 1). The same things happen when user clicks the framework and researchers button. After user have the idea about this research, the user can then go to the parameters and variables components to test the management flight simulator.

Figure 1 also shows the component of parameters and variables in the management flight simulator. There were two main elements with total of six control panels in the management flight simulator; (1) accrual rate adjustment and (2) salary rate adjustment. This study is focusing on analyzing demographic risk and salary risk on pension expenditure; therefore we only designed control panels that contain influential parameters. Others parameters can be added later if necessary. In the management flight simulator, any changes in policy made by

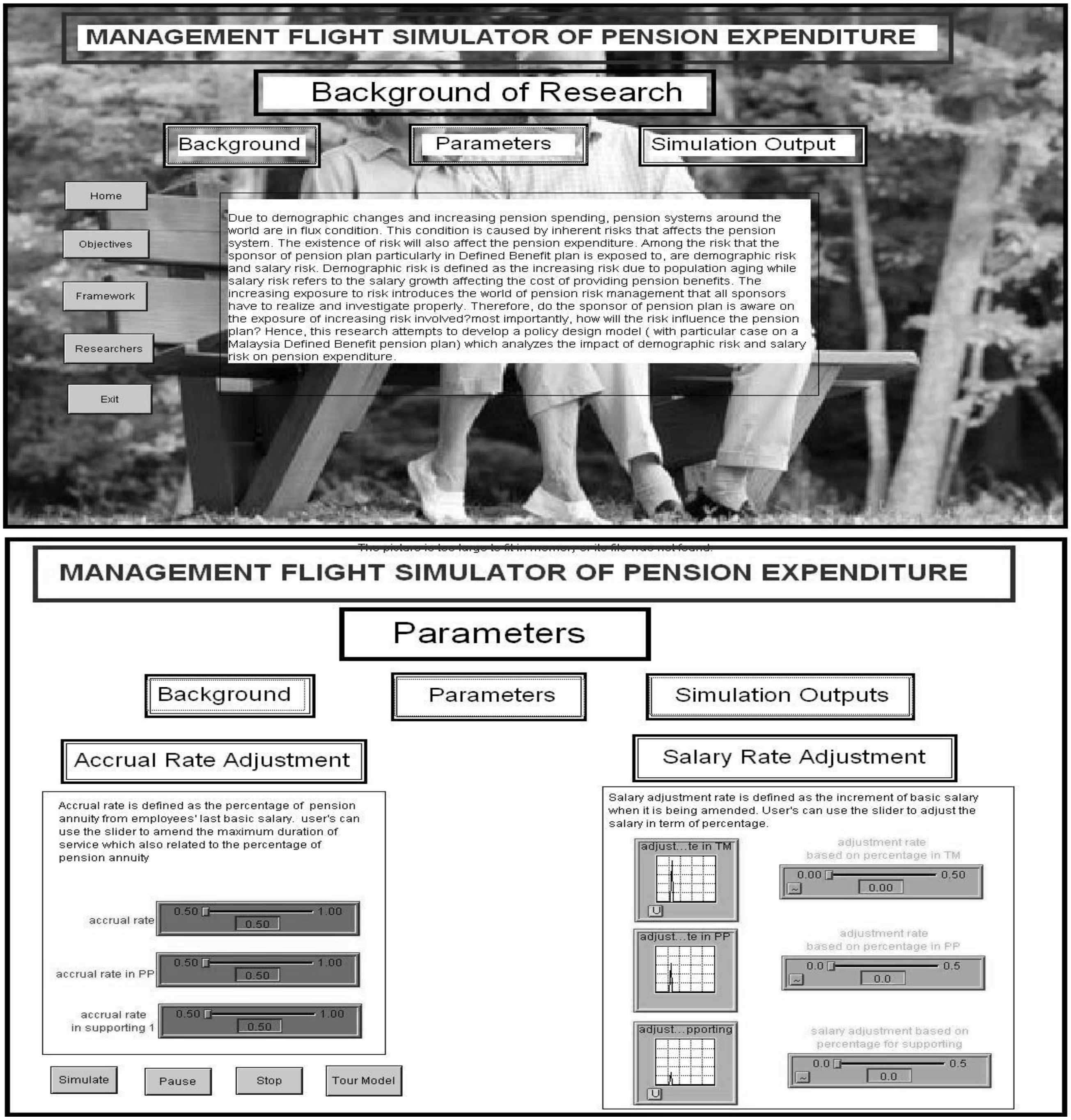
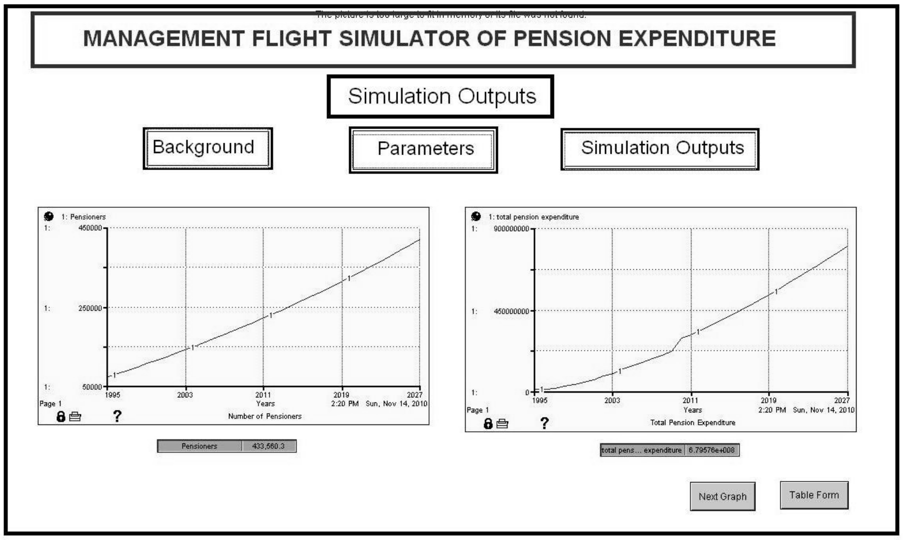


