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**A DYNAMIC MODEL OF THE PERAK WELFARE PROGRAM
TOWARDS ZERO RATED POVERTY**

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**MASTER OF SCIENCE (DECISION SCIENCE)
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Abstrak

Perak telah menjalankan pelbagai program bertujuan menangani masalah kemiskinan. Namun begitu, kadar kemiskinan di Perak masih di antara yang tertinggi di Malaysia. Oleh itu, terdapat keperluan untuk memahami interaksi antara faktor-faktor yang menyumbang kepada kemiskinan dan mengenal pasti strategi yang paling berkesan untuk membasmi kemiskinan. Kajian ini membangunkan model sistem dinamik untuk menilai keberkesanan Program Kesejahteraan Perak dalam mencapai kadar kemiskinan sifar. Model ini menggabungkan gelung maklum balas dan hubungan bersandarkan masa antara faktor utama seperti pendidikan, pendapatan, pekerjaan, dan intervensi kebajikan. Dengan menggunakan perisian Vensim, satu model stok dan aliran dibangunkan untuk mensimulasikan tingkah laku dinamik kemiskinan di bawah pelbagai senario dasar. Data untuk model ini diperoleh daripada sumber primer dan sekunder, termasuk temu bual dengan pegawai program dan laporan kerajaan. Hasil kajian menunjukkan bahawa pelaburan jangka panjang dalam skim pendidikan dan pekerjaan memberikan pengurangan kemiskinan yang paling ketara 90.6%, mengatasi langkah jangka pendek seperti bantuan kewangan langsung. Dengan menyemak semula peruntukan belanjawan berdasarkan analisis sensitiviti dan melaksanakan intervensi yang disasarkan, kajian ini membuktikan bahawa pendekatan yang terkoordinasi dan berasaskan data dapat memutuskan kitaran kemiskinan di Perak. Model yang dibangunkan memberikan perspektif yang jelas tentang dinamik kompleks pengurangan kemiskinan, menawarkan penggubal dasar alat yang teguh untuk merancang dan menilai strategi kebajikan dalam mencapai hasil pembasmian kemiskinan yang saksama dan berimpak tinggi.

Kata kunci: Pembasmian kemiskinan, Sistem Dinamik, Pengurangan kemiskinan Perak, Skim Pendidikan dan Pendapatan, Isi rumah berpendapatan B40.

Abstract

Perak has implemented many programs to tackle poverty issues. Despite various programs, the poverty rate in Perak is still among the highest rate in Malaysia. Therefore, there is a need to understand the interplay of factors contributing to poverty and identify the most effective strategies for poverty eradication. This study develops a system dynamics model to evaluate the impact of the Perak Welfare Program on achieving a zero-poverty rate. The model incorporates feedback loops and time-dependent relationships among key factors such as education, income, employment, and welfare interventions. Using Vensim software, a stock-and-flow model was developed to simulate the dynamic behavior of poverty under different policy scenarios. Data for the model were drawn from both primary and secondary sources, including interviews with program officers and government reports. The findings reveal that long-term investments in education and employment schemes yield the most significant reductions 90.6% in poverty, outperforming short-term measures such as direct financial aid. By revising budget allocations based on the sensitivity analysis and implementing targeted interventions, the study demonstrates that a coordinated and data-driven approach can effectively break the poverty cycle in Perak. The developed model provides clear perspective into the complex dynamics of poverty reduction, offering policymakers a robust tool for designing and evaluating welfare strategies in achieving equitable and impactful poverty eradication outcomes.

Keywords: Poverty eradication, System Dynamics, Perak poverty reduction, Education and income schemes, B40 households' income.

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Table of Contents

Permission to Use	ii
Abstrak	iii
Abstract.....	iv
Acknowledgement	v
Table of Contents	vi
List of Tables.....	viii
List of Figures.....	ix
CHAPTER ONE INTRODUCTION.....	1
1.1 Introduction to Poverty Problem.....	1
1.2 Background of Study.....	2
1.3 Problem Statement.....	7
1.4 Research Questions.....	8
1.5 Research Objectives.....	8
1.6 Scopes of Study.....	9
1.7 Thesis Outline.....	9
CHAPTER TWO LITERATURE REVIEW.....	11
2.1 Introduction.....	11
2.2 Issues and Challenges of Poverty Problem.....	11
2.2.1 Education.....	13
2.2.2 Employment Status.....	13
2.2.3 Level of Income.....	14
2.2.4 Geographic Characteristic and Natural Disaster.....	15
2.3 Methods Used in Analysing Poverty Problem.....	15
2.3.1 Statistical Method.....	17
2.3.2 Mathematical Method.....	20
2.3.3 Simulation Method.....	21
2.3.4 Applicability of System Dynamics for The Study.....	24
2.4 System Dynamics Approach	25
2.4.1 The Concept of System Dynamics.....	25
2.4.2 System Dynamics in Application.....	27

2.5 Summary	32
CHAPTER THREE RESEARCH METHODOLOGY.....	33
3.1 Introduction.....	33
3.2 Research Design.....	33
3.3 Data Source and Collection.....	35
3.4 Development of the Dynamic Model of Perak Eradication Welfare Program.....	35
3.4.1 Problem Articulation.....	37
3.4.2 Formulation of Dynamic Hypothesis.....	44
3.4.3 Development of Simulation Model.....	49
3.5 Base Run Simulation	54
3.6 Model Testing	58
3.6.1 Structure Validation	59
3.6.2 Behavior Validation	63
3.7 Summary	65
CHAPTER FOUR ANALYSIS AND FINDINGS.....	66
4.1 Introduction.....	66
4.2 Policy Design and Evaluation	66
4.3 Summary	70
CHAPTER FIVE CONCLUSION.....	71
5.1 Introduction.....	71
5.2 Achievements of Research Objectives.....	71
5.3 Discussion of the Findings.....	72
5.4 Limitations of the Research.....	73
5.5 Future Research.....	74
5.6 Conclusion.....	74
REFERENCES.....	76
APPENDICES.....	83

List of Tables

Table 2.1 Summary of statistical method used in poverty.....	18
Table 2.2 Summary of mathematical model used in poverty.....	20
Table 2.3 Summary of simulation method used in poverty.....	23
Table 2.4 Summary of SD Modelling Process.....	27
Table 2.5 Application of system dynamics by previous researcher.....	28
Table 3.1 Type of variables.....	38
Table 3.2 List of the variables in the system.....	49
Table 3.3 Information of initial value of stocks.....	54
Table 3.4 Simulated numerical result of people in poverty.....	57
Table 3.5 Simulated numerical result of People Welfare Development Program Perak Fund.....	57
Table 4.1 New budget allocation for schemes.....	68
Table 4.2 Number of people in poverty.....	69



List of Figures

Figure 1.1: Rate of Poverty from 1970 – 2022.....	3
Figure 1.2: The percentage of households with the lowest income 40% (B40) by state in 2014.....	6
Figure 2.1: The relation between level of education, employment and income	14
Figure 2.2: Type of used in poverty.....	16
Figure 2.3: The modeling process is iterative	26
Figure 3.1: Research process flow.....	34
Figure 3.2: System Dynamics modelling process.....	36
Figure 3.3: Total population in Perak from 2014 until 2016.....	39
Figure 3.4: Poverty rate in Perak from 2014 until 2016.....	39
Figure 3.5: The total recipient of Housing Assistance Scheme (INFRA) from 2014 until 2016.....	40
Figure 3.6: The total recipients of Income Increment Scheme (AMANJAYA Kiosk) from 2014 until 2016.....	40
Figure 3.7: The total customers of 1 AMANJAYA Mobile Store from 2014 until 2016....	41
Figure 3.8: The total recipients of Food Box Scheme from 2014 until 2016.....	41
Figure 3.9: The total recipients of Micro Credit Loan Scheme from 2014 until 2016.....	42
Figure 3.10: The total trainees of Automotive Training Scheme from 2014 until 2016.....	42
Figure 3.11: The total students of Education Excellent Scheme from 2014 until 2016.....	43
Figure 3.12: The total allocation for People Welfare Development Program from 2014 until 2016.....	43
Figure 3.13: The dynamic relationships and feedback loops within the People Welfare Development Program in Perak.....	45
Figure 3.14: Stock and flow diagram of Perak Population and People in Poverty.....	50
Figure 3.15: Stock and flow diagram of Perak Welfare Development Program Perak Fund.....	52
Figure 3.16: Stock and flow diagram of Perak Development Welfare Program Model.....	53
Figure 3.17: Simulated result of people in poverty.....	56
Figure 3.18: Simulated result of People Welfare Development Program Perak Fund.....	56
Figure 3.19: The validation tests of the Perak Development Welfare System.....	59

Figure 3.20: The dimensional consistency test of the Perak Development Welfare System.	61
Figure 3.21: The extreme condition test of the Perak Development Welfare System.....	62
Figure 3.22: Behavior reproduction test result for the total population in Perak.....	64
Figure 3.23: Behavior reproduction test result for the People Welfare Development Program Perak Fund.....	64
Figure 3.24: Behavior reproduction test result for the total people in poverty.....	65
Figure 4.1: The results of interventions for the People Welfare Development Program Perak Fund	69
Figure 4.2: The results of interventions for the number of people in poverty	70



CHAPTER ONE

INTRODUCTION

1.1 Introduction to Poverty Problem

Poverty has been an endless problem in numerous countries around the world. Tazoacha (2001) stated that poverty, the most persistent issue, is the oldest factor contributing to problems in developing countries. The World Bank (2001) defines poverty as a state of lacking well-being that can be attributed to various factors, such as insufficient income or assets, exposure to natural disasters, and barriers to education and employment. In simple terms, the World Bank primarily measures poverty by evaluating income.

Poverty drives the poor to a low level of well-being and education, deficient capacity and the chance to live better. The primary goal of The World Bank is to eradicate poverty worldwide through promoting opportunity, empowerment, and security as three key means to address this global challenge (Rumbewas, 2005). The first way is promoting the opportunity. People that live in poverty reliably accentuate the centrality of material opportunities. This implies employments, streets, electric power, credit, markets for their produce, and the schools, sanitation, water, and health services that support the health and abilities basic for work.

Besides, enhancing security is the next step in order to tackle the world issue on poverty that have been elevating by the World Bank organization. Lessening susceptibility to economic stuns, ill health, natural disasters, and inability. This requires effective national action to deal with the

danger of economy wide stuns and powerful components to decrease the dangers faced by poor people, including health- and climate-related dangers. Furthermore, it also requires building the advantages of people that live in poverty, differentiating household activities, giving a scope of protection components (insurance mechanism) to adapt to adverse stuns from public work to remain in-school projects and medical coverage.

Despite the above ways, poverty is still a world's major challenge. With the global population at around 8 billion people in 2023, approximately 700 to 750 million people are considered to be living in extreme poverty (World Bank, 2023). Nevertheless, the continuous presence of poverty in many different nations after uncouneted endeavor to eliminate this problem has recreated the enthusiasm in looking for factors of poverty trap in many creating nations (Ansah, 2010). Similar to many other countries, Malaysia as developing country is facing the challenge of poverty problem. The following section discusses about poverty in Malaysia and the background of the problem under study.

1.2 Background of Study

Even though Malaysia has been independent for 60 years and has gone through many periods of progress, poverty remains the primary challenge in the country. The exposure of impoverished living conditions within a cycle of poverty has caused significant stress for Malaysian institutions and administration (Razak, Norshahidi, Yusof & Ibrahim, 2014). Although the government of Malaysia has made significant efforts and implemented various measures to combat poverty (Shahimi, Marzuki & Embong, 2013) the poverty rates in Malaysia have decreased, as depicted in

Figure 1.1. It has to be acknowledged that the problem of poverty is still a major issue for the country since 6.2% of Malaysians in 2022 which is 487, 576 of Malaysia's households live in poverty. Indeed, this number could pose a significant obstacle for the government in reaching zero poverty rate.

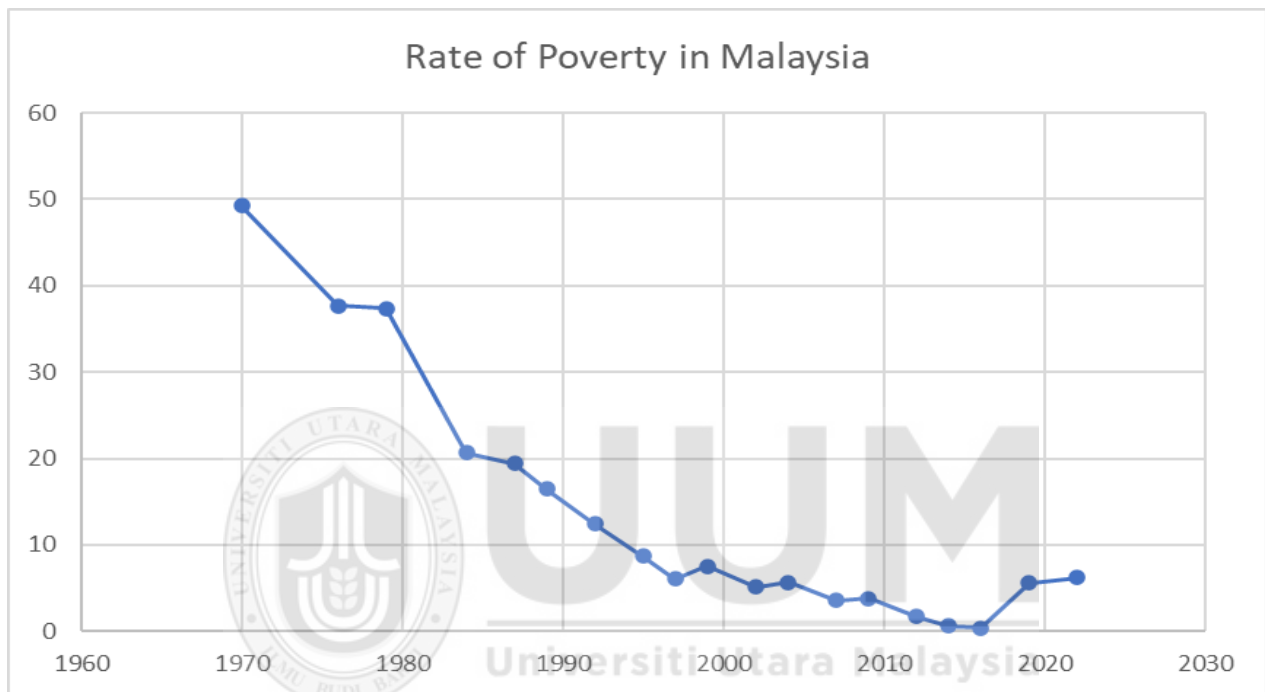


Figure 1.1. Rate of Poverty from 1970 – 2022

Source: Department of Statistic Malaysia (2022)

Figure 1.1 shows that from 1970 to 2018, Malaysia's poverty rate has significantly dropped, reflecting the nation's robust economic growth, government initiatives in rural development, and advancements in education, healthcare, and infrastructure. However, the poverty rate in Malaysia increased slightly in 2019 until 2022 compared to previous years. The rise in poverty in Malaysia can largely be attributed to the socioeconomic impacts of the COVID-19 pandemic.

Poverty has a negative impact on the Malaysia nation in terms of economy and social. In term of economic effects, the consequences of poverty have resulted in a rise in government expenditures. The government's rise in spending is a result of having to shoulder significant costs in order to eliminate poverty. This significant level of spending will consequently impact other development initiatives as it has been utilized to fund poverty alleviation programs (Oriavwate & Ukawe, 2018)

On the other hand, in term of social impact, Rahsid et. al (2018) stated the effect of poverty will cause the poor children do not have a chance in educational opportunities. The majority of them had to leave school early in order to assist their family financially by working. This will lead them to engage in illegal activities as they lack the necessary education for formal employment and lack the funds to start a business. Severe outcomes for those residing in cities are linked to criminal activities like burglaries (Bahrom, 2004).

Additional impacts are observed in relation to nature pollution. Most of the poor individuals who contribute to environmental pollution are typically poor squatters, especially when it comes to public amenities. Severe and unpleasant living conditions, limited education, and a lack of essential services increase susceptibility to disease. They are also required to cause external impacts such as water and air pollution on other individuals when they dispose of waste into rivers or the nearby environment (Chukwu, 2008). Their methods of resource utilization for survival are detrimental to the surrounding resources.

Talib et al. (2016) has reported that the low number of incomes is leading to the definition of poverty because low income cannot meet basic needs. Malay Mail (2019) stated that income gap or income inequality was a big problem in Malaysia. As a matter of fact, this issue poses the biggest challenge for the government in achieving the goal of becoming a high-income country in the future. According to the Department of Statistics Malaysia (2020), households with monthly incomes below RM 2,208 are now considered poor, an increase from the previous threshold of RM 980, reflecting changes in consumption patterns and costs.

According to Economic Planning Unit, Prime Minister's Department (2013) stated that poverty rate in Perak is second higher compared to other states in Peninsular Malaysia. Based on Figure 1.2, Perak has the highest percentage of household with the lowest income (B40) in Malaysia. Based from the record that have been provided by the Department of statistic Malaysia (2014), there are a total of 347 300 number of households with the lowest income 40% (B40) in Perak. Therefore, a poverty eradication program, was inspired by Yang Amat Berhormat Dato' Seri Diraja Dr. Zambry Bin Abd Kadir when he was appointed as Menteri Besar of Perak in 2010. This programme helps the Perak government deal with poverty problem in the state.

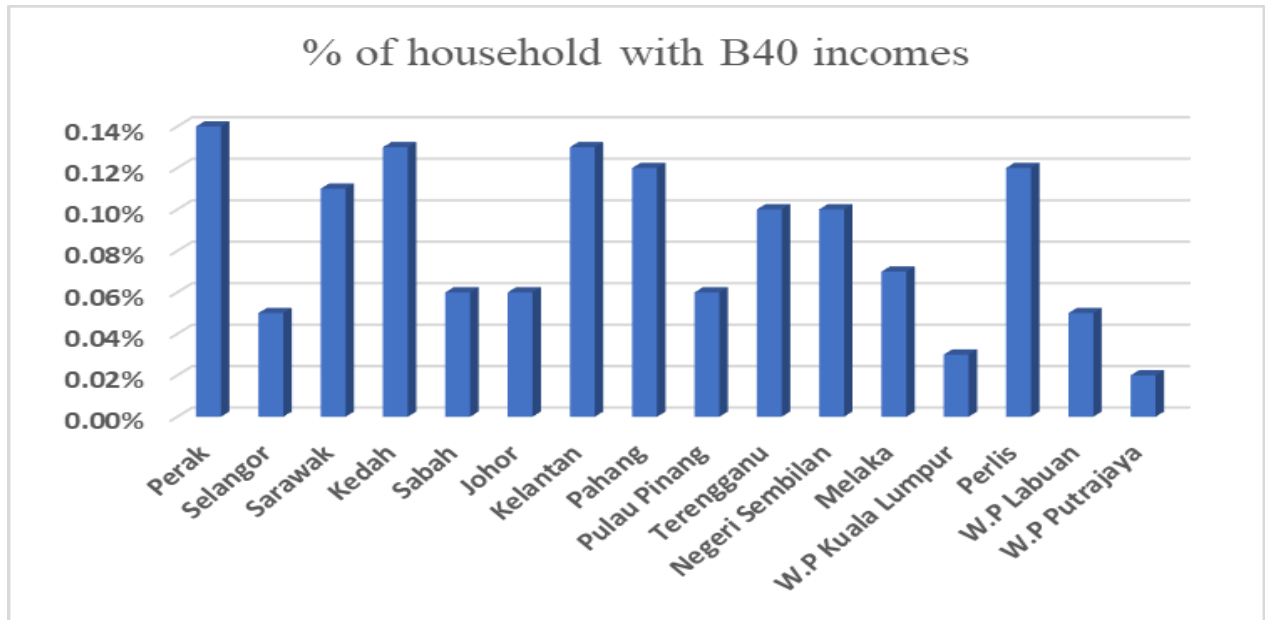


Figure 1.2. The percentage of households with the lowest income 40% (B40) by state in 2014

Source: Department of Statistic Malaysia (2014)

People Welfare Development Program is a poverty eradication program by the Perak government focusing on poverty reduction. The schemes that involved under this program such as; Housing Assistance Scheme (INFRA), Income Increment Scheme (AMANJAYA Kiosk), Automotive Training Scheme, Education Excellence Scheme, Mobile Store 1 AMANJAYA, Micro Credit Loan Scheme and Food Box Scheme. According to Utusan Malaysia (2013), these schemes managed to reduce the poverty rate in Perak from 3.5 per cent in 2009 to 1.5 per cent in 2012. However, the primary objective of this program is to achieve zero poverty rate. To put this study into points of view, next section discusses the problem under study in detail.

