

UNIVERSITI TEKNOLOGI MARA

**DEVELOPMENT OF HYBRID
SIX-STAGE BONUS MALUS AND
DEDUCTIBLE MODEL FOR FAIR
MEDICAL AND HEALTH
INSURANCE PREMIUM RATING**

**RABI'ATUL'ADAWIYAH BT ABDUL
RAZAK**

Thesis submitted in fulfilment
of the requirements for the degree of
Master of Science
(Actuarial Science)

**College of Computing, Informatics and
Mathematics**

February 2024

ABSTRACT

This research delves into the application of a Bonus Malus System (BMS) within the sphere of medical and health insurance, focusing on three principal objectives. Firstly, the study endeavours to estimate claims numbers and sizes by elucidating the most appropriate methods for premium and claim estimations. Secondly, it proposes a hybrid premium system, integrating Bonus Malus and Stop-Loss elements, to refine the precision of premium calculations in the healthcare insurance domain. Lastly, the research seeks to validate the efficacy of time-discrete Markov chain models in the context of this hybrid system. The implementation of this hybrid system is anticipated to yield a mutually beneficial outcome for both insurance companies and policyholders. For insurers, it presents an effective means of curtailing fraudulent claims, while for the insured, it shields policyholders from penalties arising from legitimate claims. This study employs Markov Chain transition models to discern the scale for the Bonus Malus System. The anticipated claim amount and frequency data for this paper were sourced from the Society of Actuaries' Project Oversight Group (POG) research project titled "Group Medical Insurance Large Claims Database Collection and Analysis" and simulated using Monte Carlo simulation in Excel. The study adopts a rigorous methodology comprising five distinct phases. Phase 1 involves controlling claim numbers and sizes, laying the groundwork for subsequent analyses. Phase 2 focuses on calculating premium income using the Bonus Malus System, while Phase 3 determines the optimal percentage for reward (bonus) and penalty (malus) within the BMS model. Phase 4 introduces simulations to ascertain the appropriate deductible amounts imposed on policies. Finally, Phase 5 concludes the methodology by estimating Medical and Health Insurance (MHI) premiums using the developed hybrid model. Through these comprehensive phases, a 6-stage BMS model is utilized, with a highest 40 percent reward (bonus) and a minimum 5 percent penalty (malus) applied to the base premium, favouring the -1/top scale for its simplicity, transparency, and consistency in penalty assessment. This study reveals that insured individuals with lower deductible amounts face a higher probability of being penalized compared to those with higher deductibles. The average deductible generated in this study ranges from \$3,164.50 to \$7,984.30, falling within the \$9,100 maximum limit stipulated by the Affordable Care Act (ACA). Consequently, an additional premium top-up is suggested to maintain a stable risk pool, deemed essential for the sustained viability of an insurance company, beyond merely covering deductibles. The findings showed, the structured premium adjustments based on policyholders' claims history, combined with the Bonus Malus System (BMS) and deductibles, ensure predictability, transparency, and risk-based pricing. This approach fosters a balanced risk pool, stabilizes premiums by curbing small claims, and promotes customer engagement. The hybrid model's estimation of Medical and Health Insurance (MHI) premiums integrates these features, providing insurers with a flexible and comprehensive framework. This innovative approach reflects the industry's commitment to transparency, risk management, and customer-centric practices in shaping the future of medical insurance.

ACKNOWLEDGEMENT

Firstly, Alhamdulillah, in His Blessing and Mercy, I wish to thank Allah for giving me the opportunity to embark on my master's and for completing this long and challenging journey successfully. My gratitude and thanks go to my supervisors, Dr. Norazliani and Sir Nazrul for all the patience and guidance towards the end of my writing. We have finally come to its end.

My appreciation goes to my colleagues and friends for helping me with this project. Will I not be able to finish this journey without your supports.

This thesis is humbly dedicated to my both father and mother for their vision and determination to educate me. My lovely husband for all the motivation and shoulder to cry on. Thank you for not giving up on me. This piece of victory is dedicated to all of you. Alhamdulillah.

Finally, to my dear self. You are wonderful. It is ok if you are a step behind others. You are at the very best pace of your life. I am very much proud of you. May the past 5 years' journey be the most valuable moments for you to carry on.

TABLE OF CONTENTS

	Page
CONFIRMATION BY PANEL OF EXAMINERS	ii
AUTHOR'S DECLARATION	iii
ABSTRACT	iv
ACKNOWLEDGEMENT	v
TABLE OF CONTENTS	vi
LIST OF TABLES	viii
LIST OF FIGURES	ix
LIST OF SYMBOLS	x
LIST OF ABBREVIATIONS	xi
CHAPTER 1 INTRODUCTION	1
1.1 Research Background	1
1.2 Motivation	5
1.3 Problem Statement	7
1.4 Research Questions	9
1.5 Research Objectives	9
1.6 Significance of Study	10
CHAPTER 2 LITERATURE REVIEW	12
2.1 Medical and Health Insurance – World and Malaysia	12
2.2 Medical Cost and Inflation	15
2.3 Medical Issues	18
2.4 Bonus-Malus System (BMS)	20
2.5 Stop Loss & Deductibles	22
2.6 Markov Chain	24
CHAPTER 3 RESEARCH METHODOLOGY	27
3.1 Introduction	27
3.2 Data Pre-Processing for Classification	28

CHAPTER 1

INTRODUCTION

1.1 Research Background

A medical and health insurance is a type of insurance coverage that covers the cost of individual's medical and surgical expenses. The individual pays a premium to the health insurance company for this coverage. The company then pays the medical expenses of the policyholder up to the limit of the policy. There are many different types of health insurance policies available, and the type of coverage that an individual selects will depend on their specific needs. Health insurance became available in the industry in the early 20th century, and it has since evolved into a major part of the global economy. Today, health insurance is an important part of the social welfare system in many countries including Malaysia.

A finding from AON (2020) Global Medical Trend Rates report, Malaysia kept its first ranking in Asia on the annual medical trend rates for two consecutive years 2019-2020 despite a slight drop-in rate from 16 percent in 2019 to 14 percent in 2020 (see Figure 1.1). It clearly shown that, Malaysia's medical trend rates in Asia Pacific (APAC) will again have a higher rate compared to the global average medical trend rate which is at 8.0 per cent and the average general inflation rate is at 3.1 per cent. This survey was conducted in order to help multinational companies to understand the factors that driving the medical cost increment while preparing a budget that could generate a premium cost for medical plan renewals in responding to the devise wellness and cost-containment initiatives.

Seeing how the medical trend increases, Jantan (2019) in his study said that the medical cost in Malaysia also showed a consistent increase from 2016 to 2018. At a starting percentage of 11.8 per cent in 2016 to 12.6 percent in 2017, it hit 13.2 percent in 2018. According to Malaysia National Health Accounts (2018), in 1997, the total expenditure on health (nominal) was RM8, 550 million. This value increases to RM24, 414 million after ten years and reached up to RM57, 361 million in 2017 with a total population of 32, 049, 900. Resulting an increment of more than 100 percent from 1997 to 2017.