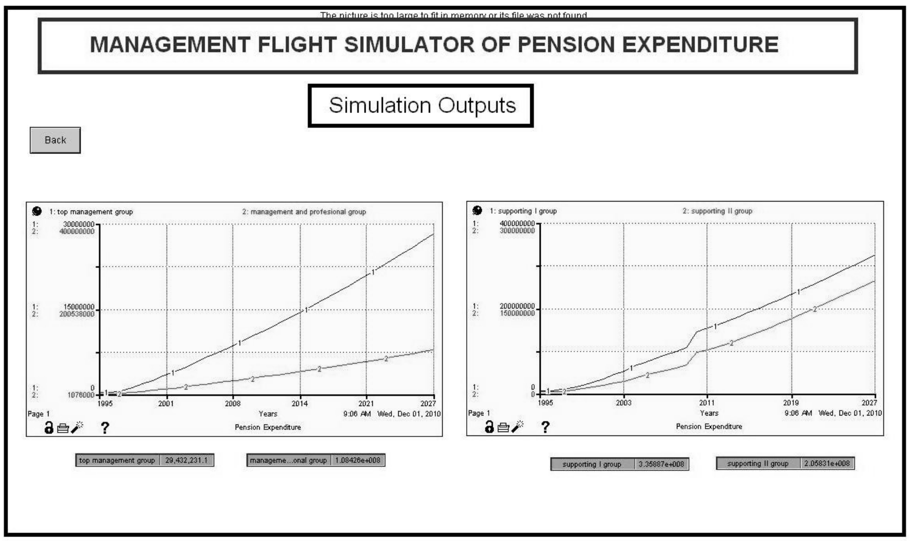
Figure 1. Background and parameter components of SD-PEX.

policymaker can be simulated by adjustments to these parameters. The user can slides the control panel to desired value and results from these changes were displayed in simulation outputs components which are in two forms; graph pad and numerical display. User also can view the results in table form by clicking the table form button (Figure 2).

FOUNDATIONS TO THE SIMULATOR

The specific foundation of the management flight simulator of pension expenditure is by using system dynamics approach. System dynamics (SD) approach exists in early 1960s when Jay W. Forrester of the Massachusetts Institute of Technology invented the





Back

9:06 AM 12/1/2010 Table 1 (Pension Expenditure)

Years	top management group	management and profesional group	supporting I group	supporting II group	total pension expenditure
Initial	203,166.09	1,075,905.25	5,146,454.55	2,082,851.99	8,508,377.88
1995	192,811.09	954,729.70	4,398,410.55	1,530,020.44	7,075,971.78
1996	540,134.53	2,168,923.85	7,428,106.38	2,627,698.28	12,764,863.05
1997	1,057,225.51	4,067,798.57	12,463,232.57	4,640,908.75	22,229,165.41
1998	1,681,182.97	6,357,412.71	18,553,178.75	7,121,616.38	33,713,390.81
1999	2,352,932.29	8,796,829.66	25,270,013.04	9,909,407.24	46,329,182.24
2000	3,078,374.86	11,347,234.09	32,472,582.13	12,902,502.75	59,800,693.83
2001	3,832,219.72	14,022,253.33	43,198,078.36	17,364,975.67	78,417,527.08
2002	4,580,993.46	16,805,935.22	50,925,797.29	20,690,307.64	93,003,033.61
2003	5,369,577.85	19,700,531.04	64,186,762.23	26,449,114.22	115,705,985.34
2004	6,270,500.37	23,018,088.87	72,321,525.71	31,152,355.34	132,762,470.28
2005	7,060,269.16	25,966,276.49	80,726,878.56	35,272,678.57	149,026,102.78
2006	7,882,036.47	29,023,989.14	89,375,892.58	39,670,208.27	165,952,126.44
2007	8,733,403.69	32,157,327.57	98,225,355.93	44,251,888.54	183,367,975.73
2008	9,612,076.82	35,386,744.90	107,270,252.28	49,011,805.39	201,280,879.38
2009	10,505,943.52	38,714,389.03	143,388,950.34	71,075,680.32	263,684,963.21
2010	11,410,864.90	42,010,981.06	152,221,120.83	75,607,103.89	281,250,070.68
2011	12,316,895.86	45,362,601.10	161,274,513.47	81,218,390.16	300,172,400.59
2012	13,247,428.46	48,797,473.37	170,510,541.98	87,412,886.12	319,968,329.93
2013	14,186,569.67	52,235,874.85	179,957,641.76	94,006,467.32	340,386,553.60
2014	15,161,847.32	55,719,730.20	189,703,204.70	100,886,108.84	361,470,891.06
2015	16,158,819.98	59,303,172.35	199,651,805.54	108,020,629.77	383,134,427.64
2016	17,149,475.92	62,990,639.93	209,834,951.16	115,382,141.44	405,357,208.44
2017	18,181,465.33	66,794,720.08	220,473,055.62	122,994,894.99	428,444,136.03
2018	19,211,024.02	70,599,396.90	231,106,833.33	130,619,251.15	451,536,505.40
2019	20,250,838.65	74,481,888.94	242,048,391.57	138,450,318.48	475,231,437.64
2020	21,319,507.86	78,461,869.09	253,240,883.37	146,463,675.41	499,485,935.73
2021	22,418,378.48	82,519,572.62	264,660,204.47	154,645,118.71	524,243,274.29
2022	23,547,067.97	86,682,664.67	276,311,297.91	163,028,720.53	549,569,751.07
2023	24,694,459.21	90,957,046.43	288,260,361.83	171,606,633.39	575,518,500.86
2024	25,856,951.03	95,215,465.64	299,785,309.52	179,861,573.10	600,719,299.29
2025	27,024,908.09	99,545,168.27	311,578,313.56	188,334,482.85	626,482,872.77
2026	28,221,918.93	103,975,116.88	323,602,215.89	196,977,486.56	652,776,738.26
2027	29,432,231.08	108,426,115.69	335,886,609.12	205,831,166.22	679,576,122.11

Figure 2. Simulation output components of SD-PEX.

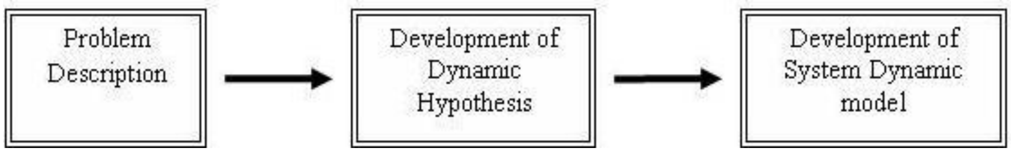


Figure 3. The process of system dynamics model development.

methodology to study a non-linear system and feedback control in engineering sciences. With the aid of computer simulation, it is a powerful tool that can be used in understanding complex system. System dynamics originally based on feedback control theory which includes both hard (quantitative) and soft (qualitative) approaches in analyzing the dynamic behaviors of the development and changes of a system (Maani and Cavana, 2000). The strength of SD is it can help to improve decision making process and policy formation, through its' characteristics of incorporating all the relevant cause and effect relationships and feedback loops in a dynamic behavior modes of systems. By developing mathematical model using differential equation concept and in virtue of computer simulation technology, SD is capable in solving a dynamic, varied, interdependent and complex system such as the problem of investigating the impact of demographic and salary risk on pension expenditure.