1.3 Problem Statement

Much of the existing literature on poverty in Malaysia has utilized linear approaches to analyze the problem. For instance, Mohd (2014) utilized chi-square analysis to investigate how poverty is related to sociodemographic factors in elderly populations. while Razak & Ibrahim (2014) used logistic regression to identify poverty determinants and predict the risk of poverty. Although these statistical techniques are useful for creating predictive models, they have significant limitations. Specifically, they struggle to predict continuous outcomes and often lead to premature conclusions about causal relationships. Correlation between variables does not necessarily indicate causation, which can result in misleading findings.

Although the Perak government has implemented the Perak Welfare Program, which includes seven schemes aimed at eradicating poverty, challenges remain in understanding the poverty issue in the state. To the best of our understanding, there have been no studies that have offered a complete perspective on the factors affecting poverty and the dynamics of the poverty issue in Perak. Poverty is inherently complex and dynamic, with interrelated factors that involve feedback mechanisms and change over time. To address these complexities, this study will incorporate a system dynamics approach to analyze poverty in Perak. In contrast to previous studies, this study employs system dynamics to identify the primary factors influencing poverty and to suggest the most effective policies or schemes to eradicate poverty in Perak. System dynamics enables a more thorough comprehension of the behavior of intricate and dynamic systems as time progresses. Hence, this study aims to determine the main factors causing poverty in Perak and suggest solutions to tackle them.

1.4 Research Questions

This study is driven by the following research questions:

1. What are the key factors contributing to poverty in Perak?
2. What is the most appropriate method for analyzing the complexities of poverty issue in Perak?
3. How can the Perak Development Welfare Program be improved to more effectively address and reduce poverty in Perak?

1.5 Research Objectives

The main objective of this study is to model the dynamic of poverty in achieving a zero-poverty rate in Perak through Perak Development Welfare Program. To accomplish this primary objective, the following specific objectives have been established:

1. To identify the key factors contributing to the poverty issue in Perak.
2. To develop a model of the poverty problem in Perak, analyzing the relationships between these factors using system dynamics modeling methods.
3. To evaluate the impact of interventions and recommend improved policy within the Perak Welfare Development Program to effectively address and reduce poverty in the region.

1.6 Scopes of Study

This study focuses on addressing the poverty issue in Perak, Malaysia. The study takes place in Perak and includes individuals classified as poor by Yayasan Bina Upaya Darul Ridzuan (YBUDR), a foundation dedicated to supporting those in need. The study population includes residents of Perak who are Malaysian citizens, encompassing both genders, all races (including Orang Asli, or Aborigines), individuals aged 15 years and above. This age group is selected as it allows YBUDR to target populations where economic activity and decision-making are more directly measurable. The study also includes individuals with varying educational backgrounds and covers all residential areas across the 10 districts of Perak, as of the years 2014-2016.

1.7 Thesis Outline

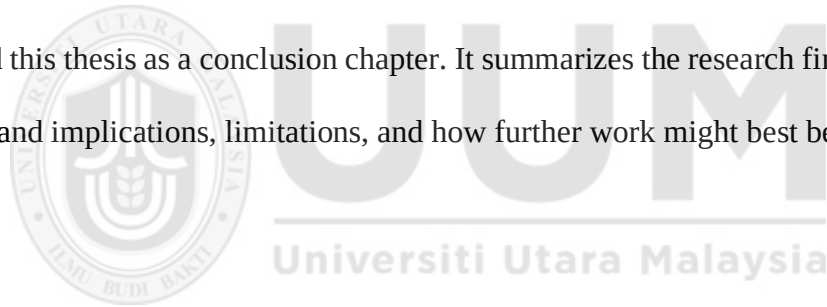
This outline serves as a structured guide to organize the key sections of this thesis, ensuring clarity and a logical flow, while also helping to maintain focus on the main objectives and research questions, facilitating a comprehensive understanding of the topic, and providing a clear roadmap for readers to follow throughout the document.

Chapter 2 discusses the main issues in poverty problem and gives an overview of past poverty literature. This section additionally presents an overview of literature on techniques that have been used from past researcher and system dynamics method.

Chapter 3 explains the research method utilized in this research to accomplish research objectives. This chapter clarifies about data source and collection, and steps involved in model development and model testing

Chapter 4 discusses about the output analysis of this research. The findings of this study list the factors that contribute to poverty, developed a system dynamics model that explains about the relationship between factors of poverty, and recommends the best policy to reduce poverty in Perak.

Chapter 5 ended this thesis as a conclusion chapter. It summarizes the research findings, discusses its contribution and implications, limitations, and how further work might best be directed.



CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In order to identify the research gap for this study, this chapter will explain about a synthesis of theoretical and empirical literature used in this study. Section 2.2 discusses the issues and challenges in poverty problem. Section 2.3 describes the method that have been used in analysing the poverty problem. Section 2.4 explains briefly about the system dynamics method and also describes this method that has been used by previous researcher in analysing poverty issue.

2.2 Issues and Challenges of Poverty Problem

Poverty has distinctive meanings to various individuals. "Poverty" was originating from the Latin term homeless, which translates to impoverished, is rooted in the word's pau-and pario, signifying "yielding nothing," referring to unproductive livestock and fields (Westover, 2008). In 2005, the World Bank Organization stated that poverty is hunger, lack of shelter, being ill and not having access to a doctor. Poverty means being unable to attend school and not knowing how to read. Townsend (2006) suggests that poverty is characterized by a lack of a job, anxiety about what lies ahead, and getting through each day without support. Throughout history, poverty has always been associated with income, which remains a central concept today.

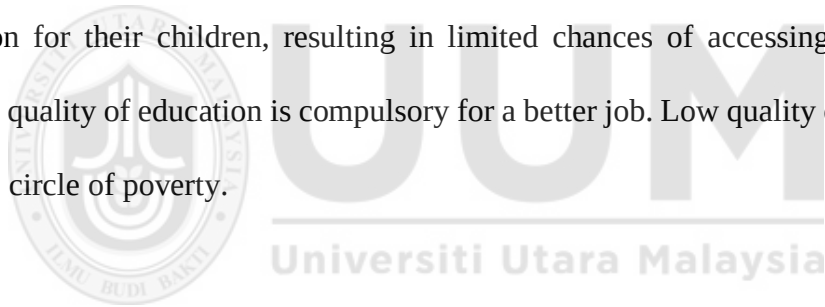
Poverty is a significant socioeconomic issue worldwide that has been subjectively and quantitatively connected with different factors, for example, the jobless, untalented, resigned, socially-avoided and destitute (Pena-Casa & Latta, 2004). Additionally, natural disaster can also drive individuals into unexpected poverty (De La Fuente, 2010). While poverty fortifies individuals' powerlessness to natural hazards, disasters exacerbate their effectively tricky conditions (Salazar, Diaz & Lopez, 2016). This creates a never-ending cycle that could lead to situations of poverty traps (De la Fuente, López-Calva, & Revi, 2008). As per the most recent, generally scattered, assessments of worldwide poverty by the World Bank (2012) in 2008, 22% of the population in creating nations lives with under \$1.25 a day in buying power equality terms, speaking to 2.5 billion people in outrageous destitution.

Poverty does not only involve working-age parents, but it is also involving children and elderly. Mohd (2014) stated that less than 10% of elderly lived in poverty and level of education, living arrangement, and employment status are the elements of poverty in elderly. According to UNICEF (2009), although with urbanisation the proportion of kids under 15 years of age living in rural poverty has declined generally speaking, yet this has led to almost 40% of children under 15 living in urban areas being in poverty. Thus, the follow subsections discuss about the factors that influenced poverty in detail.

2.2.1 Education

Poverty is involving several dimensions issue that incorporates low access of chances for an education. Therefore, education needs to be given due attention and awareness so that the quality of job and salary can be improved also enhancing the quality of life (Romer, 1990). Countries with high poverty rates are due to lack of skills, knowledge and education in writing, reading and making a right the choice for a specific situation will get the low income.

Aslankurt (2013) stated that income level for family will give substantial effect on the quality of their children education. Low-income families do not have the financial means to afford a higher quality education for their children, resulting in limited chances of accessing high school or university. High quality of education is compulsory for a better job. Low quality of education will lead to a vicious circle of poverty.



2.2.2 Employment Status

For a relationship between employment and poverty, a better poverty profile will lead to employment targeting possible. The capability of by far most of family to escape from poverty will rely upon their income from employment. Unemployment leads to zero earning (Haughton & Khandker 2009). The unemployment rate among poor is higher due lack of education or knowledge and lead to poverty.

According to Bacaksızlar et. al (2015), there are three level of employment sector; highly skilled, semi-skilled and unskilled. People with high education background can conquer these three levels of employment sector meanwhile for those who has low education background will face harsh competition in getting the job. As refer in Section 2.3.1, mostly people that has low education level is from the poor family. Hence, it will lead to a vicious circle of poverty as shown in Figure 2.1.

2.2.3 Level of Income

From the previous section, it stated that to get out from poverty is depending on earnings or income. Without some financial support or income, individual is susceptible to live in poverty particularly for an elderly (Mohd, 2014). From the study that has been conducted by Rashid & Samat (2018), stated that most of their respondents is living in poverty because of low income. Hence, it can be concluded that the living conditions of this society are influenced by limited financial factors and thus negatively affect the educational attainment of which it becomes a major obstacle to the outpouring of poverty.

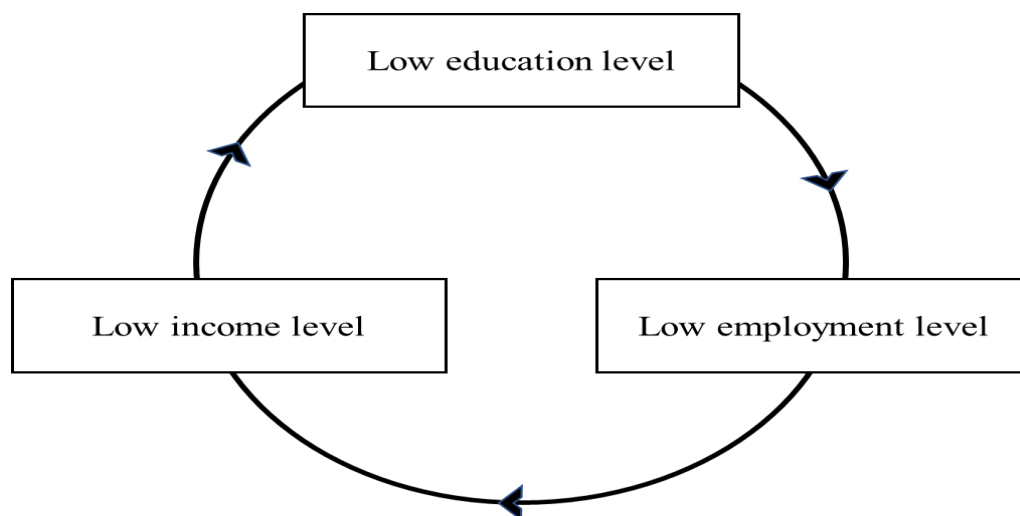


Figure 2.1. The relation between level of education, employment and income

2.2.4 Geographic Characteristic and Natural Disaster

Many of nations are characteristically poor because of the geographic characteristics of the country itself that lead to poor financial development. For instance, many of Africans stay far from the sea coast. Therefore, they need to pay high transportation costs. Additionally, the unfavorable weather conditions in Africa also lead to depleted soils and unpredictable rainfall. Between five million and 12 million hectares of land are lost annually due to extreme degradation, leading to negative impacts on agricultural operations.

According to De La Fuente (2010), natural disaster can still bring about fatal or injury, leads to disturbance of socio-economic activities and devastation to property or physical assets that pushing people into sudden poverty. For example, one third of Bangladesh is hit by floods that occur during the monsoon season each year. This is a serious issue since it has disrupted the agricultural activities. Even though strategies for mitigation and preparation were carried out, natural disaster is still harmful, particular in economic growth.

2.3 Methods Used in Analysing Poverty Problem

In literature, there are several techniques that have been used by previous researcher in poverty domain. There are three type of methods which statistical method, mathematical method and simulation method in analyzing poverty problem (refer Figure 2.2). Section 2.3.1 will explain more about statistical method that have been used in previous studies; chi square analysis and logistic regression.

Next, Section 2.3.2 describes about mathematical modelling that have been used in poverty problem by previous researchers. Section 2.3.3 discusses about simulation method; system dynamics in analyzing poverty problem.

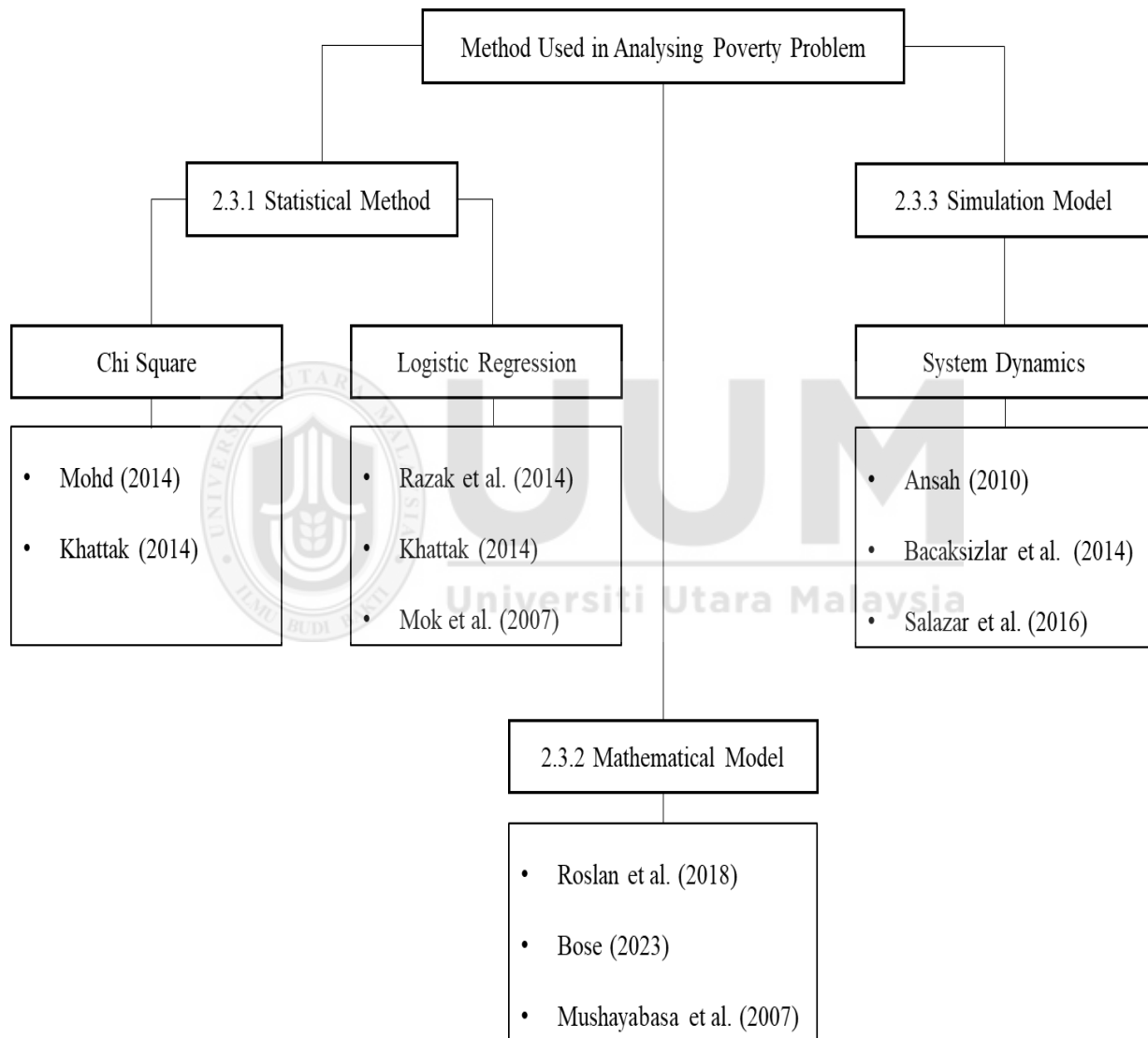


Figure 2.2. Type of methods used in poverty

2.3.1 Statistical Method

There are numerous approaches employed for researching poverty. The majority of prior research examines poverty through the use of statistical methods. Chi square analysis is one of the statistical methods that have been used in poverty problem. Chi square analyses are frequently employed to examine the relationship between categorical variables. In Malaysia, Mohd (2014) utilized chi square analysis to examine the correlation between poverty and various socio demographic factors. Chi square analysis is one of quantitative technique that have been used to analyze poverty incidence among elderly in Malaysia. Result of study have found that education level, living arrangement and employment status have strongly related with poverty incidence among elderly in Malaysia.

Khattak (2014) used chi square analysis in poverty study in Pakistan. The chi square method is utilized to study the relationship between poverty and various demographic factors, leading to disparities in poverty levels. Logistic regression also has been used in this study. Logistic regression method is utilized to examine the connection between a dependent variable and multiple independent variables. The goal of logistic regression is to identify the connection between child labor and poverty. The results show that these variables; gender, household size, household income, household head education and marital status are linked to poverty.

Besides, the study developed a binary logistic regression model to identify factors causing poverty and predict the likelihood of experiencing poverty (Razak et al., 2014). The research revealed that education is a primary concern for both government and households as it is essential for reducing poverty. Insufficient education increases the risks of poverty, while higher education levels increase the likelihood of being not-poor (Razak et al., 2014). From above discussion, statistical methods used in poverty can be summarized as in Table 2.1.

Table 2.1

Summary of statistical method used in poverty

Author	Method Used in Poverty	Considered Factors	Explanation of Method Used
Mohd (2014) <i>Poverty Issues Among Malaysian Elderly</i>	Chi Square Analysis	a) Limited financial support b) Rising of living cost	Chi square analyses test is commonly used for testing relationship between categorical variables.
		c) Health-related issue d) Employment challenges e) Housing issues	This study used the chi square test to evaluate the relationship among poverty with some socio demographic factors and living arrangement on poverty.
Khattak (2014) <i>Relationship between Poverty and Child Labour: A Case</i>		a) Lack of access in education b) Family structure and cultural factor c) Economic factor	The Chi-square method is utilized to analyze the connection between poverty and various demographic factors, leading to the creation of a poverty gap.

<i>Study of Nowshera– Pakistan</i>	Logistic Regression	d) Social inequality e) Lack of government enforcement	The relationship between child labor and poverty was explored using logistic regression.
Razak, Norshahidi, Ibrahim, (2014) <i>Determinants of Poverty</i>		f) Limited awareness of the long-term impact of child labour g) Lack of social support system	The binary logistic regression model is developed in this study in order to distinguish the determinants of poverty and to anticipate the risk of being poor.
Mok, Gan & Sanyal (2007) <i>The Determinants of Urban Household Poverty in Malaysia</i>	Logistic Regression	a) Family structure b) Employment in the informal sector c) High-cost living d) Social welfare	Chi square analyses test is commonly used for testing relationship between categorical variables.
		e) Health and disability f) Education and skill g) Household Income	This study used the chi square test to evaluate the relationship among poverty with some socio demographic factors and living arrangement on poverty.

2.3.2 Mathematical Model

A mathematical model is a representation of a system utilizing mathematical ideas and terminology. The act of creating a mathematical model is known as mathematical modeling. Typically, a mathematical model is made up of relationships and variables. Entities such as algebraic operators, functions, differential operators, and others can establish the relationship. Variables are abstractions of device parameters that are of interest and are able to be measured (Bender, 2000).

Multiple earlier researches have examined the issue of poverty through the application of mathematical methods. In Malaysia, Roslan et al. (2018) employed mathematical techniques to examine this problem. Utilizing ordinary differential equations (ODEs) enables the examination of dynamics within the poverty-poor-crime model in west Malaysia. Table 2.2 presents a summary of past research that utilized mathematical models to analyze the issue of poverty.

Table 2.2

Summary of mathematical model used in poverty

Author	Explanation of Method Used	Limitations
Roslan, Alias, Malik & Zakaria (2018) <i>A Mathematical Model on The Dynamics of Poverty, Poor and Crime in West Malaysia</i>	The primary aim of this research was to develop a dynamic poverty-crime model system for the West Malaysia case study. Utilizing ordinary differential equations (ODEs) enables them to investigate the model.	a) Simplification of complex social dynamics b) Lack of empirical validation

Bose (2023) <i>Growth, Poverty Trap, and Escape</i>	A mathematical analysis was used to analyze equilibrium points to determine the stability and existence of poverty traps. Besides, this analysis explored the conditions under which economies transition between states of poverty and prosperity.	a) Assumption of homogeneity
Mushayabasa, Bhunu, Webb & Dhlamini (2012) <i>A Mathematical Model for Assessing the Impact of Poverty on Yaws Eradication</i>	A mathematical model was created to study how poverty affects the spread of yaws. Robust and high-quality mathematical methods were employed to examine the model's equilibrium points	a) Simplified assumptions b) Data constraints

2.3.3 Simulation Model

Simulation method is one of the most widely used tools. The intricacy of a problem involves diverse factors that are interconnected in multiple ways. Accordingly, the issue under study needs a method that manages with complexity and enables the issue to be seen from different sources. Based on Edmonds (2008), simulation method is the most effective way to illustrate the behaviors of a complex system when a study is generally complex. Simulation technique involves creating a model to represent the characteristics, behaviors, and functions of a selected system or process in order to mimic its functioning. The model depicts the system directly, while the simulation shows how the system functions throughout time.

System dynamics is a viewpoint on future events that focuses on “stocks” also “flows” amidst processes and their relationship. Some instances of poverty traps are illustrated in system dynamics literature, which involve scenarios like accumulating debt, experiencing natural disasters, and lacking access to education opportunities (Ansah, 2010), (Salazar, Diaz & Lopez, 2016), (Bacasizlar & Barlas, 2015). An analysis is conducted using a system dynamics model of an emerging economy, with population, production, and public debt accumulation as key factors. The policy analysis suggested that the most effective way to decrease poverty and public debt accumulation is by increasing public investment or savings (Ansah, 2010).

Meanwhile, Salazar et al. (2016) claimed that the generic framework developed elucidates the dynamics of key pressures in every flood-prone community. According to Gillespie, Robards and Cho (2004) cited by Salazar et al. (2016) people interested in increasing their level of preparedness can recognize that the purpose of this system is to enhance safety levels or raise awareness, as these aspects impact the perceived necessity, leading to the development of infrastructure and the necessary training to boost preparedness levels.

Besides, Bacaksizlar et al. (2015) presented the system dynamics model related to specific aspects of “the vicious circle of poverty”. Their aim to study the relationship among poverty and education opportunity. Based on the findings of their study, equalizing education opportunities is considered a crucial factor in fighting working poverty, along with the increase in the net job growth rate.

Therefore, a system dynamic is a method for comprehending and simulating the actions of intricate systems over a period. It involves internal feedback loops and time delays that impact the behavior of the entire system. From above discussion, simulation method used in poverty can be summarized as in Table 2.3.

Table 2.3

Summary of simulation method used in poverty

Author	Method	Considered Factors	Explanation of Method Used
Ansah (2010) <i>Modeling the Dynamics of Poverty Trap and Debt Accumulation</i>	System Dynamics	a) Income b) High population growth c) Insufficient Investment d) Debt Accumulation	Created a framework by combining system dynamics with poverty trap and debt overhang theory to explain the structural causes of poverty trap and analyze the connection between internal poverty trends and public debt accumulation.
Bacaksizlar and Baslar (2015) <i>The Feedback Dynamics Between Poverty and Education Opportunity: Vicious Circle of Poverty</i>		a) Education b) Employment c) Socio-economic mobility	Created a system dynamics model to analyze the interactions between poverty and educational opportunities. Utilized the system dynamics model for assessing the long-term impacts of social policy suggestions in Turkey.
Salazar, Diaz and Lopez (2016) <i>Natural Disasters and Poverty: Understanding the Systemic Complexity</i>		a) Natural disasters	Developed a structure to examine flood prevention strategies and obstacles in policy creation through the use of System Dynamics methodology.

2.3.4 Applicability of System Dynamics for The Study

System Dynamics is an effective method for understanding, analyzing, and addressing complex problems over time. It employs feedback loops, stocks, and flows to model the behavior of dynamic systems. This approach is applicable across various fields, including poverty analysis, healthcare, environmental systems, and others. It is often regarded as more effective for analyzing poverty than statistical and mathematical methods due to its ability to model complex, interconnected, and dynamic systems (Łatuszyńska, & Fate, 2019). Poverty is not static phenomenon, it characterized by feedback loops, time delays, and non-linear relationships among factors (Ahmad & Kustiwan, 2019) such as health, education, employment, and economic growth.

Furthermore, system dynamics is more effective for poverty analysis because it captures the dynamic feedback loops that drive poverty traps, incorporates time delays to simulate the long-term effects of policies, and handles non-linear and complex systems (Suryani et al., 2012), reflecting real-world interactions. It also allows for policy simulation, enabling the testing of interventions before implementation, and requires less reliance on large datasets compared to statistical methods. While statistical and mathematical approaches provide valuable insights, they often fall short in addressing the long-term, multidimensional, and dynamic nature of poverty. In contrast, system dynamics offers a more comprehensive and actionable understanding of poverty and potential solutions. Therefore, system dynamics is an excellent tool for examining the relationship between poverty and its contributing factors in Perak.

2.4 System Dynamics Approach

System dynamics involves analyzing the behavior of a complex and dynamic system over time by studying policy design and analysis. Since 1960 era, system dynamics method has been broadly used in various areas, for example; finance, economic, education and environmental. The following subsections will discuss more on system dynamics methodology where this study fits into.

2.4.1 The Concept of System Dynamics

System dynamics was first introduced by Jay W. Forrester from the Massachusetts Institute of Technology in the mid-1950s, employing computer-aided techniques (Maani & Cavana, 2000). In the late of 1950s, system dynamic approach was reached out to non-corporate fields (Forrester, 1961). System dynamics is a method that aims to accurately represent the functioning of a system, focusing on understanding and creating policies (Sharp, 1977). In the meantime, Kim (1996) describes system dynamics as a simulation model that deals with deterministic, dynamic, non-linear, and closed boundary systems.

On the flip side, system dynamics is also described as a foundation of feedback control theory that combines both quantitative and qualitative methods to study the dynamic behaviors of system growth and changes (Maani & Cavana, 2000). According to Jay Forrester (2007), system dynamics functions as a methodology that focuses on examining, studying, and simulating the actions of complex systems. System dynamics stands out from other computer simulation methods due to its inclusion of feedback loops, stocks, and flows.

The primary objective of system dynamics is to understand the interactions between elements within a system. The parts of a system communicate through feedback loops, causing a modification in one component that affects the rest. In system dynamics, the issue being examined is analyzed as a complete system. System dynamics improves decision-making and policy formation by integrating cause and effect relationships, time delays, and feedback loops in a dynamic system behavior mode. According to Sterman (2000), the modelling process of system dynamics involves 5 iterative stages (refer Figure 2.3)

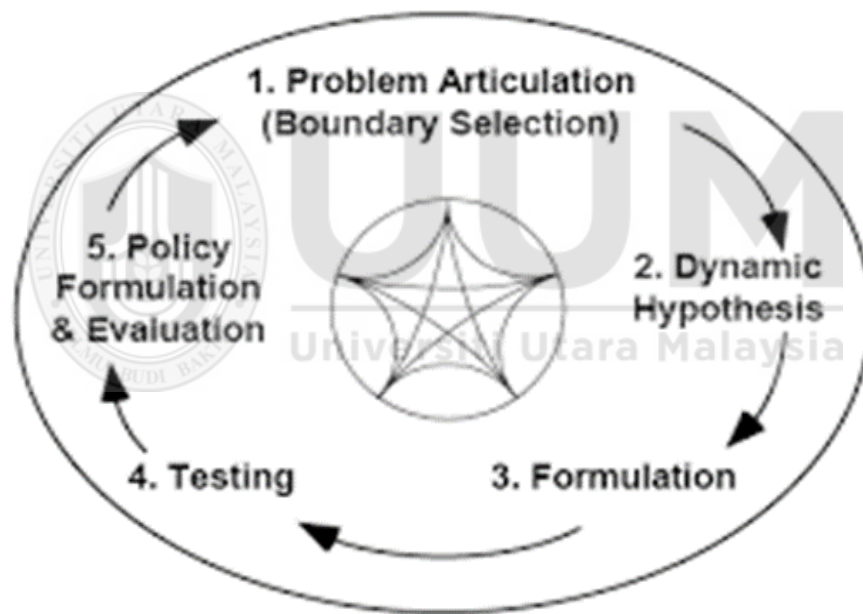


Figure 2.3. The modeling process is iterative

Source: Sterman (2000)

From above discussion, the stages in the modelling process can be summarized as in Table 2.4.

Table 2.4

Summary of SD Modelling Process

Stages	Descriptions
Problem articulation	- Defining the problem. The problem must be dynamic and have feedback nature. - Developing references mode - Set time horizon by choosing an appropriate time horizon to ensure developed model presents the problem emerged.
Formulation of dynamic hypothesis	Formulate conceptual model by using causal loop diagram (CLD) that clarify the causes behind the problematic dynamic.
Development of a simulation model	Develop a formal simulation model by using stock and flow diagram with a model equation to run a model. This simulation will produce an explicit description of the system behavior
Model testing	Testing the simulation model through structure validation and behavior validation to build the confidence of develop model
Policy design and evaluation	Conducting various scenario to seek for better performances once the model has passed the validation tests.

2.4.2 System Dynamics in Application

System dynamics modeling is now crucial for implementing strategies, analyzing policies, and designing in various fields such as health care management, transportation, education, and agriculture. This section explains about system dynamics method that have been used in many application areas by previous researcher. Table 2.5 displayed the diverse and effective use of system dynamics in tackling intricate and interconnected systems.

Table 2.5

Application of system dynamics by previous researcher

Author	Applications Area	Research Area	Explanation of Method Used
Rwashana & Williams (2014) <i>System Dynamics Modeling in Healthcare: The Ugandan Immunization System.</i>		Uganda	Creates a simulation model using system dynamics to understand the dynamics of immunization in order to help decision-making by proposing policies to enhance immunization utilization.
Hassan (2017) <i>A System Dynamics Analysis of Malaysian Healthcare Resources</i>		Malaysia	The aim of this research is to examine how healthcare resources interventions affect the accessibility and affordability of healthcare. Utilizing the system dynamics model helps in comprehending the feedback structure and the complex system of healthcare resources' components.

Kumar (2014) <i>Modelling rural healthcare supply chain in India using system dynamics</i>		India	The primary focus of this work is on the distribution of Iron Folic Acid tablets in rural healthcare systems owned by the state government. System dynamics technique was utilized for modeling and simulating the entire supply chain.
Kulkarni (2018) <i>An Approach to Develop a System Dynamics Model for Education Effectiveness Evaluation</i>		India	Creates a system dynamic model for building an evaluation model of education effectiveness. The system dynamics model shows how the professor's teaching style is related to the effectiveness of education.
Bozиков, Relic & Dezelic (2018) <i>Use of System Dynamics Modeling in Medical Education and Research Projects</i>	Education	Croatia	The purpose of this document is to showcase the use of System Dynamics modeling applications in educational and research projects at a university in Croatia and to evaluate the created models in terms of the actual problems addressed, as well as the design, methods, and software utilized.

Brennen & Molloy (2020) <i>A System Dynamics Approach to Sustainability Education.</i>		Ireland	This study aims to demonstrate how this methodology can help students and educators recognize the interconnectedness of environmental, social, and economic factors and how they influence sustainable development.
Udin, Marimin, Sukardi, Buono & Halid (2014) <i>A System Dynamics Simulation of Rice Agroindustry Development by Divestment Pattern for Increasing Rice Production and Farmer Income</i>	Agriculture	Indonesia	In this research, a system dynamics simulation approach was utilized to identify the optimal strategy for advancing a rice agroindustry by transferring ownership to a collective of farmers.
Reinker & Gralla (2018) <i>A System Dynamics Model of the Adoption of Improved Agricultural Inputs in Uganda, with Insights</i>		Uganda	This paper aims to discover which interventions can boost both the supply and demand for high-quality seeds in markets such as Uganda's. System dynamics models are capable of mimicking the results of various intervention combinations to aid in pinpointing the most effective leverage points for facilitating change. This paper creates a

<i>for Systems Approaches to Development</i>			model that portrays the dynamics mentioned earlier.
Frederick, David & Alex (2010) <i>A Systems Dynamics Approach to Explore Traffic Congestion and Air Pollution Link in the City of Accra, Ghana</i>		Accra, Ghana	Create a viewpoint from system dynamics on the issue of traffic congestion and air pollution in Accra. System dynamics modeling takes into account the complexities of the space and time aspects of such problems. Furthermore, system dynamics method has a unique ability to examine the cause-and-effect connections and feedback loops within the system.
Setiafindari, Anggara & Masril (2017) <i>Transportation Mode Selection using System Dynamics Approach</i>	Transportation	Indonesia	The modeling aims to give a summary of the choices for problem-solving transportation methods that can help decrease greenhouse gas emissions. This includes assessing transport options from both government and user perspectives.

2.5 Summary

This chapter has reviewed the previous work in poverty problem. From literature, there are four main factors influenced poverty such as education, level of income, employment status and natural disaster. These factors can lead to vicious cycle of poverty. In the preceding sections, it was determined that many researchers have utilized various strategies to address the issue of poverty, including statistical methods, mathematical approaches, and system dynamics modeling. System dynamics modeling technique has been extensively utilized in researching poverty issues in system dynamics literature. Additionally, the system dynamics approach has been extensively applied in various fields like healthcare, transportation, education, and agriculture.

However, this study differs from other studies in several perspectives:

- (i) This study focuses on identifying the main factors that contribute to the poverty problem in Perak.
- (ii) This study provides a holistic view of the effect of the feedback between identified factors in poverty problem.
- (iii) This study demonstrates the dynamic behaviour of poverty problem in Perak through policy design and evaluation process.
- (iv) This study will suggest the best schemes under the Perak Welfare Development Program to decrease the poverty rate among individuals in Perak.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the research methodology and details the procedures followed to achieve the study's objectives. This will be presented in four main sections. Section 3.2 discusses an overview about research methodology, framework and design holistically. Section 3.3 describes the source of data and how data were collected briefly. Following this, Section 3.4 look into the system dynamics modeling method. Finally, Section 3.5 details the software utilized in this study.

3.2 Research Design

The research design is a comprehensive procedure that covers the processes, techniques, and tools employed in this study. Figure 3.1 illustrates the research process flow. The process begins with problem articulation and boundary selection, informed by personal interviews with several officers from Yayasan Bina Upaya Darul Ridzuan (YBUDR) and document analysis, including the YBUDR Annual Report, to gain a thorough understanding of the issue being studied. Following this, a dynamic hypothesis is formulated. The subsequent step involves developing a simulation model, which incorporates data calibration. Once the simulation model is developed, it undergoes rigorous testing to build confidence in its accuracy and reliability. After successful testing, the model is employed to design and evaluate policies aimed at enhancing poverty reduction efforts.

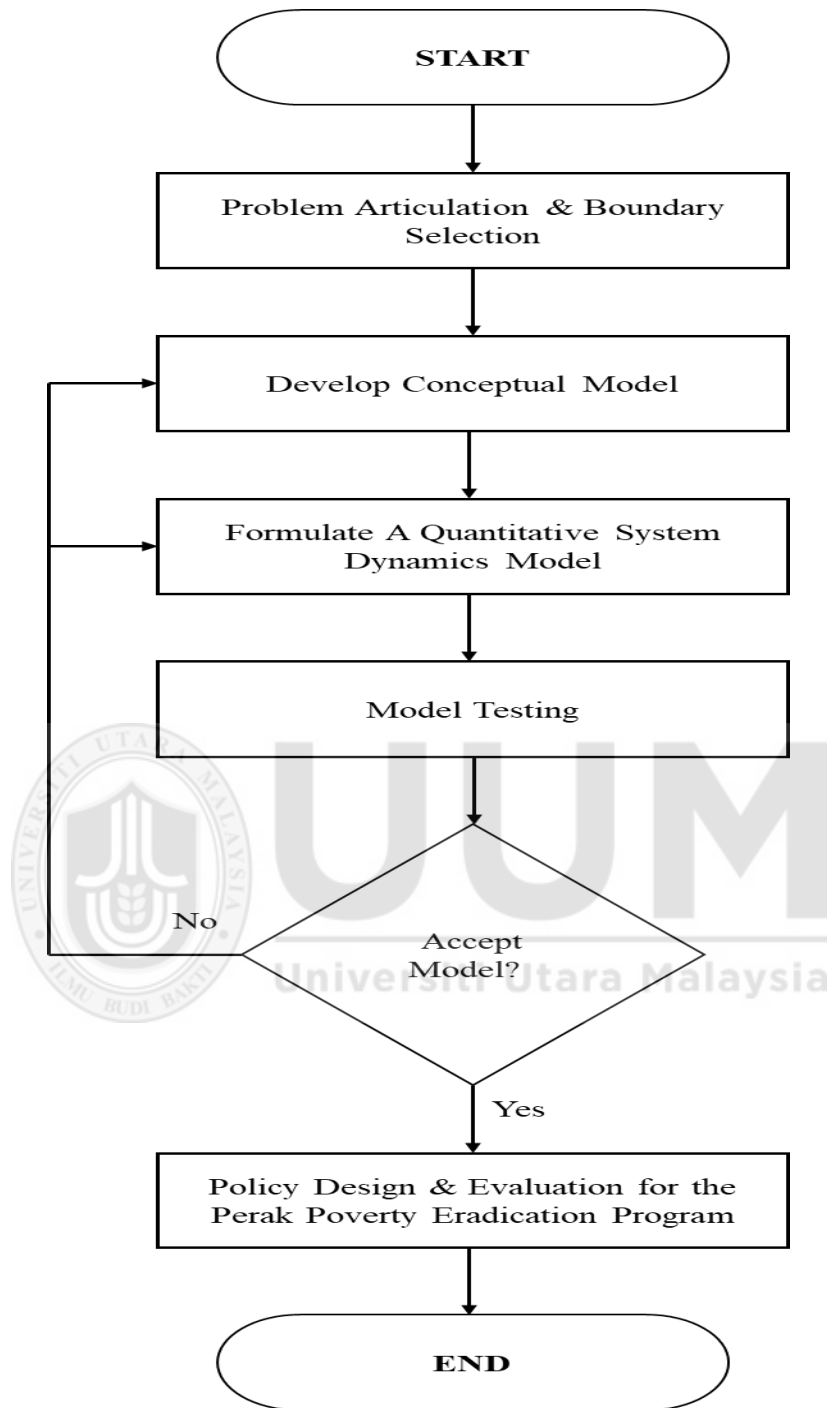


Figure 3.1. Research process flow

3.3 Data Source and Collection

Data collection involves gathering and preparing information, data, or relevant materials to answer research questions, test hypotheses, and assess specific outcomes. This research utilizes both primary and secondary data. Primary data is gathered directly through face-to-face interviews with managers and executives at Yayasan Bina Upaya Darul Ridzuan (YBUDR). Secondary data, conversely, comprises information previously gathered by other individuals or organizations. Secondary data for this study includes records from the Department of Statistics Malaysia for the years 2014 to 2016, the 1Malaysia Internet Center, and the annual reports of Yayasan Bina Upaya Darul Ridzuan.