As proposed by Maani and Cavana (2000), there are three general steps in developing system dynamics model as shown in Figure 3. These steps will be used in order to analyze pension expenditure due to demographic and salary risk. The step started with problem description which involves the process of understanding the problem, system characteristics is deepened, also factors that affected pension expenditure and system boundaries is recognized. Then, development of dynamic hypothesis consisting of building a causal loop diagram shows the causality between the factors that had been recognized. Lastly, the process ended with developing a system dynamic model through computer simulation.

PROBLEM DESCRIPTION

In this research, Malaysia public pension plan is studied to analyze pension expenditure due to salary and demographic risk. In Malaysia, public pension plan is also exposed to demographic risk and salary risk since the public pension plan is based on unfunded Defined Benefit (DB) plan. In this pension plan, the employees' benefits after retirement are determined by their final basic salary and duration of services which is the maximum duration of services is 25 years (300 months). Also, the retirement benefits are paid through government budget. This pension plan is available for permanent public workers who have met certain requirements and being confirmed in the service. After confirmation, the public employees get to choose their desired pension plan between two plans offered. If the worker chooses DB plan, he/she has to be in service not less than 10 years in order to be eligible to receive 2% of pension benefit from his/her last basic salary for every accumulated services. Workers who have worked for at least 25 years and above are eligible to receive 50% pension annuity from their last basic salary. The pension annuity will be paid until the worker pass away and the annuity is continuously paid to the eligible family members. The pension benefit received by eligible family member is known as derivative pension. The compulsory retirement age in this pension plan is 55 years old, but the retirement age has been raised up to 56 years old in October, 2001 and then to 58 years old effective on July, 2008. However, the increment of retirement age does not indicate that the maximum duration of service will also change. The maximum duration of service can also be amended without increasing the retirement age. Therefore, the percentage of pension annuity is depended on the amendment of maximum duration of service. Hence, with effect from July, 2008, public workers who have been in service for 30 years and above are eligible to receive 60% pension annuity from their last basic salary. There are three groups of employees in Malaysia's public sector which are top management group, management and professional group and supporting group (supporting group is divided to supporting I and supporting II group). Each group is classified by salary schemes also known as scheme of service; which indicate the priority in establishment and level of salary. In Malaysia's public sector, there are two types of salary changes involved; the salary increased due to yearly salary increment and salary adjustment. Yearly salary increment is an even salary increment for all workers which ranges between 3 and 9% from their basic salary while salary adjustment is defined as an adjustment in a worker's basic salary announced by the policy makers every 5 years period depending on the government's financial capability or when there is a need in doing so, such as due to increasing living cost and etc. Between years of 1995 until 2008, the public workers had received 4 salary adjustments which are in 2000, 2002, 2003 and the latest in 2007 (Table 1). The salary adjustment rate in 2000 and 2002 is a 10% increment from basic salary for all groups of service. In 2003, salaries was adjusted not according to the percentage. The salary increment is in amount of RM110 (for top management group), RM65 (for management and professional group) and RM15 (for supporting group). Then, most recently in 2007, the salary adjustment is made by group of service as shown in Table 1. Workers in top management group received an increment of 7.5% from their basic salary while workers in management and professional group and supporting group received an increment of 15% and 25 to 35% from their basic salary, respectively. Every time the salary adjustment is announced, the pension annuity for all pensioners is adjusted to the same rate as in salary adjustment.

Due to Malaysia's public pension system whereby the percentage of pension annuity is depended on the amendment of maximum duration of service as well as the existence of derivative pension, in this study, the demographic risk is defined as the risk that the public workers is attaining the maximum duration of services at compulsory retirement age and the pensioners (or pension recipients) will live longer. Also, the salary risk is focusing on the increment of salary when the basic salary is adjusted.

DYNAMICS HYPOTHESIS

In this research, an interview session was arranged with the Departmental Head of Actuary in Ministry of Finance to investigate the

Table 1. Personnel according to group of service and salary adjustment rate.

Group of service	Salary adjustment rate		
	2000 and 2002 (%)	**2003**	**2007 (%)**
Top management	10	RM 110	7.5
Management and profesional	10	RM 65	15
Supporting I	10	RM 15	25
Supporting II	10	RM15	35

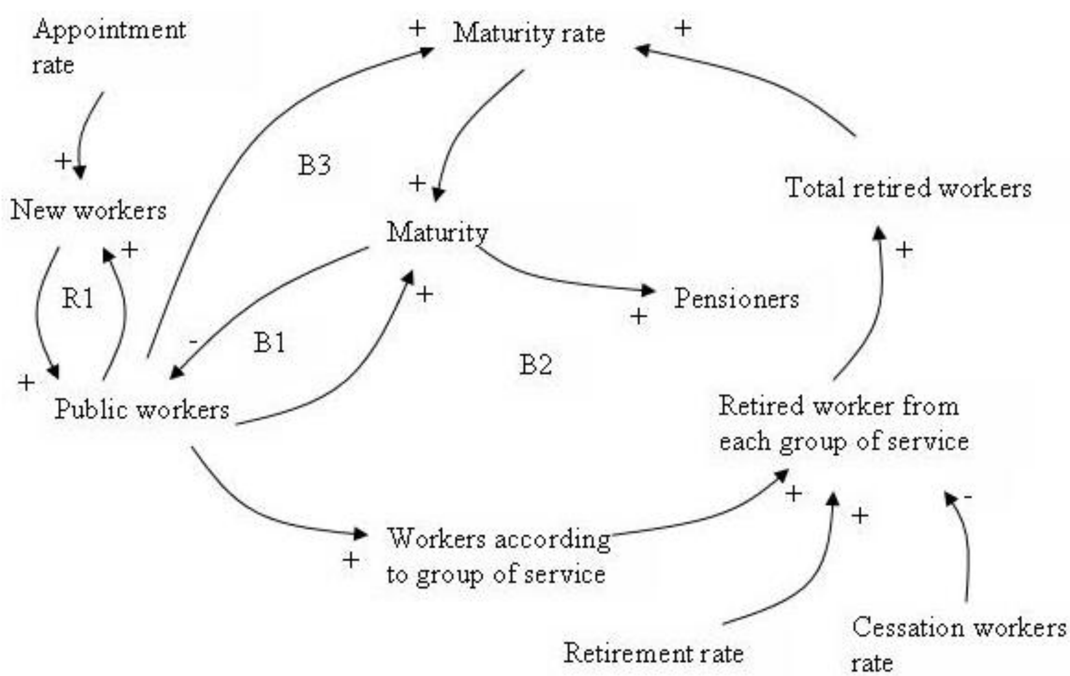


Figure 4. Causal loop diagram of population model.

factors that affect pension expenditure and how they are interrelated. The next interview session was carried out with the Director of Pensions Division in Malaysia Public Service Department (PSD) in order to gain in depth information regarding the pension system for public workers. After that, few visits were conducted with the senior officers in pension division and deputy accountant of PSD to further discuss the pension system, available data and related information. Through the literature review in Shimada et.al. (1990), Chang (1999), Chang and Cheng (2002), Chaim (2006, 2007), and Jimeno et al. (2008) and from the interview sessions, causal loop diagram is used to analyze the inter-relationships among these factors.

Causal loop diagram (also known as feedback loop) is a part of system dynamic modeling which is used to analyze complex relationship that exists in dynamic system**.** A causal loop is referred to as influence diagram or mathematically known as directed graphs. A causal loop enlighten a dynamic process of a system in which the chain effects of a cause are traced, through a set of related variables, back to the original cause. A causal loop is formed when a set of variables has been linked together in a connected path. There are two types of causal loop which are reinforcing loop (indicate by the symbol R+) and balancing loop (indicate by the symbol B-). Balancing loops tend to stabilize the model and reinforcing loops tend to destabilize. The loop is defined as positive (known as reinforcing loop) when the number of negative relationships is even, otherwise the loop is negative (known as balancing loop). Causal loop is also represented by an arrow headed line with a symbol "+" which implies that a change in the influencing variable will produce a change of the same direction in the target variable, while the symbol "-" mean the effect will be seen in an opposite direction between the influencing variable and the target variable. The causal loops relation is a helpful tool to predict the impact of desired factors in the system holistically (Chaim, 2006).

Causal loop diagram of pension expenditure system consists of two parts; (1) causal loop diagram of population model and (2) causal loop diagram of pension expenditure. The first part of causal loop diagram illustrates three balancing loops and one reinforcing loop. In causal loop diagram of population model (Figure 4), appointment rate and numbers of new workers will increase the number of public workers (Reinforcing loop, R1). As aforementioned, public workers consist of three groups of services which are top management workers, management and professional workers and supporting workers. Hence, any change in the number of workers in group of service, retired workers from each group of service, total retired workers, and maturity rate will also cause an opposite change in the number of public workers (Balancing loop, B1 and B2). Maturity rate and maturity level which represents the ratio

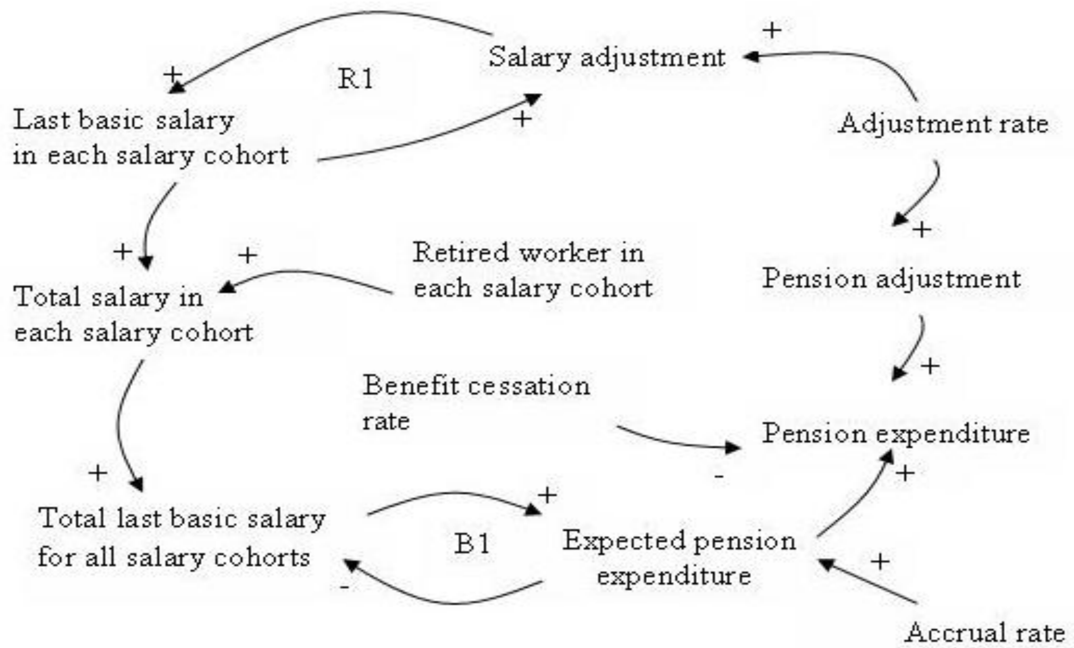


Figure 5. Causal loop diagram of pension expenditure.

of workers that reach compulsory retirement age will cause a decline to the numbers of public workers (Balancing loop, B3). Simultaneously, the number of retired workers from each group of service varies as a result of retirement rate and cessation rate.

The second part of causal loop analysis is on how the pension expenditure is estimated (Figure 5). Classification of retired worker is split up by a salary cohort also known as scheme of service. The total last basic salary for all salary cohorts is depended on total salary in each salary cohort while the total salary in each salary cohort is depended on numbers of retired workers in each salary cohort and the last basic salary in each salary cohort. Loop R1 represents the increment of last basic salary in each salary cohort as a result of salary adjustment. While, loop B1 acts to decreases the total last basic salary for all salary cohorts as the expected pension expenditure increases. Also, the expected pension expenditure is determined by a total last basic salary for all salary cohorts and accrual rate. Accrual rate is defined as the percentage of pension annuity from employees' last basic salary. In the same time, last basic salary in each salary cohort will be affected by salary adjustment and adjustment rate while pension expenditure is affected by pension adjustment, adjustment rate and benefit cessation rate.

DEVELOPMENT OF SYSTEM DYNAMICS MODEL

In this research, all factors presented in Figures 4 and 5 were transformed into stock and flow diagrams (Figures 6 to 8) by using iThink software to build the system dynamics model of pension expenditure. The development of system dynamics model includes several types of variables such as stocks, flows, converters and connectors. Stock which is also known as levels act as a reservoir to accumulate quantities (represented by rectangle) and describe the condition of the system. The flows increasing (inflow) and decreasing (outflow) a stock are also known as rates (represented by valve). The condition of stock will depend on the rates while the rates can be affected by a factor affecting inflow or outflow which is known as converter or auxiliaries (represented by circle). Finally, the connectors represent cause and effect links within the model structure is represented by the single-line arrow (Maani and Cavana, 2000). The system dynamics model of pension expenditure contains 3 main sectors which are the population sector, salary scheme sector and pension expenditure sector.