3.4 Development of the Dynamic Model of Perak Welfare Development Program

The model employs five stages to achieve the research objectives, as shown in Figure 3.2. The process begins with problem articulation, which involves identifying the model's purpose, recognizing key factors or variables, and establishing a time horizon. The subsequent step is to develop a dynamic hypothesis, illustrated by a causal loop diagram. The model then undergoes two forms of validation tests, structural tests and behavioral tests to ensure accuracy and reliability. Finally, the process concludes with the formulation and assessment of policies to address the identified issues.

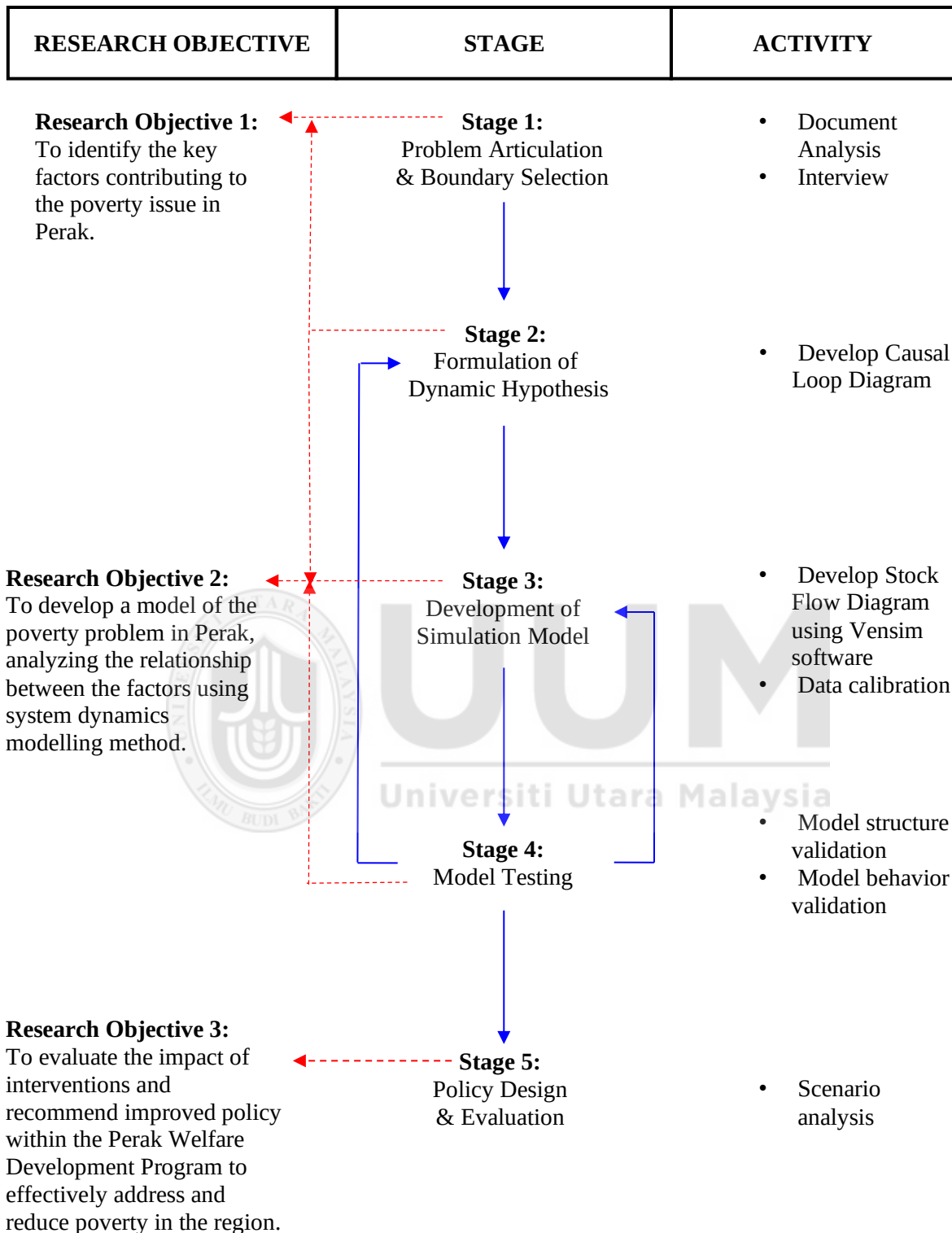


Figure 3.2. System Dynamics modelling process

3.4.1 Problem Articulation

This subsection discusses the activities in Stage 1 (refer Figure 3.1). An apparent aim is the absolute most essential part for successful modelling study. Problem articulation is used to identify the main factors that influence poverty in Perak. This initial step is crucial. A useful model must target a specific problem rather than attempting to model the entire system. Critically this poverty issue must be dynamic and have input nature.

The procedures engaged with this stage are as per the following:

i. **Define the model's purpose**

The aim of developing the model in this research is to analyze the relationships amongst factors using the system dynamics method.

ii. **Identify the key variables**

There are three types of variables in a system dynamics model, namely endogenous, exogenous, and excluded:

Endogenous variables: These variables are generated within the system and are determined by the system's structure.

Exogenous variables: These variables are external to the system and influence the system but are not influenced by it.

Excluded variables: These variables are omitted from the model because they are not relevant to the problem being analyzed.

Table 3.1 lists the variables involved in this study.

Table 3.1

Type of variables

List of variables		
Endogenous	Exogenous	Excluded
Education Level	Perak Population	Head of Household's Gender
Status of Employment	Birth Rate	Status of Mariage
Income Level	Death Rate	Strata
Income Increment Scheme	People in Poverty	Household Size
Food Box Scheme	Poverty Death Rate	Natural Disaster
Mobile Store 1 AMANJAYA	Poverty Relief Rate	Age
Housing Assistance Scheme (INFRA)	Poverty Birth Rate	Head of Household's Occupation
Micro Credit Loan Scheme		
Education Excellence Scheme		
Automotive Training Scheme		

iii. **Develop reference mode**

A reference mode consists of literal graphs and other graphic data that plot the behavior of key variables over time as shown in Figure 3.3 to Figure 3.12.

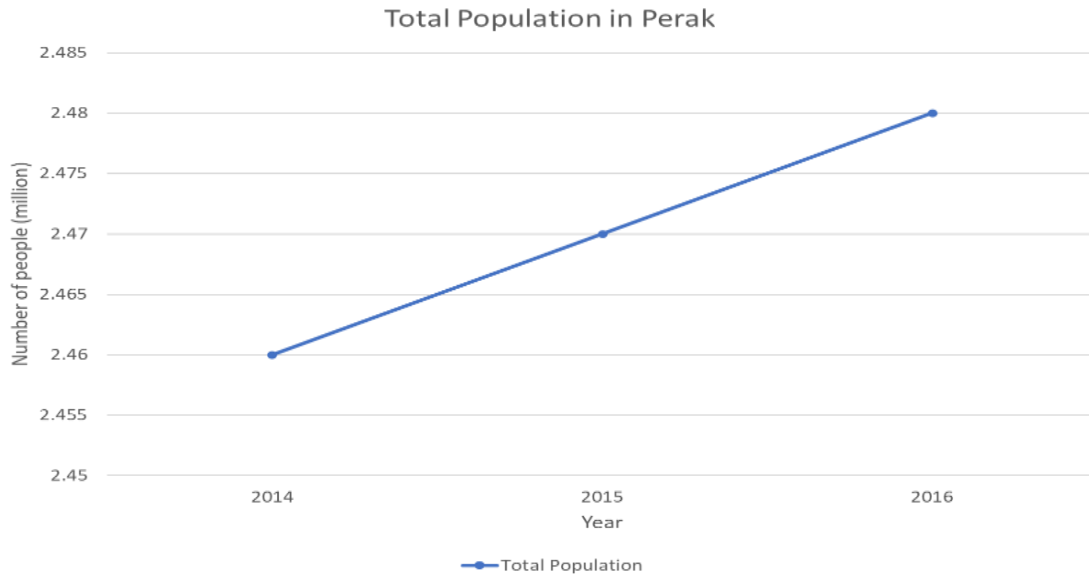


Figure 3.3. Total population in Perak from 2014 until 2016

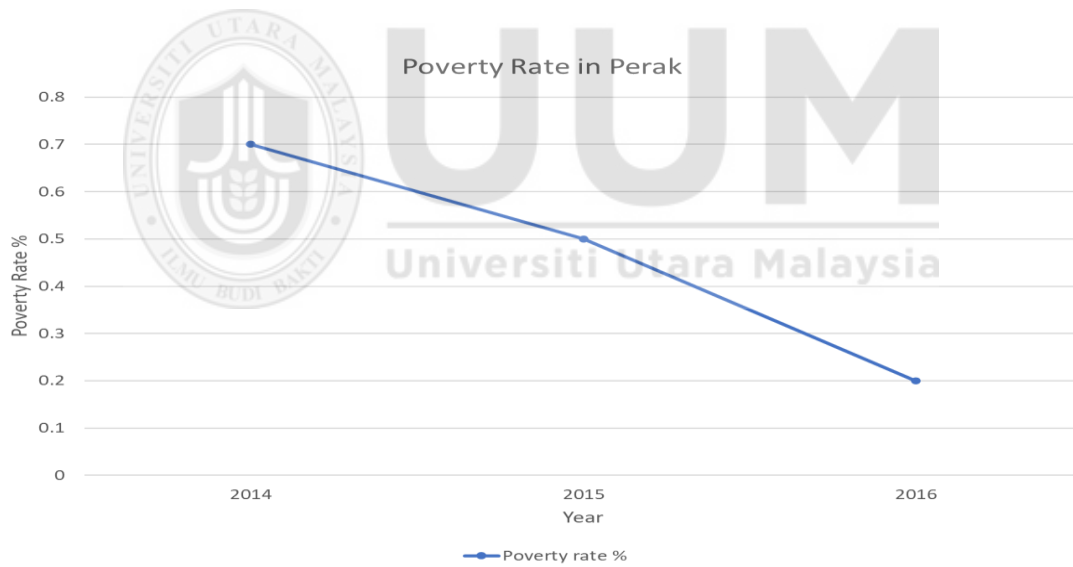


Figure 3.4. Poverty rate in Perak from 2014 until 2016

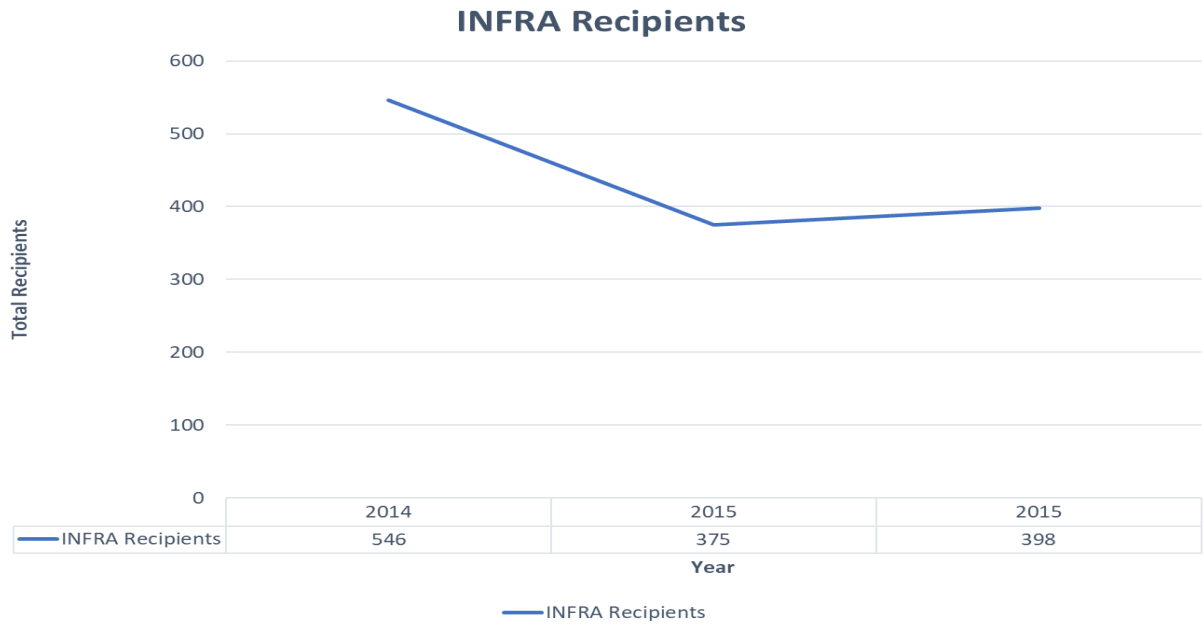


Figure 3.5. The total recipient of Housing Assistance Scheme (INFRA) from 2014 until 2016

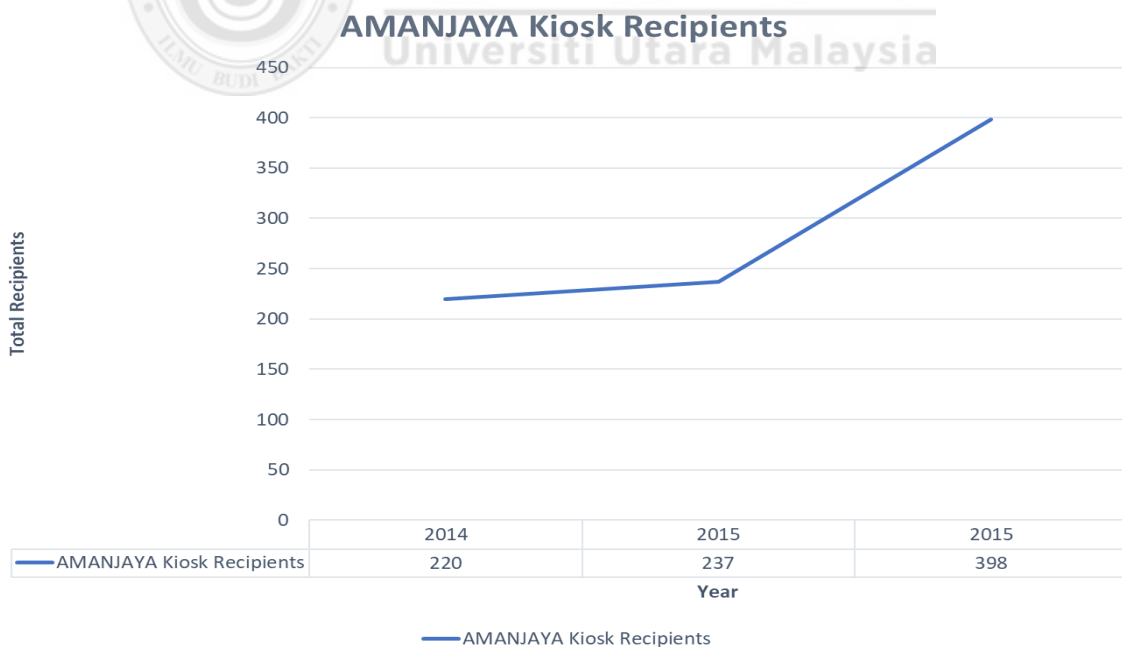


Figure 3.6. The total recipients of Income Increment Scheme (AMANJAYA Kiosk) from 2014 until 2016

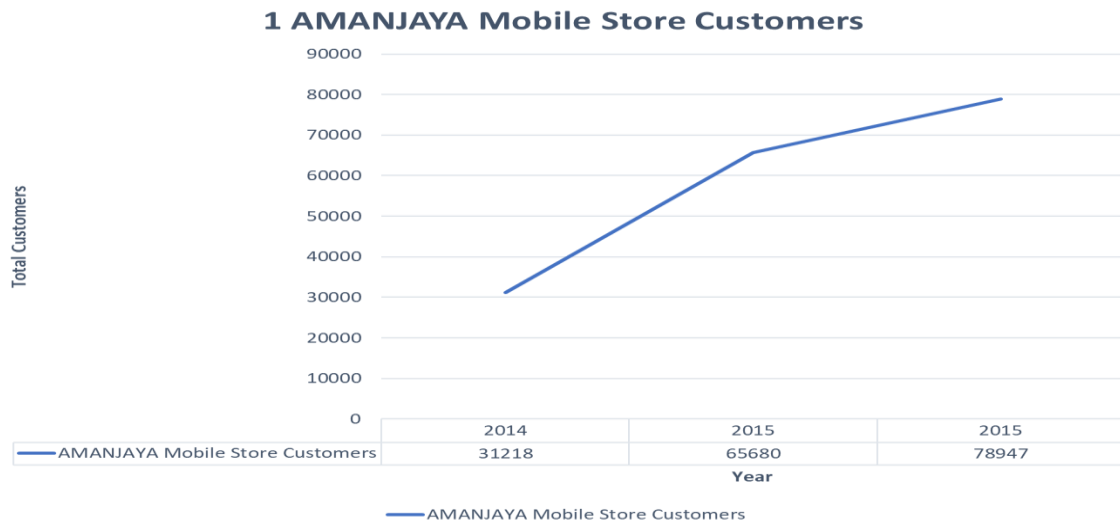


Figure 3.7. The total customers of 1 AMANJAYA Mobile Store from 2014 until 2016

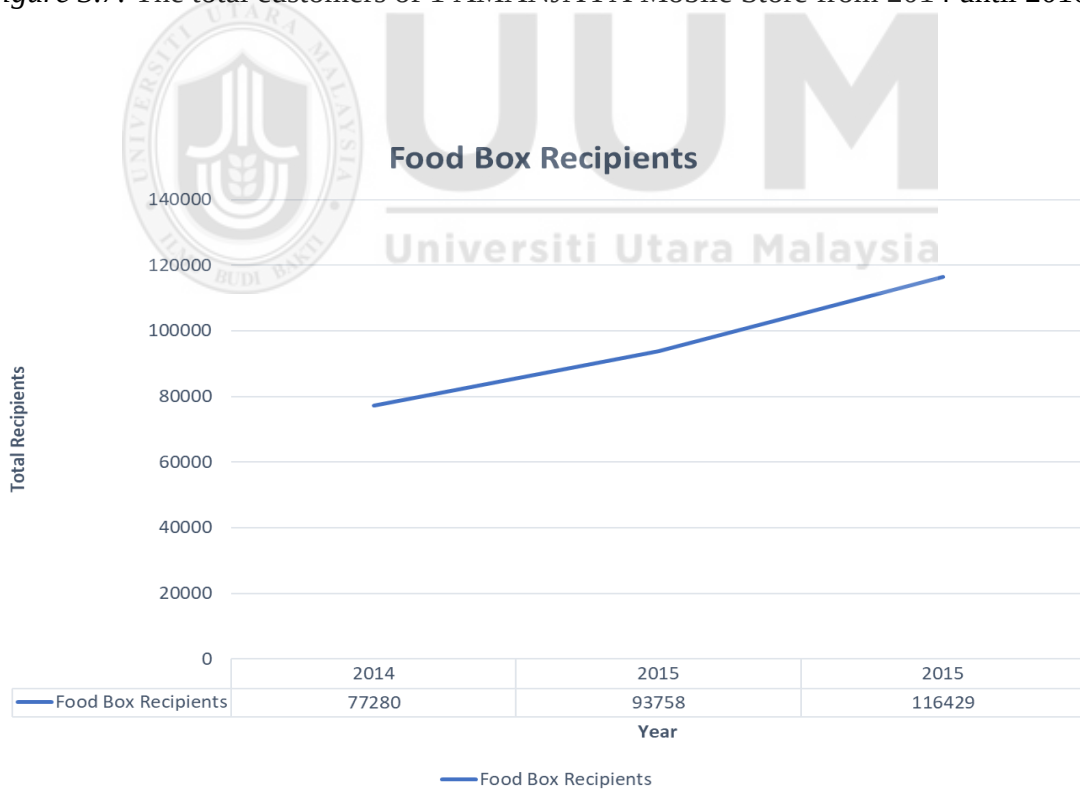


Figure 3.8. The total recipients of Food Box Scheme from 2014 until 2016

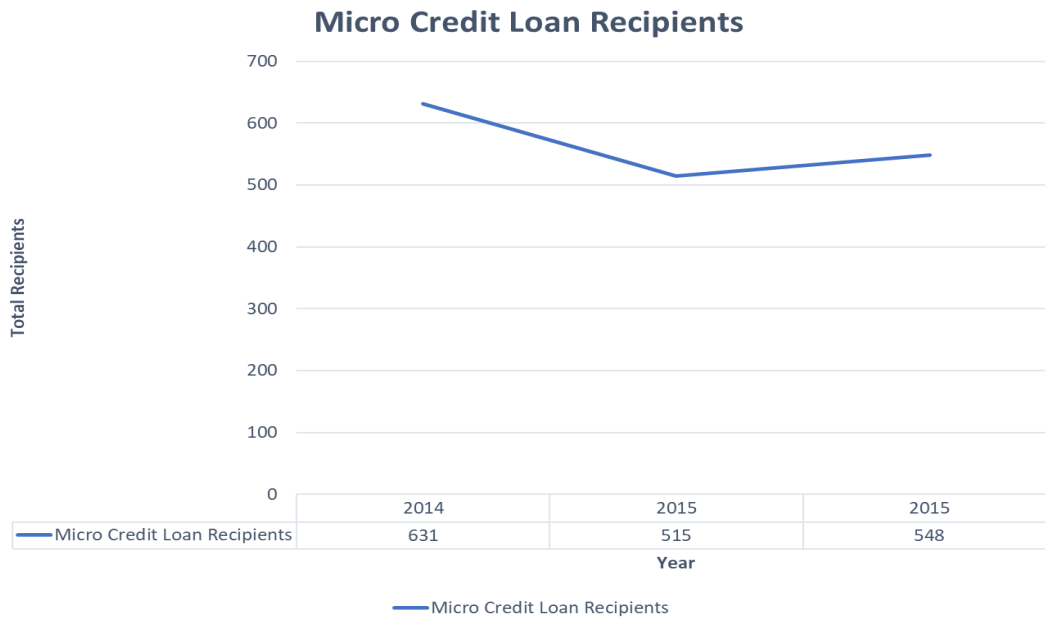


Figure 3.9. The total recipients of Micro Credit Loan Scheme from 2014 until 2016

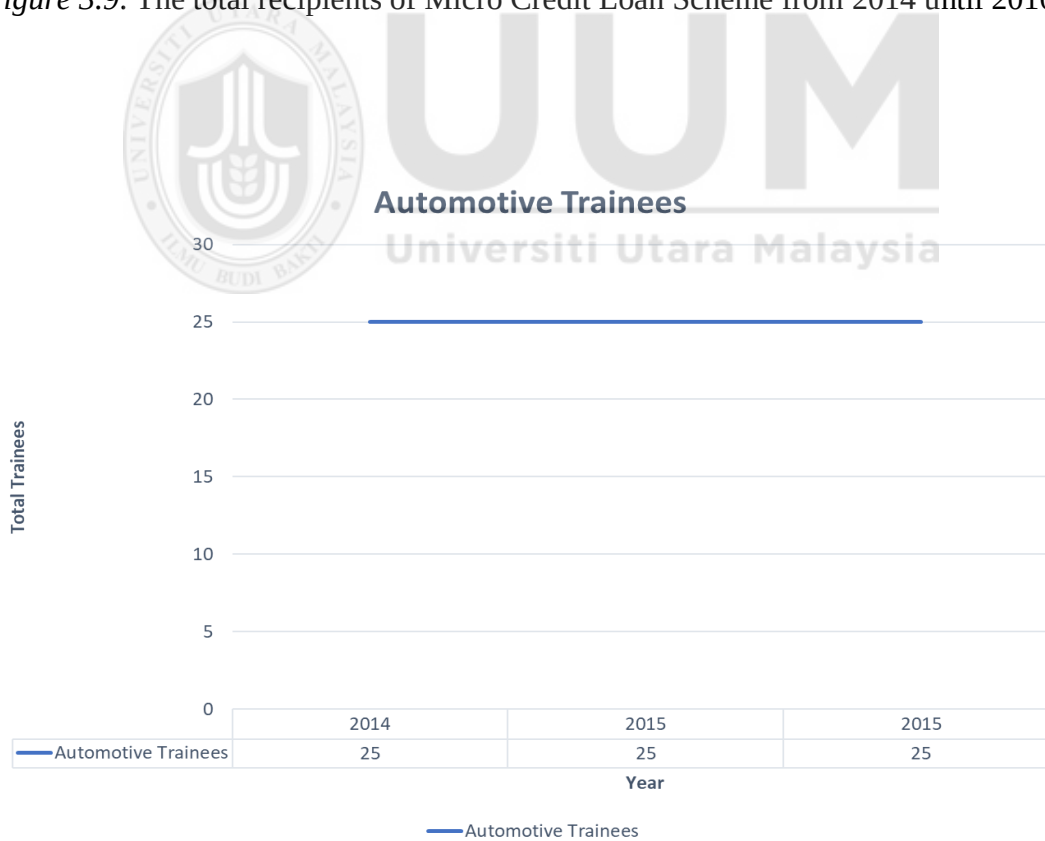


Figure 3.10. The total trainees of Automotive Training Scheme from 2014 until 2016

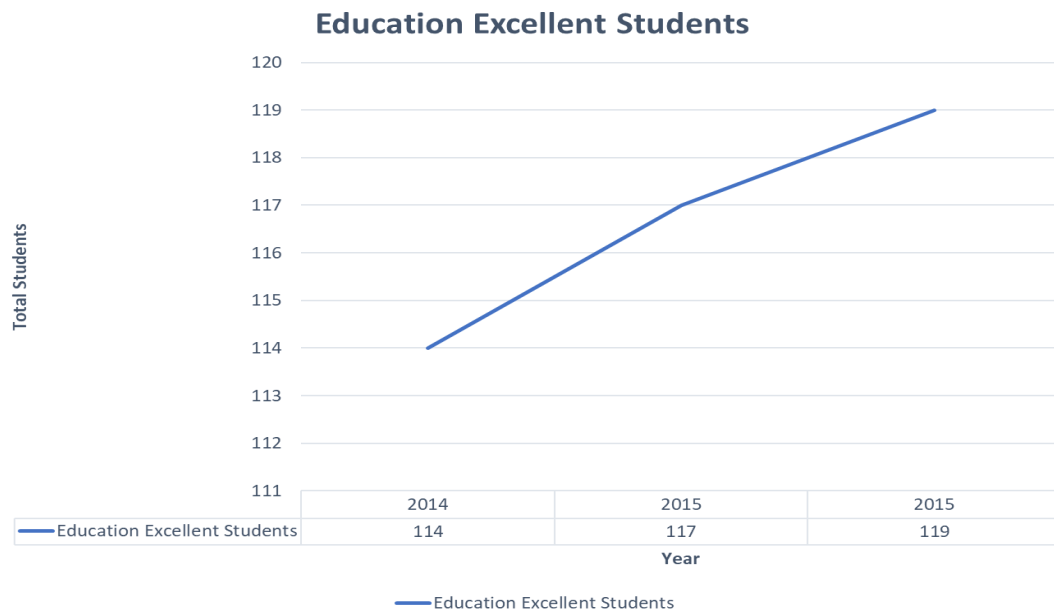


Figure 3.11. The total students of Education Excellent Scheme from 2014 until 2016

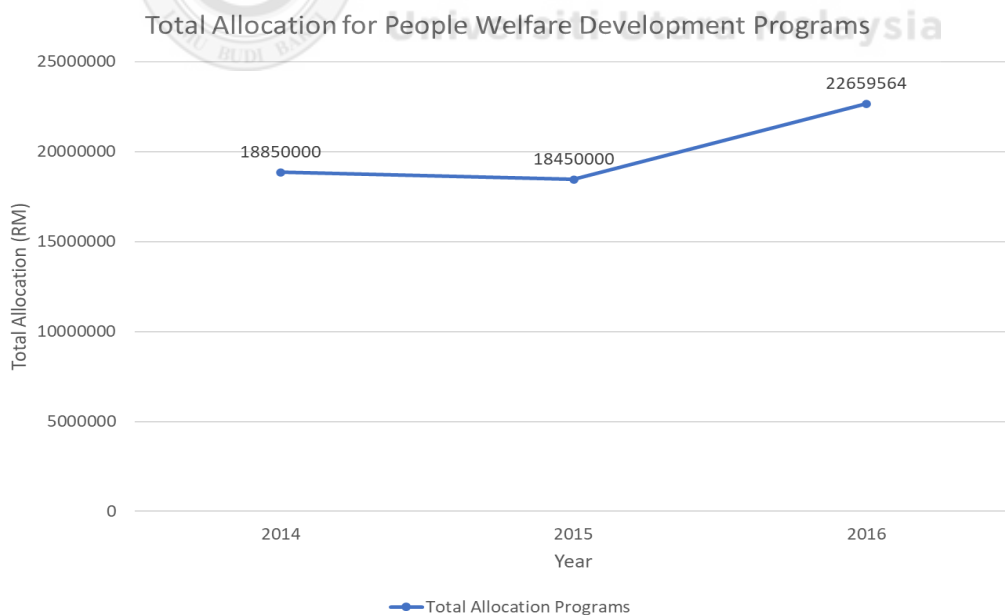


Figure 3.12. The total allocation for People Welfare Development Program from 2014 until 2016.

iv. **Set time horizon**

Selecting an appropriate time horizon is a critical procedure to guarantee that the created model shows how the issue developed. The historical data supporting this study span from 2014 to 2016. The future time horizon extends from 2017 to 2019.

3.4.2 Formulation of Dynamic Hypothesis

Formulating a dynamic hypothesis entails creating a working theory that explains the emergence of the problem by illustrating the connections between key variables or factors using a causal loop diagram (CLD). In the second stage of system dynamics modeling (see Figure 3.2), the system description and reference mode are utilized to develop a causal map of feedback processes that are believed to drive the problem's dynamics. The CLD in Figure 3.13 illustrates the primary cause and effect relations among the key variables contained by the poverty problem system. Specifically, it highlights the interactions between factors such as education level, natural disasters, income level, and employment status, demonstrating how these elements influence one another within the system.

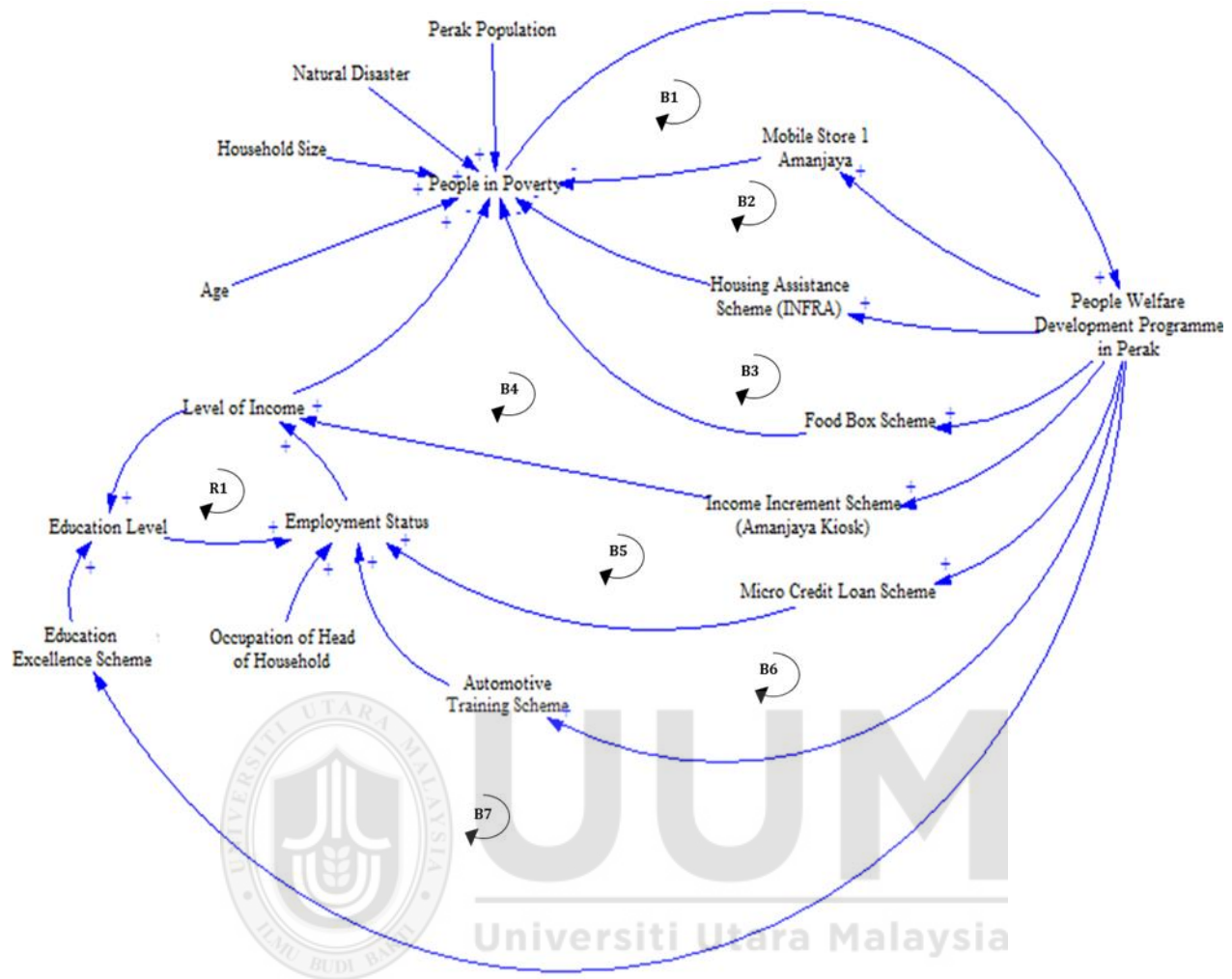


Figure 3.13. The dynamic relationships and feedback loops within the People Welfare Development Program in Perak

To explain the dynamic hypothesis of the poverty problem, the CLD (Figure 3.13) features eight dominant feedback loops: one reinforcing loop (R) and seven balancing loops (B). This CLD illustrates the dynamic relationships and feedback loops within the People Welfare Development Programme in Perak. Here's a detailed explanation of the relationships between the variables and their interactions over time:

Perak Population

Natural Disaster positively influences the number of people in poverty due to the adverse effects on livelihood. Larger household sizes contribute to increased poverty levels. Age influences the likelihood of falling into poverty, possibly due to dependency ratios.

People in Poverty

The number of people in poverty is influenced by various factors such as household size, age, and natural disasters and is directly impacted by multiple welfare schemes aiming to reduce poverty.

People Welfare Development Programme in Perak

Mobile Store 1 AMANJAYA, Housing Assistance Scheme (INFRA), Food Box Scheme, Income Increment Scheme (AMANJAYA Kiosk), Micro Credit Loan Scheme, Automotive Training Scheme, and Education Excellence Scheme all positively impact the welfare program, aiming to reduce poverty.

Level of Income

The level of income is positively influenced by welfare schemes such as the income increment scheme, microcredit loans, and automotive training. Higher income levels can reduce poverty by improving living standards.

Education Level

The education level is improved through the Education Excellence Scheme. Higher education levels lead to better employment status and income, creating a reinforcing loop (R1) that further reduces poverty.

Employment Status

Employment status is enhanced by higher education levels and training schemes. Positive employment status leads to higher income and reduced poverty.

Feedback Loops

1. Reinforcing Loop

R1: Education Level → Employment Status → Level of Income → People in Poverty: Higher education leads to better employment, higher income, and reduced poverty, which in turn promotes more education, continuing the cycle.

2. Balancing Loops

B1: Mobile Store 1 AMANJAYA positively impacts people in poverty, aiming to reduce their numbers.

B2: Housing Assistance Scheme (INFRA) provides housing, reducing the number of people in poverty.

B3: Food Box Scheme alleviates immediate food needs, reducing poverty.

B4: Income Increment Scheme (AMANJAYA Kiosk) directly improves income, reducing poverty.

B5: Micro Credit Loan Scheme provides financial support, reducing poverty.

B6: Automotive Training Scheme improves skills, employment, and income, reducing poverty.

B7: Education Excellence Scheme enhances education, leading to better employment and income, reducing poverty.

Dynamic Relationships Over Time

Impact of Welfare Schemes

The welfare schemes are designed to gradually reduce poverty by enhancing housing, food security, income, education, and employment opportunities. Each scheme has a targeted impact that collectively contributes to the overall decrease in poverty levels.

Influence of External Factors

Natural disasters can intermittently increase poverty levels, counteracting the welfare schemes' efforts. Household size and age demographics can influence the effectiveness of poverty reduction strategies.

Income and Education Feedback

As income levels rise, education opportunities increase, leading to better employment and further income growth, creating a virtuous cycle. Improved employment and education levels positively impact poverty reduction over time.

This causal loop diagram illustrates the complex interplay between various factors influencing poverty and the effectiveness of welfare schemes. The positive feedback loops reinforce the benefits of improved income and education, while the welfare schemes provide targeted interventions to address immediate and long-term poverty reduction. External factors, such as natural disasters and demographic variables, also significantly influence the dynamics of poverty and welfare in Perak.

3.4.3 Development of Simulation Model

To analyze the relationships between variables over time, the causal loop diagram (CLD) is converted into a stock and flow diagram (SFD) for simulation purposes. The simulation model was developed using Vensim software. Table 3.2 lists all the variables considered in the system. Figure 3.14 and Figure 3.15 illustrate the SFD of the developed System Dynamics simulation model.