The population sector

The population sector illustrates the dynamics that are involved in various population categories. The number of public workers is depended on an appointment rate and the numbers of new workers. The public workers consist of top management group, management and professional group and supporting group. Therefore, there are three main stocks representing retired workers for each group of service. The total number of retired workers from each of this group will then affect maturity rate. Maturity rate represents the ratio of workers that reach compulsory retirement age and become pensioners. Also, due to the existence of derivative pension, the cessation workers in each group of service represent number of pensioners that no longer received pension annuity. The equations of this sector are (**S** = Stock, **R** = Rate, **C** = Converter):

S $$P(t) = P(t-dt) + M * dt \quad (1)$$

R $$M = MR * PW \quad (2)$$

C $$MR = \sum R_{T,P,S} \Big/ PW \quad (3)$$

S $$PW(t) = PW(t-dt) + (NW - M) * dt \quad (4)$$

R $$NW = PW * AR \quad (5)$$

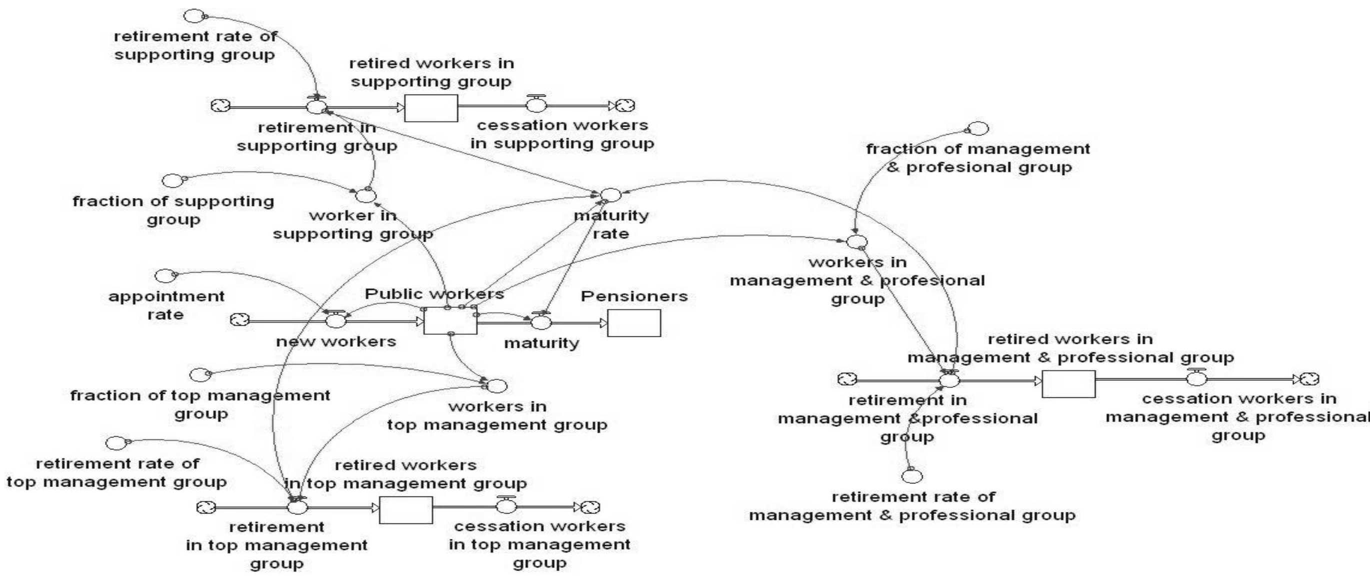


Figure 6. System dynamics model for population sector.

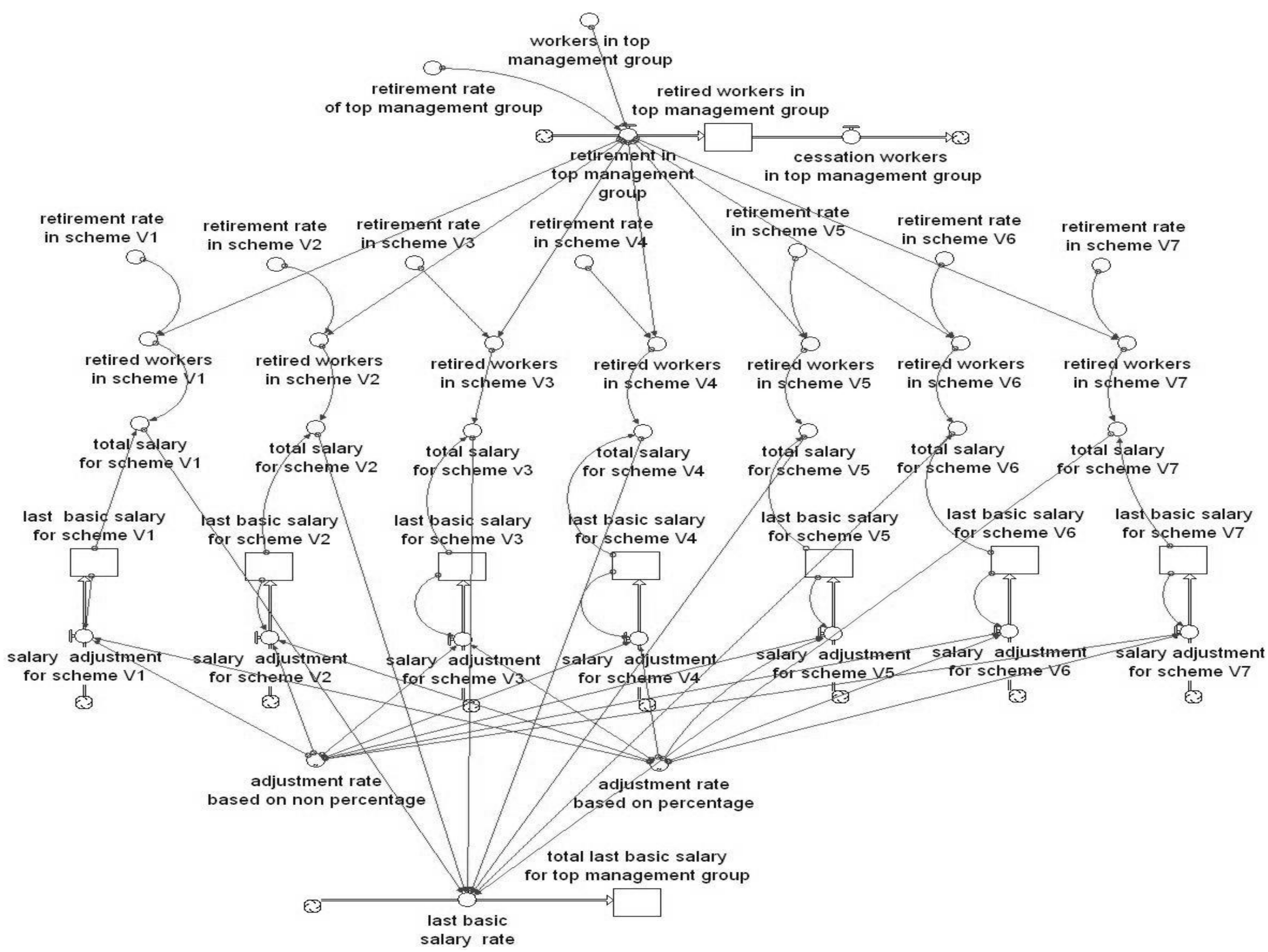


Figure 7. System dynamics model for salary scheme sector.