Table 3.2

List of the variables in the system

Name of Variable	Type of Variable
Perak Population	Stock
Birth Rate	Flow
Death Rate	Flow
Birth Factor	Auxiliary
Death Factor	Auxiliary
People in Poverty	Stock
Rate of Poverty	Flow
Poverty Relief Rate	Flow
Education Level	Auxiliary
Annual Budget Factor	Auxiliary
Employment Status	Auxiliary
Level of Income	Auxiliary
Micro Credit Loan Scheme	Auxiliary
Housing Assistance Scheme (INFRA)	Auxiliary

Automotive Training Scheme	Auxiliary
Mobile Store 1 AMANJAYA	Auxiliary
Education Excellence Scheme	Auxiliary
Income Increment Scheme (AMANJAYA Kiosk)	Auxiliary
Food Box Scheme	Auxiliary
People's Welfare Development Program in Perak	Auxiliary

Perak Population and People in Poverty

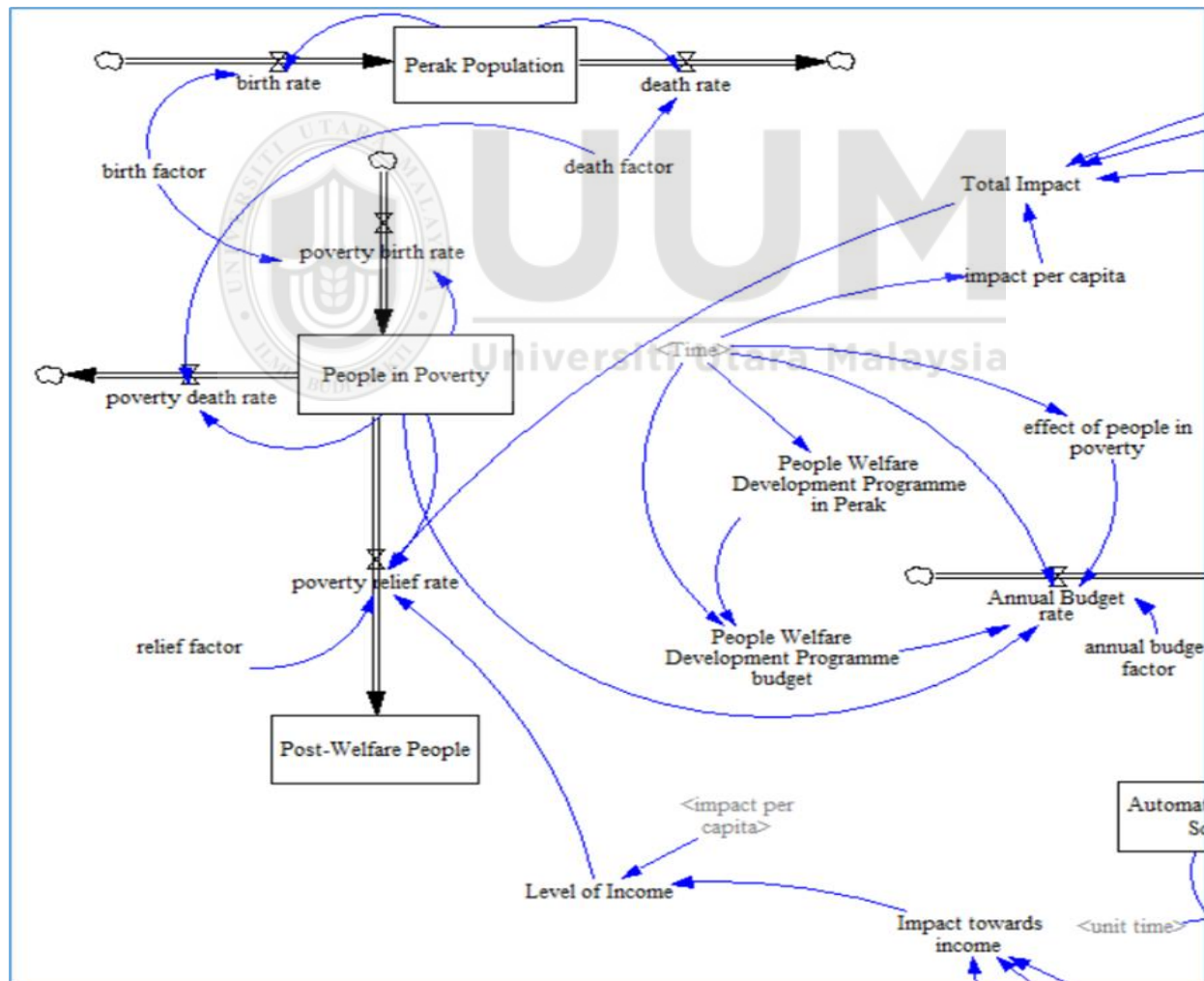


Figure 3.14. Perak Population and People in Poverty's stock and flow diagram

In this model (Figure 3.14), activities begin by identifying the total population of Malaysia. The "Perak population" variable represents the inflow of people residing in Perak. From Figure 3.14 illustrates the number of people that live in Perak; Malaysian citizen based on Eq (3.1) and the number of people lives in poverty based on Eq (3.2)

$$PP_{MC}(t) = PP_{MC}(t-dt) + (BR - DR) * dt \quad (3.1)$$

Where:

PP_{MC} = Perak population

BR = Birth rate

DR = Death Rate

$$PLP(t) = PLP(t-dt) + (ROP - PR) * dt \quad (3.2)$$

Where:

PLP = People in poverty

ROP = Rate of poverty

PR = Poverty relief rate

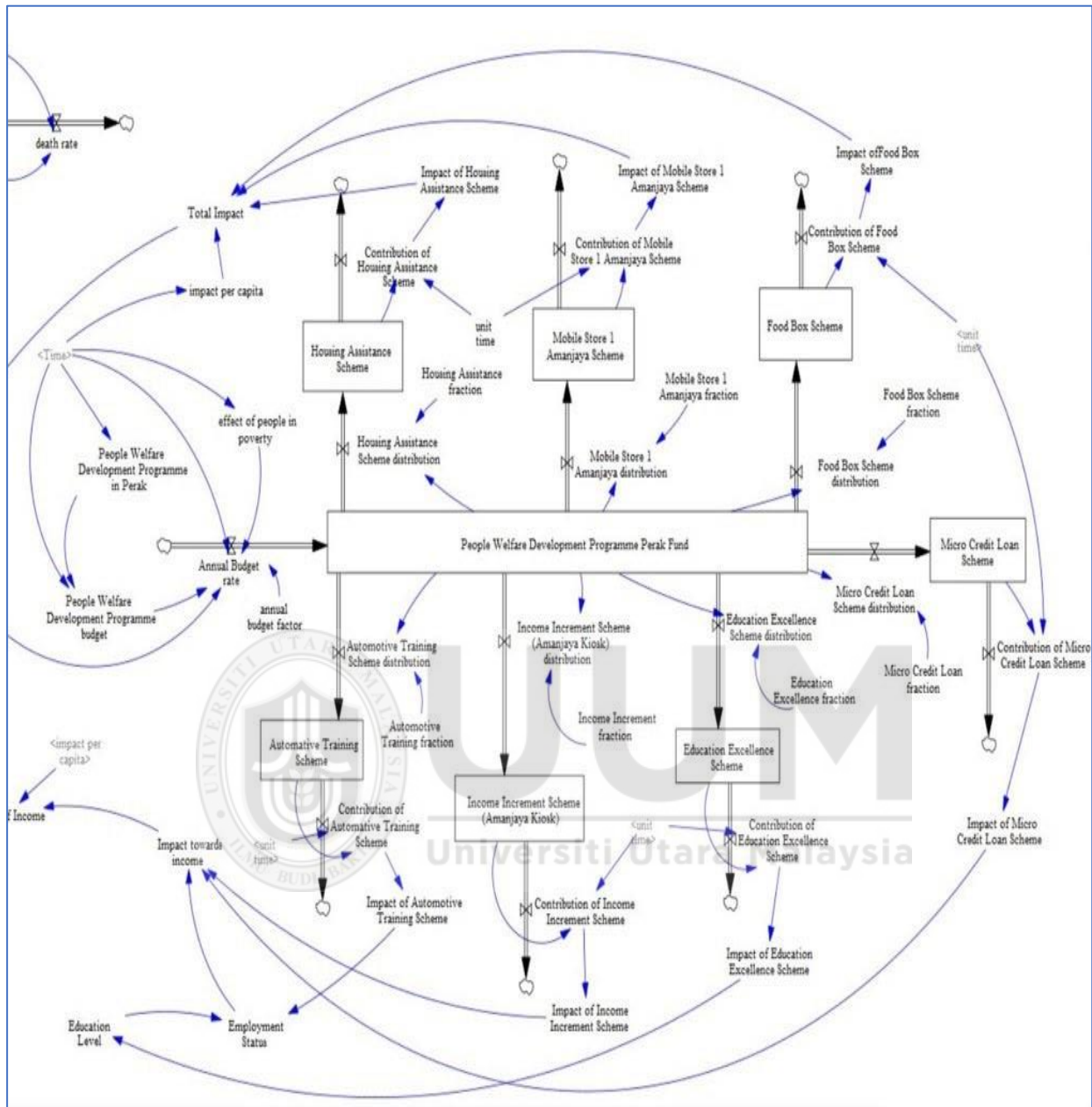


Figure 3.15. Perak Welfare Development Program Perak Fund's stock and flow diagram

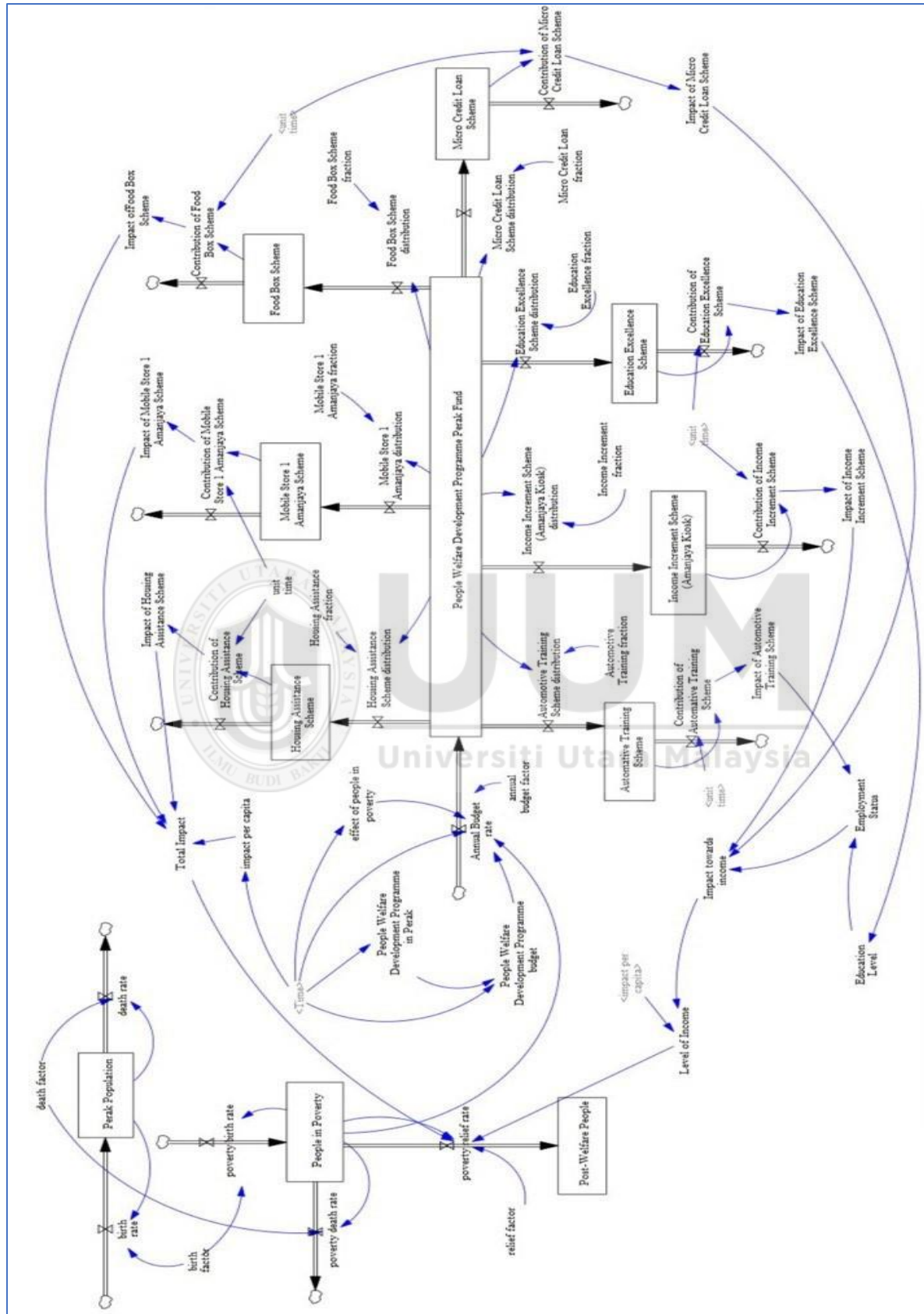


Figure 3.16. Perak Development Welfare Program system's stock and flow diagram

This stock-flow diagram represents the dynamics of the People Welfare Development Programme in Perak, illustrating the relationships between different variables and their influence on population, poverty, and various welfare schemes. This diagram illustrates the intricate interdependencies between population dynamics, poverty alleviation programs, and socioeconomic factors. Each variable and flow reflects the complex interactions that determine the success of welfare initiatives in Perak.

3.5 Base Run Simulation

The simulation presents results from a base run of the model, utilizing current parameter values. The primary objectives of the base run are twofold. The first objective is to assess whether the model generates plausible behavior in current states. Additionally, the base run serves as a benchmark for comparing non-default runs, including extreme condition and policy analysis scenarios (Diker, 2003). Table 3.3 shows the initial values for each stock in the developed model.

Table 3.3

Information of initial value of stocks

Stock	Initial Value	Unit
Perak Population	2460000	People
People in Poverty	17260	People
Post Welfare People	0	People
People Welfare Development Program Perak Fund	18850000	RM
Housing Assistance Scheme	5500000	RM
Mobile Store 1 AMANJAYA Scheme	500000	RM

Food Box Scheme	3900000	RM
Micro Credit loan Scheme	7700000	RM
Education excellence Scheme	150000	RM
Income Increment Scheme (AMANJAYA Kiosk)	1000000	RM
Automotive Training Scheme	100000	RM

The results from the base run are shown in the Figure 3.17 and Figure 3.18, display the simulated number of people in poverty, and the simulated People Welfare Development Program Perak Fund. From Figure 3.17, along with the time, it is shown that the number of people in poverty is decreased. Whereas from Figure 3.18, generally, the People Welfare Development Program Perak Fund is slowly increased throughout the years. Besides, Table 3.4 and Table 3.5 display the simulated numerical results for people in poverty and the People Welfare Development Program Perak Fund.

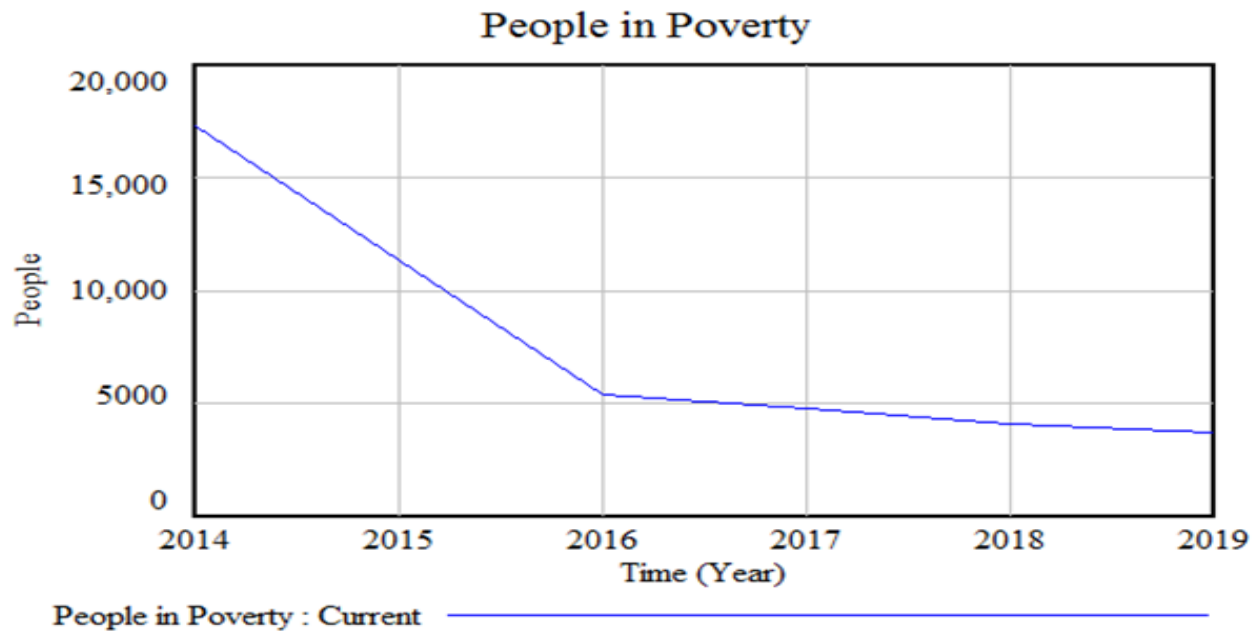


Figure 3.17. Simulated result of people in poverty

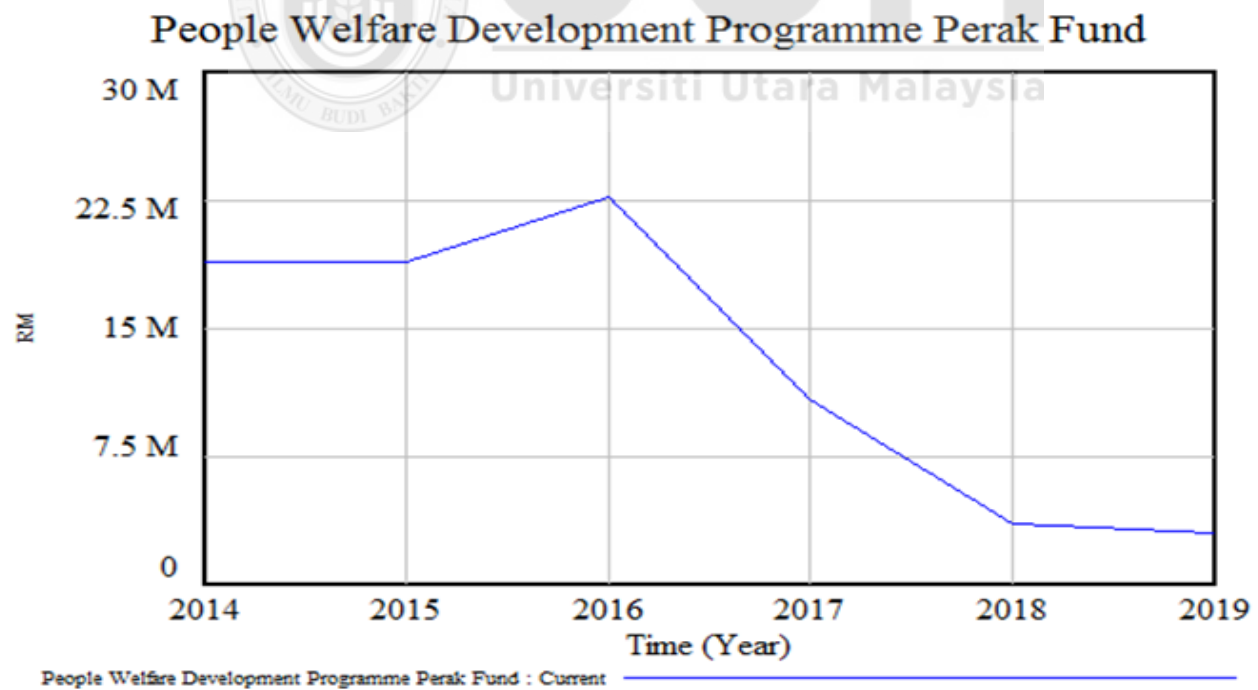


Figure 3.18. Simulated result of People Welfare Development Program Perak Fund.

Table 3.4

Simulated numerical result of people in poverty

Time (Year)	People in Poverty
2014	17260
2015	11322
2016	5398
2017	4795
2018	4061
2019	3720

Table 3.5

Simulated numerical result of People Welfare Development Program Perak Fund

Time (Year)	People Welfare Development Program Perak Fund (RM)
2014	18850000
2015	18850000
2016	22699250
2017	10827000
2018	34995300
2019	29625600

3.6 Model Testing

This section covers the testing procedures necessary to establish confidence in the developed model. According to Figure 3.2 in Chapter 3, this represents the fourth stage of the modelling method. In system dynamics modeling, the main aim of the validation process is to confirm the model's structural validity in relation to its intended purpose. The accuracy of the model's behavior in replicating real-world behavior is also assessed, but this is only valuable if we have sufficient confidence in the model's structure (Barlas, 1996). Therefore, the fundamental validation sequence in this study involves first assessing the structural validity of the model and then evaluating the accuracy of its behavior, but only after the structure has been deemed adequate.

The goal of verification in a simulation model is to ensure that there are no conflicts between the model and the dynamic hypothesis, and that the model performs what we intend to do. Furthermore, the aim of validation is to demonstrate that the model adequately represents the real system with respect to the dynamic problem of interest. Model reliability is confirmed by structural validity and behavior validity (Barlas, 1996 and Sterman 1984). Figure 3.19 shows the validation tests where to be meaningful, the structure validity test is carried out first before the behavior validity test (Sapiri, Zulkepli, Ahmad, Abidin and Hawari, 2017).

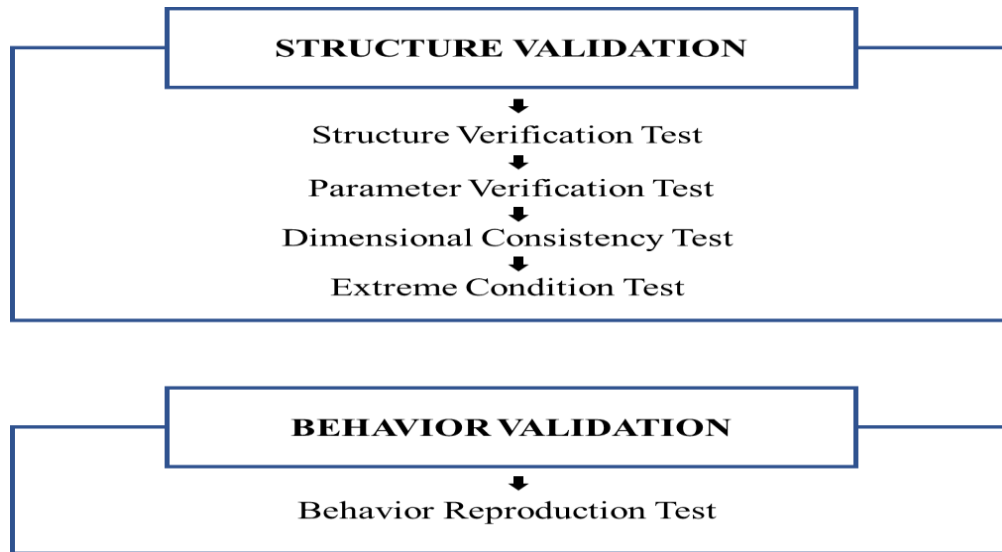


Figure 3.19. The validation tests of the Perak Development Welfare System

3.6.1 Structure Validation

The intent of structure validation tests is to establish whether the model is an appropriate and meaningful structure that matches the model's purpose. There are four types of tests that have been conducted towards the developed model for structural validation. The first is structure verification test, followed by parameter verification test, then the built-in dimensional consistency test, and last but not least is extreme condition test.

i. Structure Verification Test

The first test is the Structure Verification Test, which involves directly comparing the model's structure with the real system it represents. This may involve having a knowledgeable expert review the model assumptions for the comparable parts of the real system. In this test, the model's structure is directly compared to that of the real system. In this research, the model

structure verification tested by gaining some criticism regarding the developed system through interview with YBDUR officer.

ii. **Parameter Verification Test**

Parameters that are calibrated in the model can be validated by comparing them with real-life observations and the corresponding knowledge of the actual system. It aims to verify whether the parameters align both conceptually and numerically with real-life data. In this research, all parameters lie within a plausible range of values reflective of the actual poverty system. This is done by referring the model parameters from the historical data of welfare program from YBDUR.

iii. **Dimensional Consistency Test**

This test evaluates the dimensional consistency of the model's rate equations. As in this research, every dimensional unit of the variables included will be checked in the Vensim software so that it is consistent and apt to confirm the validity of the modelled system built. The unit of the variables in the model is accepted if the test of the unit is displayed as OK (refer Figure 3.20). Otherwise, the unit of the variables needs to be revised.

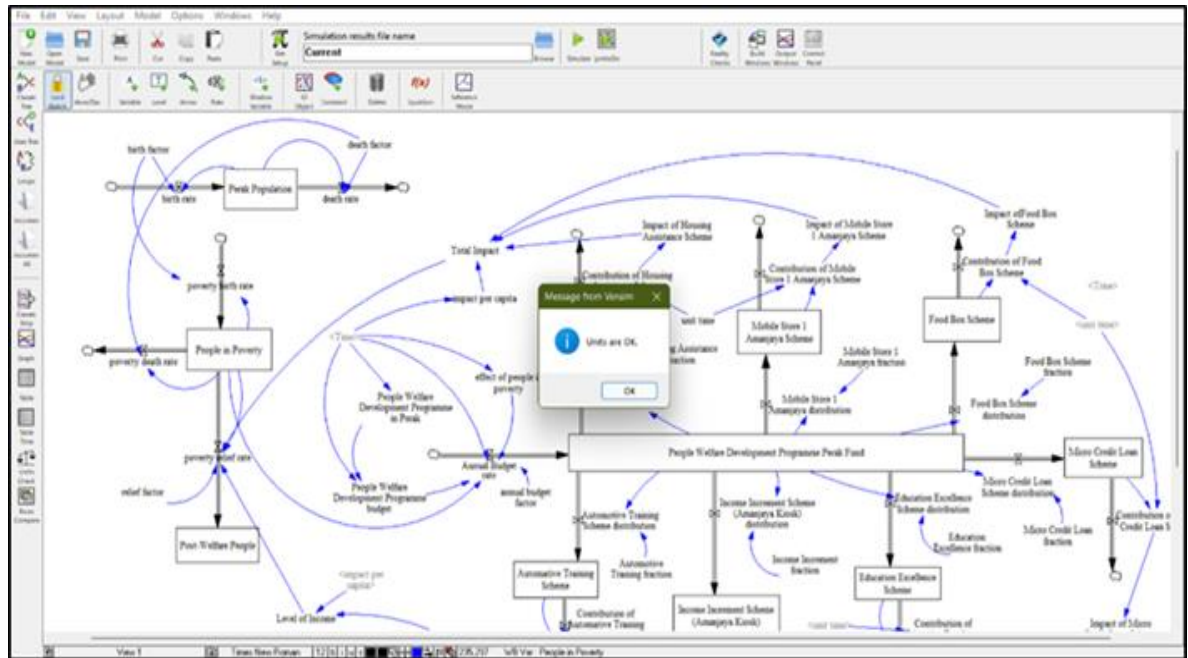


Figure 3.20. The dimensional consistency test of the Perak Welfare Program System.

iv. Extreme Condition Test

The Extreme Condition Test is a crucial validation method in system dynamics modeling, used to assess the robustness and reliability of the model under hypothetical, extreme scenarios. This test pushes the model to its limits by introducing unrealistic or extreme conditions that are not expected in real-life situations. The purpose is to evaluate whether the model behaves logically and consistently even under such conditions, which helps to confirm the structural integrity and accuracy of the model.

In this study, the extreme condition test was applied to the People Welfare Development Programme Fund in Perak. By simulating a scenario where no new funding is introduced after 2014, the model's behavior under the assumption of a complete halt in financial support was examined. This test aims to validate the model by observing if it responds in a way that aligns with theoretical expectations.

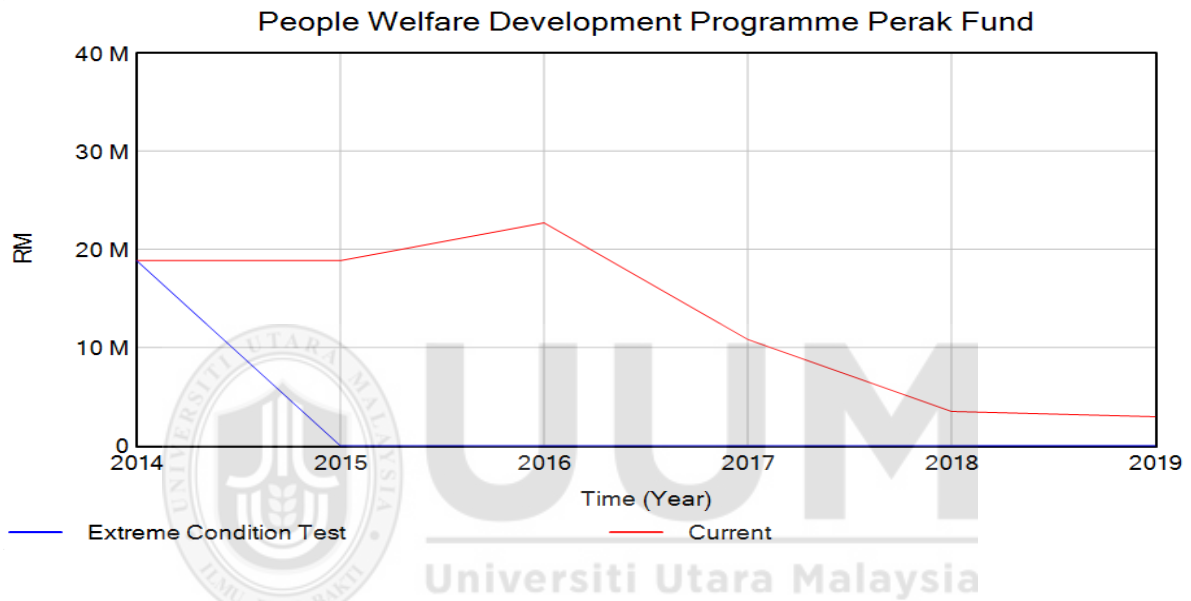


Figure 3.21. Extreme condition test result for Perak Welfare Development Program Perak Fund.

The results of the extreme condition test, as shown in the Figure 3.21, indicate that the developed model is valid. Under the scenario of no additional funding (blue line), the model demonstrates that the programme's funds are depleted by 2015, which is a logical outcome given the absence of financial replenishment. This confirms that the model correctly simulates the dynamics of the People Welfare Development Programme, reinforcing confidence in its ability to represent real-world funding behavior under various conditions. By performing this test, the model has been validated as capable of not only replicating current conditions but

also reacting predictably in extreme cases, further strengthening its credibility for policy analysis and decision-making.

3.6.2 Behavior Validation

The behavior validation test evaluates how closely the simulated model behavior aligns with the observed behavior of the actual system. Following the completion of structural validity tests, the model's behavior was compared with statistics from the Department of Statistics Malaysia and Yayasan Bina Upaya Darul Ridzuan. Generally, the actual data was sourced from annual reports spanning 2014 to 2016. This document encompasses a broad range of data, including the total population in Perak, as well as details on various welfare and development programs such as the People Welfare Development Programme Perak Fund, Housing Assistance Scheme (INFRA), Mobile Store 1 AMANJAYA Scheme, Food Box Scheme, Automotive Training Scheme, Income Increment Scheme (AMANJAYA Kiosk), Education Excellence Scheme, and Micro Credit Loan Scheme. Additional data on various aspects of the model were collected through interviews and utilized for calibrating the model.

i. Behavior Reproduction Test

For the behavior reproduction test, the simulated results (base-run) and the real data (reference mode) for the stocks are plotted. Real values referring to the period of 2014 until 2016 and the simulated results are from 2014 until 2019. Figures 3.22 to 3.24 demonstrate the outcomes of the behavior validation test. The behavior of the variables is valid as the simulated graph (Current) is almost fitted with the historical graphs (historical data).

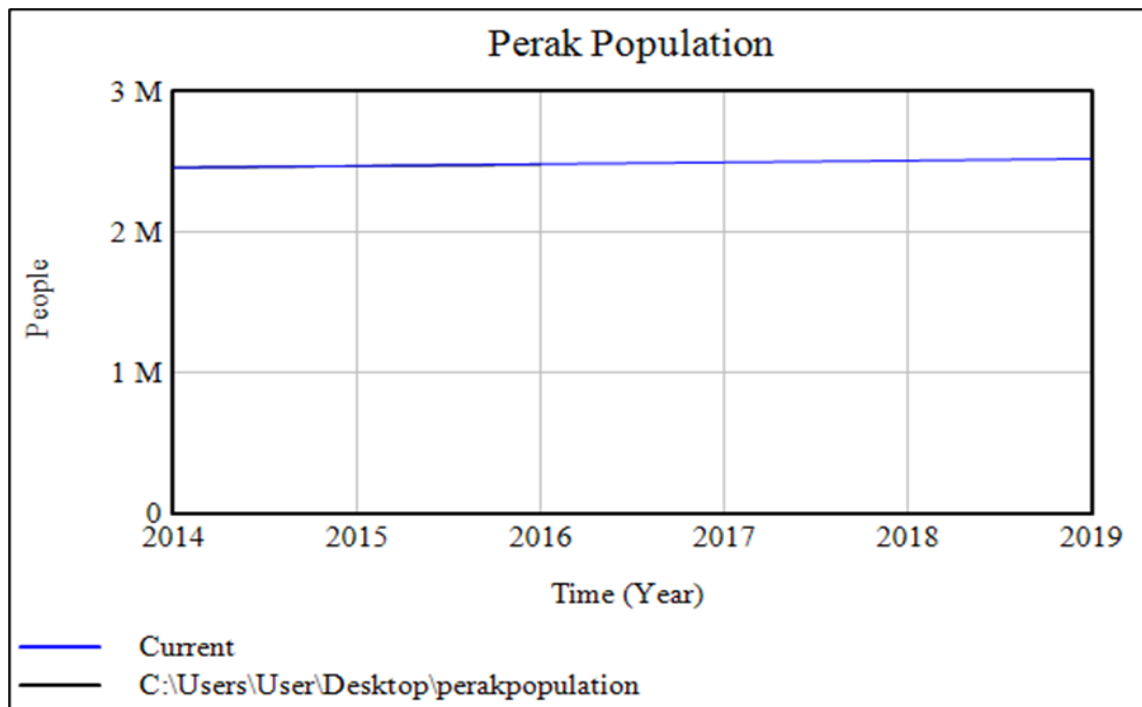


Figure 3.22. Behavior reproduction test result for the total population in Perak.

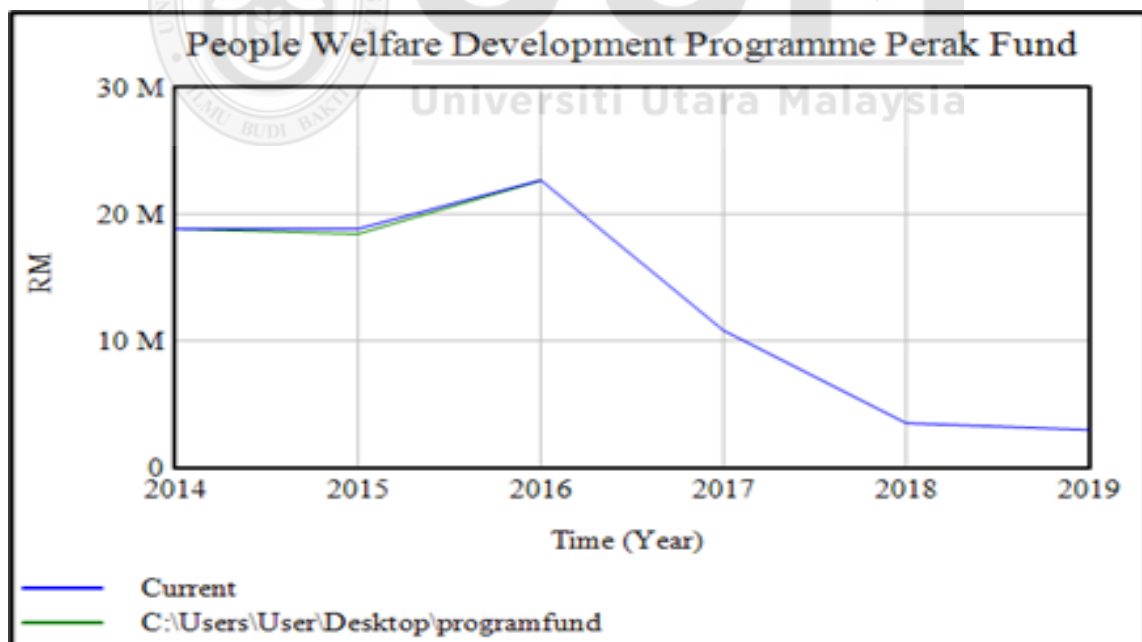


Figure 3.23. Behavior reproduction test result for the People Welfare Development Program Perak Fund

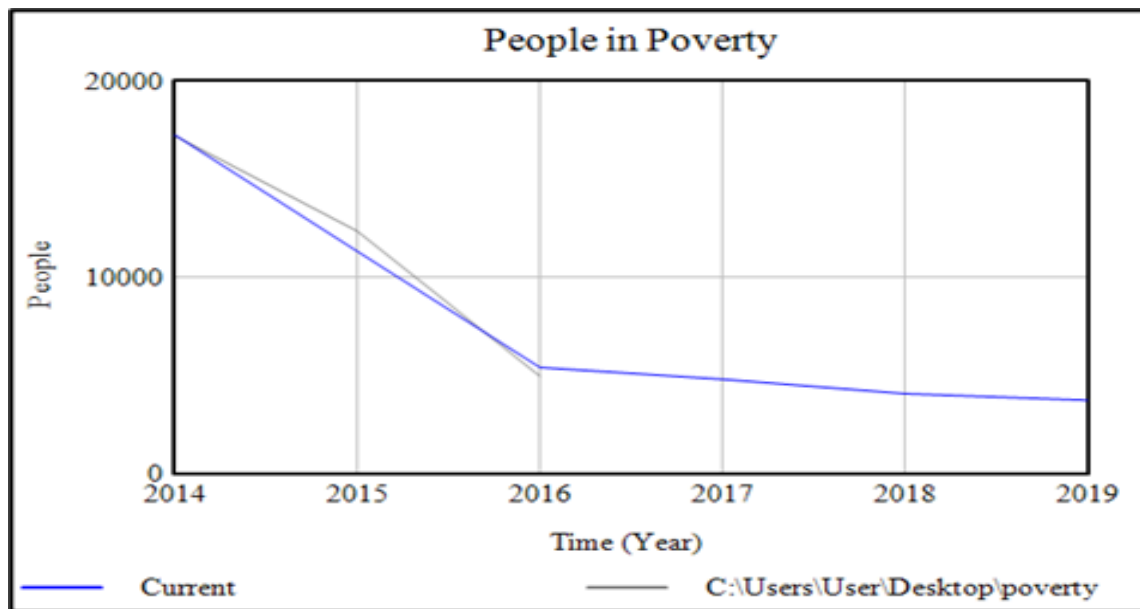


Figure 3.24. Behavior reproduction test result for the total people in poverty.

3.7 Summary

This chapter covered the four stages in developing and testing the system dynamics model for the Perak Welfare Development Program. The next chapter will address the policy design and evaluation and analysis.

CHAPTER FOUR

ANALYSIS AND FINDINGS

4.1 Introduction

This chapter presents a detailed analysis of the outputs generated from the stages discussed in the previous chapter. It addresses the third objective by proposing improved policy schemes tailored to various scenarios. The chapter concludes with an in-depth evaluation of the outputs and a comprehensive assessment of the proposed policies.

4.2 Policy Design and Evaluation

Several tools are available for conducting policy testing analysis. This work primarily utilizes two key methods: sensitivity analysis, and scenario analysis (Stermann, 2000; Maani and Cavana, 2000), to evaluate and assess the resilience of different plans and strategies. As part of this process, the model's performance was evaluated in a variety of possible scenarios. Furthermore, scenario analysis aids in analyzing how "what-if" changes in significant parameters could have an impact on the behavior of the system.

Therefore, this stage facilitates experimentations, design system structures and strategies for improved system behavior. After pass all the validation test, this subsection discusses the policy design and analysis phase. People Welfare Development Program is a program by the Perak government aiming at poverty reduction. The schemes that involved under this program is;

- (i) Housing Assistance Scheme (INFRA): The project component is divided into 2 categories; Build New and House Repair works.

- (ii) Income Increment Scheme (AMANJAYA KIOSK): This scheme provides free kiosks to entrepreneurs to make a more revenue income in business.
- (iii) Automotive Training Scheme: It is providing training opportunities to individuals aged 18 and above to gain basic skills to enable them to enter the job market.
- (iv) Education Excellence Scheme: Distribute monthly allowance assistance according to the education level for the selected students.
- (v) Mobile Store 1 Amanjaya: Goods sold at this mobile store are 5% cheaper than current market prices.
- (vi) Micro Credit Loan Scheme: To provide sustainable income to poor people.
- (vii) Food Box Scheme: In this scheme, it provides basic necessities of food such as rice, sugar, flour, soy sauce, cooking oil, creamer and rice noodle.