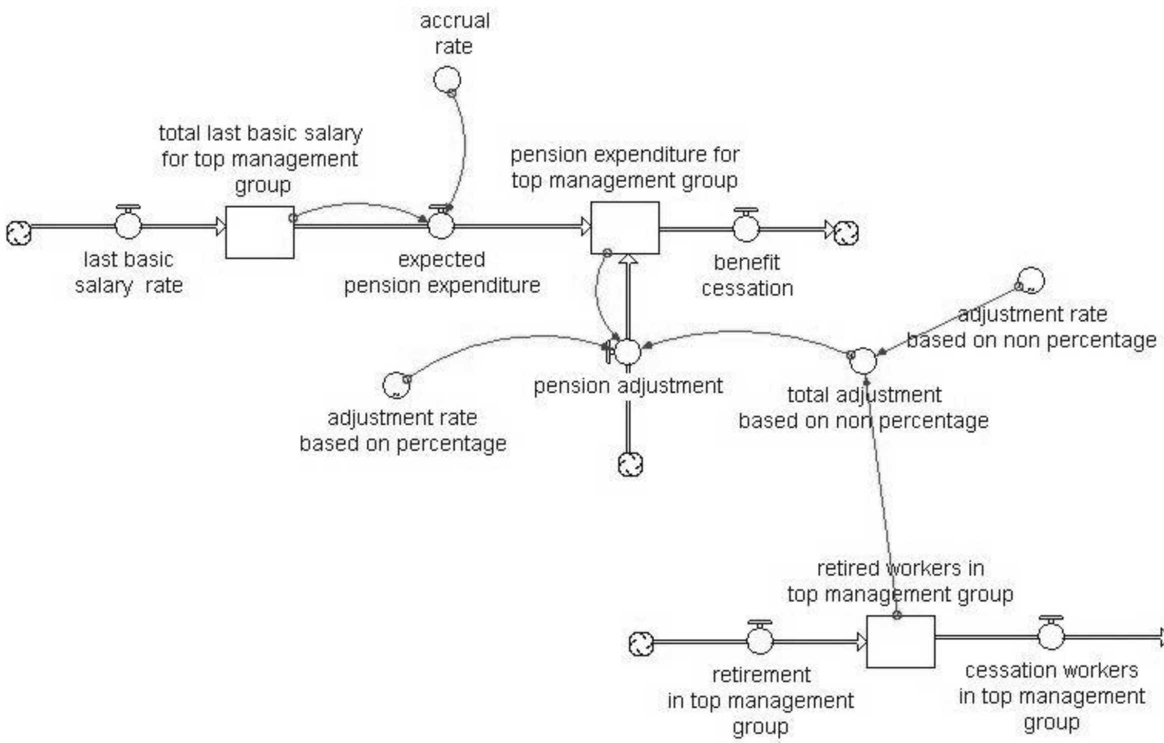


Figure 8. System dynamics model for pension expenditure sector.

S $$RW_{T,P,S}(t) = RW_{T,P,S}(t-dt) + (R_{T,P,S} - CW_{T,P,S}) * dt \quad (6)$$

R $$R_{T,P,S} = RR_{T,P,S} * W_{T,P,S} \quad (7)$$

C $$W_{T,P,S} = PW * F_{T,P,S} \quad (8)$$

where P = pensioners, M = maturity, MR = maturity rate, PW = public workers, NW = new workers, AR = appointment rate, $RW_{T,P,S}$ = retired workers in top management, management and professional and supporting group, $R_{T,P,S}$ = retirement in top management, management and professional and supporting group; $W_{T,P,S}$ = workers in top management, management and professional and supporting group; $F_{T,P,S}$ = fraction of workers in top management, management and professional and supporting group.

The salary scheme sector

Salary scheme sector shows the retirement in top management group (similar procedures applies to management and professional and supporting group) which is categorized by salary cohort also known as scheme of services. Retirement in top management group depended on workers in top management group and top management retirement rate. In top management group, there are 7 salary schemes ranging from V1 until V7. The numbers of retired workers in each salary schemes is depended on retirement in top management group and retirement rate. Then, total salary in each salary scheme is influenced by the number of retired workers and the last basic salary in each salary scheme. The last basic salary in each salary scheme is affected by two types of adjustment rate which are based on percentage and non-percentage. Lastly, total salary for all salary schemes determines the last basic salary rate and total last basic salary for top management group. The equations of this sector are (**S** = Stock, **R** = Rate, **C** = Converter):

R $$R_T = W_T * RR_T \quad (9)$$

C $$RW_{V1-V7} = R_T * RR_{V1-V7} \quad (10)$$

C $$TS_{V1-V7} = LBS_{V1-V7} * RW_{V1-V7} \quad (11)$$

S $$LBS_{V1-V7}(t) = LBS_{V1-V7}(t-dt) + (SA_{V1-V7}) * dt \quad (12)$$

C $$SA_{V1-V7} = (LBS_{V1-V7} * ADRP) + ADRNP \quad (13)$$

S $$TLBS_T(t) = TLBS_T(t-dt) + LBSR \quad (14)$$

Table 2. Information of the model base run.

Parameter	Value
Appointment rate	0.03
Retirement rate in top management group	0.01
Retirement rate in management and professional group	0.004
Retirement rate in supporting group	0.01
Fraction of top management group	0.01
Fraction of management and professional group	0.22
Fraction of supporting group	0.77
Range of retirement rate for each salary scheme in top management group	0.002 - 0.6
Range of retirement rate for each salary scheme in management and professional group	0.0001-0.5
Range of retirement rate for each salary scheme in supporting group	0.0001-0.2

R $LBSR = \sum TS_{V1-V7}$ (15)

where R_T = retirement in top management group, W_T = workers in top management group, RR_T = retirement rate of top management group, TS_{V1-V7} = total salary in scheme V1-V7, LBS_{V1-V7} = last basic salary in scheme V1-V7, RW_{V1-V7} = retired workers in scheme V1-V7, SA_{V1-V7} = salary adjustment in scheme V1-V7, $ADRP$ = adjustment rate based on percentage, $ADRNP$ = adjustment rate based on non percentage, $TLBS_T$ = total last basic salary in top management group, and $LBSR$ = last basic salary rate.

Pension expenditure sector

The pension expenditure sector is the focus of this study because it is the main interest of the proposed model and related to all other sectors. In pension expenditure sector, the pension expenditure is calculated for top management group (similar procedures applies to management and professional and supporting group) by referring to the principles used in Shimada et al. (1990) and Jimeno et al. (2008). From the total last basic salary in top management group, the expected pension expenditure is determined by the total last basic salary and accrual rate. The calculation of pension expenditure includes pension adjustment too. It means when the salary adjustment is announced, the pension annuity for all pensioners is adjusted to the same rate as in salary adjustment. The pension adjustment consists of two types of adjustment rate which are based on percentage and non-percentage. Pension adjustment based on percentage adjustment rate is influenced by the pension expenditure and the percentage of adjustment rate. While, pension adjustment based on non-percentage adjustment rate is determined by the total numbers of pensioners and the non-percentage adjustment rate, RM 110. Simultaneously, pension expenditure is affected by benefit cessation rate. The equations of this sector are (**S** = Stock, **R** = Rate, **C** = Converter):

S $PE_T(t) = PE_T(t-dt) + (EPE + PA - BC) * dt$ (16)

R $EPE = TLBS_T * ACR$ (17)

R $PA = (PE * ADRP) + TANP$ (18)

C $TANP = RW_T * ADRNP$ (19)

where PE_T = pension expenditure for top management group, EPE = expected pension expenditure, PA = pension adjustment, BC = benefit cessation, $TLBS_T$ = total last basic salary for top management group, ACR = accrual rate, $TANP$ = total adjustment based on non percentage $ADRP$ = adjustment rate based on percentage, and $ADRNP$ = adjustment rate based on non percentage.

Pension expenditure for management and professional group and supporting I and II group is calculated as similar procedures applies to top management group. In management and professional group, the salary schemes ranges from scheme 41 until scheme 54 while in supporting group, the salary schemes are ranges from scheme 1 until scheme 16 for supporting Group II and scheme 17 until scheme 40 for supporting Group I.

SIMULATION AND RESULTS

An actual data provided by Public Service Department is used to simulate the system dynamics model of pension expenditure from 1995 to 2027. The time step for simulation is 1 year and information of the model base-run is listed in Table 2.

In the base-run simulation, we assume the initial value of accrual rate is 0.5. This rate implies that all workers have been in service for 25 years and eligible to received 50% pension annuity from their last basic salary. We also assume starting from 2008 that the pension annuity will be paid continuously to the eligible family member if the pensionable officer died. The base-run simulation results of pension expenditure for top management group, management and professional group and supporting I and

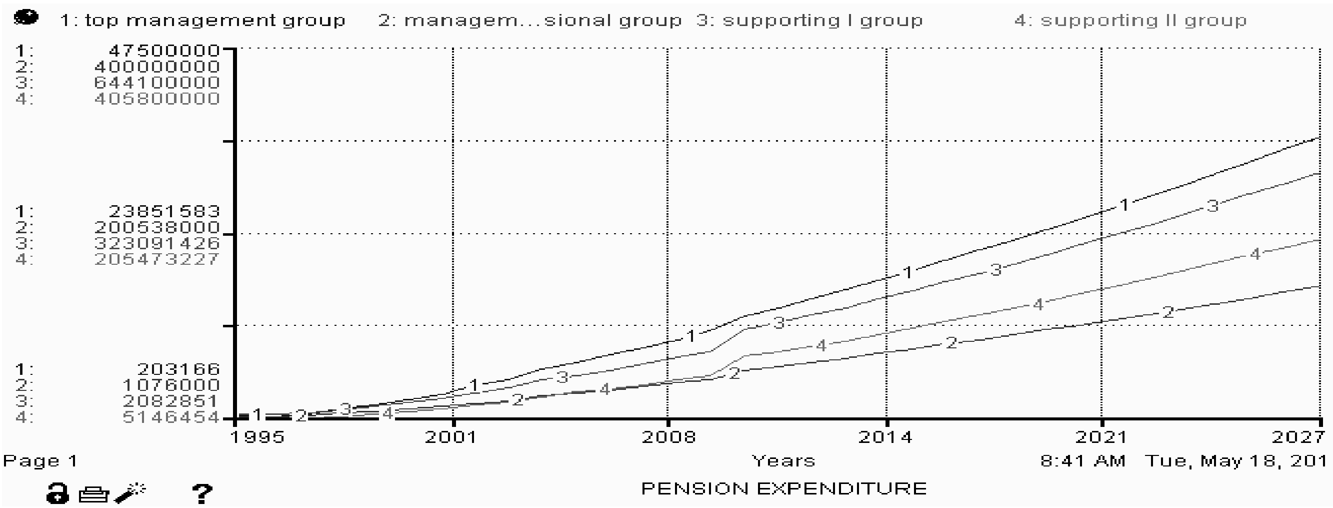


Figure 9. Simulation result of pension expenditure for all group of service.

Table 3. Assumptions on future salary adjustment rate.

Group of service	Salary adjustment rate		
	2013 (%)	**2018**	**2023 (%)**
Top Management	10	RM 110	7.5
Management and profesional	10	RM 65	15
Supporting I	10	RM 15	25
Supporting II	10	RM 15	35

supporting II group are presented in Figure 9. Along with the time, it is shown that pension expenditure for all group of service increased. The effect of salary adjustment can be seen clearly after 2008 in which pension expenditure is continuously increased for each service group.

Next, two different scenarios were simulated to examine whether the simulation model perform correctly when some parameters value were changed. In each scenario, different shocks on certain parameters were imposed, and the effect on total pension expenditure (total pension expenditure is the summation of pension expenditure for all group of service) was analyzed by comparing the result with the base-run scenario. In this simulation, salary adjustment rate, appointment rate and retirement rate were chosen as a testing parameter since these factors have significant influence on pension expenditure.

Scenario I

In the first scenario, the parameters involves were salary adjustment rate, appointment rate and retirement rate. There were two types of salary adjustment rate; (1) adjustment rate based on percentage and (2) adjustment rate based on non-percentage. According to policy in Malaysia's pension system, depending on government's financial capability, for every period of 5 years the basic salary will be adjusted. From this policy, three salary adjustment; in 2013, 2018, and 2023, will be applied in this scenario. We assumed the salary adjustment rate will follow the same rate as in the historical data (Table 3). Then, the value of appointment rate and retirement rate for each group of service remains the same as in the base-run simulation.