Based on the current system performance, alternative budget allocation for each scheme is designed for better system performance in achieving zero rated poverty. This allocation is based on the sensitivity analysis of the impact of each scheme toward reducing the number of people in poverty in Perak. Sensitivity analysis approach was used in this study wherein multiple parameters related to the schemes are varied simultaneously. These parameters are systematically varied across plausible ranges to evaluate their impact on reducing poverty. Table 4.1 list parameter for the intervention.

Table 4.1

New budget allocation for schemes

Scheme	Budget allocation (%)	
	Base run	Intervention
Income Increment Scheme (AMANJAYA Kiosk)	0.050	0.300
Education Excellence Scheme	0.008	0.200
Automotive Training Scheme	0.005	0.200
Micro Credit Loan Scheme	0.328	0.100
Food Box Scheme	0.283	0.100
Housing Assistance Scheme (Infra)	0.263	0.050
Mobile Store 1 AMANJAYA	0.063	0.050
Total	1.000	1.000

Based on the sensitivity analysis results, the budget allocation was adjusted to prioritize high-impact schemes, as detailed in Table 4.1. A subsequent scenario analysis was conducted to evaluate the effectiveness of reallocating budgets across these schemes using the sensitivity findings. Figures 4.1 and 4.2 illustrate the outcomes of the scenario analysis, demonstrating how the revised budget allocation has significantly reduced the number of people living in poverty over time (see Table 4.2 for detailed data). This analysis indicates that the revised budget allocation can reduce poverty by 90.6% compared to the current system, with the Education Excellence Scheme, Automotive Training Scheme, and Income Increment Scheme having the most substantial impact.

Table 4.2

Number of individuals living in poverty

Time (Year)	2014	2015	2016	2017	2018	2019
People in Poverty: Intervention	17260	11322	5119	4485	3714	3374
People in Poverty: Current	17260	11322	5398	4795	4061	3720

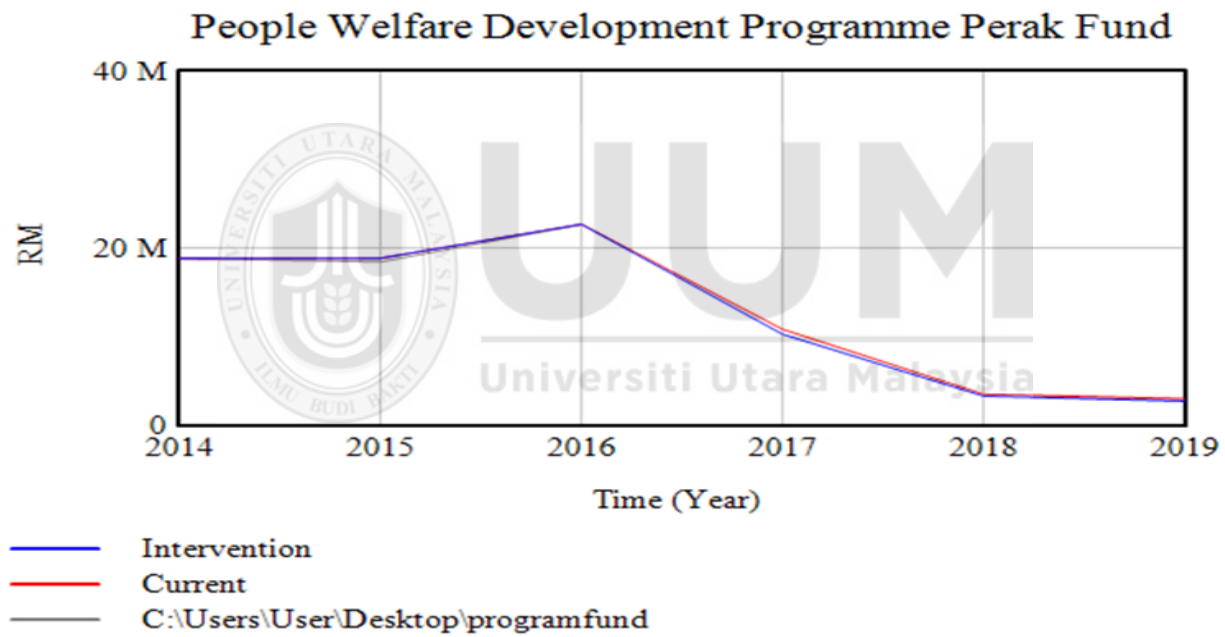


Figure 4.1. The results of interventions for the People Welfare Development Program Perak Fund

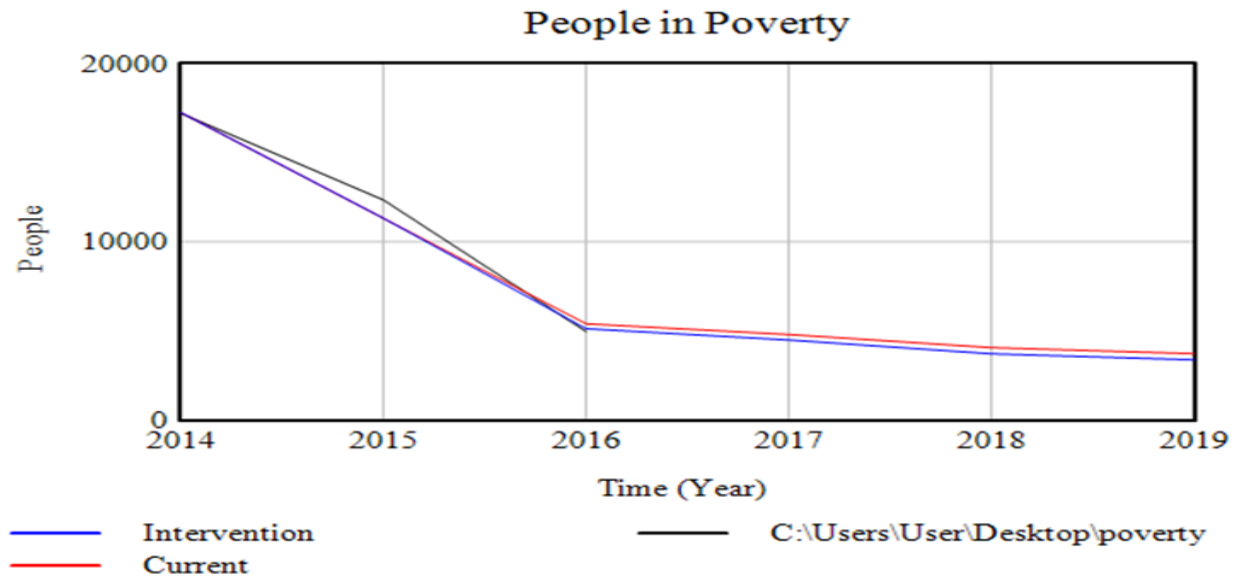


Figure 4.2. The results of interventions for the number of people in poverty

4.3 Summary

Chapter 4 presents the analysis of the outcomes derived from the sensitivity and scenario evaluations conducted on budget allocations. Initially, the sensitivity analysis identified high-impact schemes that significantly influence poverty reduction. This chapter emphasizes the importance of strategic budget reallocation in enhancing the effectiveness of poverty reduction initiatives, highlighting the critical role of targeted high-impact programs.

CHAPTER FIVE

CONCLUSION

5.1 Introduction

The formulation and analysis of the system dynamics model for the Perak Welfare Development Program significantly contribute to understanding the dynamics of poverty reduction in Perak. This chapter summarizes the study presented in the previous chapters, discusses the main findings, and ends with a discussion on the study's limitations and recommendations for future research.

5.2 Achievements of Research Objectives

The main objective of this study was to achieve a zero-poverty rate in Perak. The primary factors contributing to poverty in Perak are inadequate education, low-income levels, and unstable employment status, highlighting the need for targeted interventions in these areas to improve economic well-being. Therefore, the formulation and analysis of the system dynamics model for the Perak Welfare Development Program have provided valuable insights into how various policy interventions and budget allocations can influence poverty rates over time. This model provides deeper insights into the dynamics involved and the potential long-term effects of various welfare strategies. It provides strategic recommendations for budget allocation to schemes under the Perak Welfare Development Program, aiming to positively impact poverty reduction.

5.3 Discussion of The Findings

The findings of this research align with prior research emphasize the essential role of education and employment in reducing poverty. For instance, Romer (1990) emphasized that improving education quality is essential for enhancing job opportunities and income levels. Our results support this view, demonstrating that the Education Excellence Scheme and the Automotive Training Scheme significantly reduce poverty in the long term. Similarly, Bacaksızlar et al. (2015) underscored the link between education and employment opportunities, which our model reflects by showing that increased budget allocation to these schemes positively impacts poverty reduction.

However, our study diverges from earlier research regarding the effectiveness of direct financial assistance schemes like the Food Box Scheme and Housing Assistance Scheme. While previous studies (Rashid and Samat, 2018) have suggested that such schemes are crucial for immediate poverty alleviation, our model indicates that these schemes have a relatively smaller long-term impact compared to education and income increment schemes. This difference may stem from the dynamic modeling approach used in this study, which allows for the evaluation of long-term impacts and feedback loops, thereby revealing the compounding benefits of education and skill development over direct financial aid.

This study is significant as it equips the Perak government with a deeper understanding of the key factors driving poverty in the region. Additionally, it serves to educate the public about the far-reaching negative consequences of poverty and the urgency of addressing it through preventive measures. By proposing strategic interventions and optimized budget allocations to the schemes

under the Perak Welfare Development Program, this study aims to support the government's efforts in eradicating poverty and achieving a zero-rated poverty level.

5.4 Limitations of The Research

While the system dynamics model developed in this study is reliable, it does have several limitations. First, the model relies on historical data from 2014 to 2016, meaning any changes in the socio-economic environment or policy implementations after this period are not captured. This temporal limitation may affect the applicability of our findings to the current context. Second, the model's accurateness depends on the quality and completeness of the data utilized. Although data from credible sources like the Department of Statistics Malaysia and Yayasan Bina Upaya Darul Ridzuan were utilized, some parameters had to be estimated or derived from interviews, introducing potential biases.

Third, the model simplifies complex socio-economic interactions into manageable variables and feedback loops. This abstraction, while necessary for simulation purposes, might overlook nuanced factors such as cultural influences, psychological barriers to education, and informal economic activities, which also play significant roles in poverty dynamics.

5.5 Future Research

Subsequent studies should tackle these restrictions by integrating more recent data to validate and update the model, thereby ensuring it accurately represents current socio-economic conditions. Additionally, integrating qualitative data through field studies and surveys could enhance the model's comprehensiveness by capturing less quantifiable aspects of poverty. Future studies could also explore the interplay between poverty and other socio-economic factors not extensively covered in our model, such as healthcare access, mental health, and social capital. Including these factors would provide a more holistic view of poverty dynamics and the effectiveness of various intervention schemes. Lastly, extending the model to other regions with different socio-economic contexts would be valuable. Comparative studies could identify region-specific factors and determine whether the findings from Perak are generalizable or require region-specific adjustments. This would be particularly useful for policymakers aiming to adapt successful poverty eradication strategies to different local contexts.

5.6 Conclusion

The Perak administration faces numerous challenges in achieving zero-rated poverty, and there has been a lack of studies offering a holistic view of the poverty situation in the region. This research provides the administration with an overview of the interactions between various factors influencing poverty and illustrates the dynamic behavior of poverty in Perak throughout the policy design and evaluation process. Additionally, it serves as a guide for identifying more effective solutions and policies within the Perak Eradication Welfare Program to address poverty issues more effectively.

In summary, the system dynamics model formulated in this study provides key insights into the impacts of various poverty alleviation strategies. The findings accentuate the implication of education and income increment schemes over direct financial assistance in achieving long-term poverty reduction. Nevertheless, the model's limitations suggest the need for future research to incorporate more up-to-date and comprehensive data and to consider additional socio-economic factors affecting poverty. By addressing these gaps, future studies can strengthen the effectiveness and relevance of dynamic modeling in the ongoing efforts to eradicate poverty in Perak.



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APPENDICES

(01) Annual budget factor= 0.009

Units: RM/(Year*Year)

(02) Annual Budget rate= IF THEN ELSE (Time=2014, 1.885e+07, annual budget factor*People Welfare Development Programme budget*(effect of people in poverty*People in Poverty))

Units: RM/Year

(03) Automotive Training Scheme= INTEG (Automotive Training Scheme distribution-Contribution of Automotive Training Scheme, 100000)

Units: RM

(04) Automotive Training fraction=0.005

Units: 1/Year

(05) Automotive Training Scheme distribution= People Welfare Development Programme Perak Fund*Automotive Training fraction

Units: RM/Year

(06) birth factor= 0.105

Units: 1/Year

(07) birth rate= birth factor*Perak Population

Units: People/Year



(08) Contribution of Automative Training Scheme= Automative Training Scheme*unit time

Units: RM/Year

(09) Contribution of Education Excellence Scheme= Education Excellence Scheme*unit time

Units: RM/Year

(10) Contribution of Food Box Scheme= Food Box Scheme*unit time

Units: RM/Year

(11) Contribution of Housing Assistance Scheme= Housing Assistance Scheme*unit time

Units: RM/Year

(12) Contribution of Income Increment Scheme= "Income Increment Scheme (Amanjaya Kiosk)"*unit time

Units: RM/Year

(13) Contribution of Micro Credit Loan Scheme= Micro Credit Loan Scheme*unit time

Units: RM/Year

(14) Contribution of Mobile Store 1 Amanjaya Scheme= Mobile Store 1 Amanjaya Scheme*unit time

Units: RM/Year

(15) death factor= 0.1

Units: 1/Year

(16) death rate= Perak Population*death factor

Units: People/Year

(17) Education Excellence fraction= 0.008

Units: 1/Year

(18) Education Excellence Scheme= INTEG (Education Excellence Scheme distribution-
Contribution of Education Excellence Scheme ,150000)

Units: RM

(19) Education Excellence Scheme distribution= People Welfare Development Programme Perak
Fund*Education Excellence fraction

Units: RM/Year

(20) Education Level= Impact of Education Excellence Scheme

Units: RM/Year

(21) effect of people in poverty= IF THEN ELSE(Time<=2016, 5e-05 , 2e-05)

Units: 1/People

(22) Employment Status= Education Level+Impact of Automotive Training Scheme

Units: RM/Year

(23) FINAL TIME = 2019

Units: Year

The final time for the simulation.

(24) Food Box Scheme= INTEG (Food Box Scheme distribution-Contribution of Food Box Scheme, 3.9e+06)

Units: RM

(25) Food Box Scheme distribution= People Welfare Development Programme Perak Fund*Food Box Scheme fraction

Units: RM/Year

(26) Food Box Scheme fraction= 0.283

Units: 1/Year

(27) Housing Assistance fraction= 0.263

Units: 1/Year

(28) Housing Assistance Scheme= INTEG (Housing Assistance Scheme distribution-Contribution of Housing Assistance Scheme, 5.5e+06)

Units: RM

(29) Housing Assistance Scheme distribution= People Welfare Development Programme Perak Fund*Housing Assistance fraction

Units: RM/Year



(30) Impact of Automotive Training Scheme= $0.008802 \times \text{Contribution of Automotive Training Scheme}$

Units: RM/Year

(31) Impact of Education Excellence Scheme= $0.008899 \times \text{Contribution of Education Excellence Scheme}$

Units: RM/Year

(32) Impact of Housing Assistance Scheme= $0.008226 \times \text{Contribution of Housing Assistance Scheme}$

Units: RM/Year

(33) Impact of Income Increment Scheme= $0.009124 \times \text{Contribution of Income Increment Scheme}$

Units: RM/Year

(34) Impact of Micro Credit Loan Scheme= $0.008568 \times \text{Contribution of Micro Credit Loan Scheme}$

Units: RM/Year

(35) Impact of Mobile Store 1 Amanjaya Scheme= $0.007312 \times \text{Contribution of Mobile Store 1 Amanjaya Scheme}$

Units: RM/Year

(36) Impact of Food Box Scheme= $0.008283 \times \text{Contribution of Food Box Scheme}$

Units: RM/Year

(37) impact per capita= IF THEN ELSE (Time<=2015, 0.38, 0.04)

Units: People*Year/RM

(38) Impact towards income= Employment Status+Impact of Income Increment Scheme+Impact of Micro Credit Loan Scheme

Units: RM/Year

(39) Income Increment fraction= 0.05

Units: 1/Year

(40) "Income Increment Scheme (Amanjaya Kiosk) distribution"= People Welfare Development Programme Perak Fund*Income Increment fraction

Units: RM/Year

(41) "Income Increment Scheme (Amanjaya Kiosk)"= INTEG ("Income Increment Scheme (Amanjaya Kiosk) distribution"-Contribution of Income Increment Scheme, 1e+06)

Units: RM

(42) INITIAL TIME= 2014

Units: Year

The initial time for the simulation.

(43) Level of Income= Impact towards income*impact per capita

Units: People

(44) Micro Credit Loan fraction= 0.328

Units: 1/Year

(45) Micro Credit Loan Scheme= INTEG (Micro Credit Loan Scheme distribution-Contribution of Micro Credit Loan Scheme, 7.7e+06)

Units: RM

(46) Micro Credit Loan Scheme distribution= People Welfare Development Programme Perak Fund*Micro Credit Loan fraction

Units: RM/Year

(47) Mobile Store 1 Amanjaya distribution= People Welfare Development Programme Perak Fund*Mobile Store 1 Amanjaya fraction

Units: RM/Year

(48) Mobile Store 1 Amanjaya fraction= 0.063

Units: 1/Year

(49) Mobile Store 1 Amanjaya Scheme= INTEG (Mobile Store 1 Amanjaya distribution-Contribution of Mobile Store 1 Amanjaya Scheme, 500000)

Units: RM

(50) People in Poverty= INTEG (poverty birth rate-poverty death rate-poverty relief rate, 17260)

Units: People [0,?]

(51) People Welfare Development Programme budget= IF THEN ELSE (Time<=2016, People Welfare Development Programme in Perak*1.1, People Welfare Development Programme in Perak)

Units: Year

(52) People Welfare Development Programme in Perak= $2e+06 \cdot \text{Time} + 2e+07$

Units: Year

(53) People Welfare Development Programme Perak Fund= INTEG (Annual Budget rate-Automotive Training Scheme distribution-Education Excellence Scheme distribution-Food Box Scheme distribution-Housing Assistance Scheme distribution-"Income Increment Scheme (Amanjaya Kiosk) distribution" -Micro Credit Loan Scheme distribution-Mobile Store 1 Amanjaya distribution , $1.885e+07$)

Units: RM

(54) Perak Population= INTEG (birth rate-death rate, $2.46e+06$)

Units: People

(55) "Post-Welfare People"= INTEG (poverty relief rate,0)

Units: People

(56) poverty birth rate= IF THEN ELSE (People in Poverty<=0, 0 , birth factor*People in Poverty)

Units: People/Year

(57) poverty death rate= IF THEN ELSE(People in Poverty<=0, 0 , death factor*People in Poverty)

Units: People/Year

(58) poverty relief rate= IF THEN ELSE(People in Poverty <=0, 0 , (Total Impact+Level of Income)*relief factor)

Units: People/Year

(59) relief factor= 0.1

Units: 1/Year

(60) SAVEPER = TIME STEP

Units: Year [0,?]

The frequency with which output is stored.

(61) TIME STEP = 1

Units: Year [0,?]

The time step for the simulation.

(62) Total Impact= (Impact ofFood Box Scheme+Impact of Housing Assistance Scheme+Impact of Mobile Store 1 Amanjaya Scheme) *impact per capita

Units: People

(63) unit time= 1

Units: 1/Year