Figure 10 displayed the result of salary adjustment in 2013, 2018 and 2023. It shows that the graph of base-run scenario and salary adjustment shock scenario increased along time. Also, it is observed that the graph with salary adjustment scenario show a significant increase in 2023 when there is relatively higher salary adjustment shock in the simulation model. It is indicate that the system has successfully captured the salary adjustment shocks.

Scenario II

In scenario II, the parameters involves were the same as Scenario I with an introduction of shock on appointment rate and retirement rate starting from 2009 until 2027. We

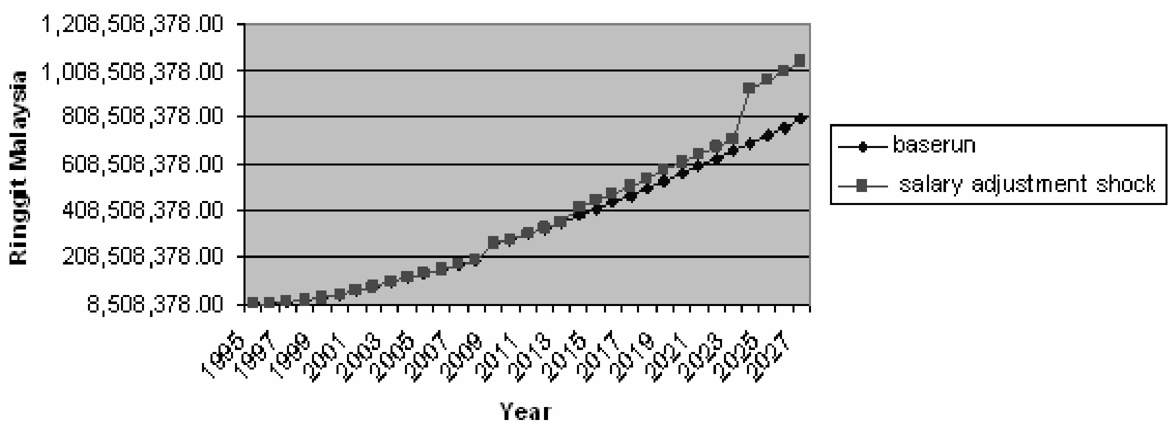


Figure 10. Simulation result of total pension expenditure with salary adjustment shock.

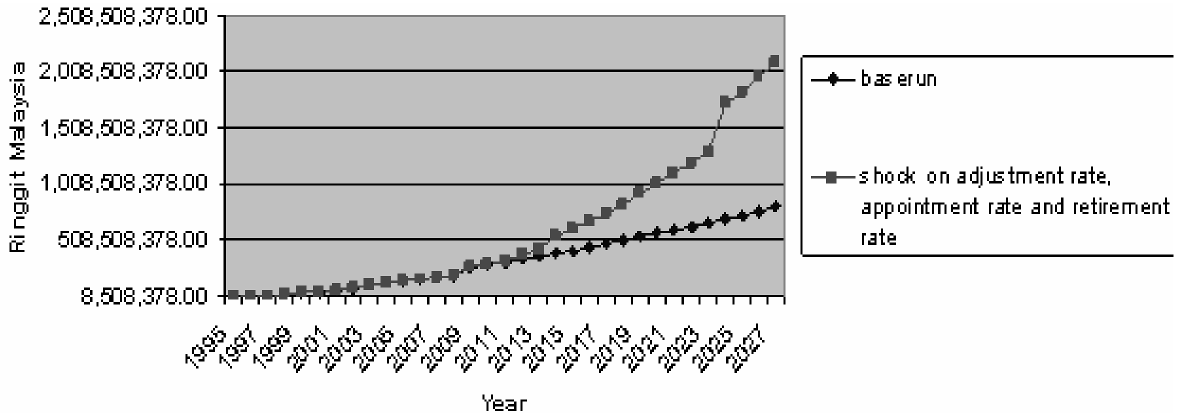


Figure 11. Simulation result of total pension expenditure with salary adjustment, appointment rate and retirement rate shock.

assumed the value of appointment rate and retirement rate double from the original values in the base-run simulation, that is, appointment rate increased to 0.06 and retirement rate for top management, management and professional group and supporting group increased to 0.02, 0.008 and 0.02, respectively. Meanwhile, value of salary adjustment rate will remain the same as in Scenario I. Figure 11 depicted the result of total pension expenditure with a shock imposed on salary adjustment, appointment rate and retirement rate. The increment of appointment rate and retirement rate values causes higher pension expenditure. It is because more workers were retired and thus policymakers have to pay more pension annuity. Therefore, the simulation model shown significant changes when a shock on salary adjustment rate, appointment rate and retirement rate are simultaneously imposed. There was a significant increment of pension expenditure when a higher value of salary adjustment rate (particularly in 2023), appointment rate and retirement rate imposed in the simulation. Therefore, it is proved that the design of system dynamics model of pension expenditure model is acceptable/reasonable and the model can reflect different impact on pension expenditure due to demographic and salary changes.

APPLICATION OF THE MODEL

Based on developed system dynamics model, a management flight simulator was constructed as described previously. Management flight simulator is a user's interface that acts as a decision making tool for policymaker to simulate interactive experimentation of policy changes. We simulate the effect on pension expenditure with accrual rate increased to 0.6 using the management flight simulator. The increment of accrual rate to 0.6 means policymaker has to pay 60% pension annuity from workers' last basic salary and we assumed the pension annuity will continuously paid until the pensioners (or pension recipients) died. The result of the simulation in 2027 is particularly shown in Table 4.

Table 4. Simulation result of pension expenditure in 2027.

Pension expenditure in 2027 (in Ringgit Malaysia)			
Top management	**Management and professional**	**Supporting I**	**Supporting II**
36,446,689.23	143,339,998.42	432,444,383.82	200,573,870.30

From the simulation result, with an accrual rate of 0.6, pension expenditure in 2027 for top management, management and professional, Supporting I and II group reaches approximately RM 36,446,689.23, RM 143,339,998.42, RM 432,444,383.82 and RM 200,573,870.30, respectively. It is shown that pension expenditure in each group of service in 2027 increases 100% from pension expenditure in 1995. Higher pension expenditure was affected due to increment of accrual rate and higher life expectancies of pensioners (or pension recipients) which imply policy maker have to pay pension annuity for a longer time. Based on the simulation conducted, it can be concluded that demographic and salary changes will continuously affect pension expenditure. Also, we believe that the development of management flight simulator of pension expenditure is a highly effective tool in analyzing the impact of demographics risk and salary risk on pension expenditure.

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