PRESCRIPTIVE ANALYTICS: COMPUTER SCIENCE STUDENT PROJECTION ANALYSIS BASED ON SYSTEM DYNAMICS MODELLING AND SIMULATION

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BORANG PENGESAHAN STATUS LAPORAN

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PRESCRIPTIVE ANALYTICS: COMPUTER SCIENCE STUDENT PROJECTION ANALYSIS BASED ON SYSTEM DYNAMICS MODELLING AND SIMULATION

NATASHA AMIERA BINTI AZMAN

This report is submitted in partial fulfilment of the requirements for the Bachelor of Computer Science (Artificial Intelligence) with Honours.

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

DECLARATION

I hereby declare that this project report entitled

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(PROF MADYA TS DR ZURAIDA ABAL ABAS)

DEDICATION

I dedicate this thesis to my beloved parents for their love and support for me throughout my journey in pursuing my education. I hope that achieving the completion of this project will fulfil their expectations they have put for me in life.

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I would like to express my heartfelt gratitude to my esteemed Prof Madya Ts Dr Zuraida Abal Abas, whose unwavering dedication and guidance have been instrumental in shaping my academic journey. Your wisdom and mentorship have not only enriched my knowledge but also inspired me to strive for excellence.

To my beloved parents, Rokiah binti Md Yatim and Azman bin Jantan, I owe an immense debt of gratitude. Your unwavering support, encouragement, and sacrifices have been the cornerstone of my achievements. Your love and belief in me have been my driving force.

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I am truly fortunate to have had such incredible people in my life, and I wouldn't have reached this milestone without your collective support and encouragement. Thank you from the bottom of my heart.

ABSTRACT

The purpose of this project is to find an approach to acquire a prediction of the number of students enrolled to help in the process of decision and policy making at universities as well as provide an approximate number of graduates which can be considered 'ICT experts' that can be supplied to the industry. Through the help of system dynamics, a model has been created to show the flow of enrolment as well as to study the effects of a change of scenario to the future. Data on enrolment of students into courses under FTMK between 2015 to 2022 is acquired and fed into the model. The model is initially able to replicate the flow of enrolment of students through courses. After succeeding in doing so, several scenarios are applied as an analysis of the model's capabilities. It is found that the model was able to create simulated values that have an error rate of less than 25% which is exceptionally good. A baseline scenario was done to be used as a comparison with the other scenarios which are enrolment of 120 students from 2023 onwards, increasing 10% from the first scenario and increasing 20% from the first scenario. It is found that the model is able to create a forecast of an increase of graduates in the future and becomes almost static in the future after 2028. This is most probably due to the ability of the management to manage the enrolment of students more properly because humans evolve to achieve a skill through experience. Therefore, the model is able to produce a prediction that is somewhat useful.

ABSTRAK

Tujuan projek ini adalah untuk mencari pendekatan untuk memperoleh ramalan bilangan pelajar yang mendaftar untuk membantu dalam proses membuat keputusan di universiti serta menyediakan anggaran bilangan graduan yang boleh dianggap sebagai 'pakar ICT' yang boleh dibekalkan kepada industri. Melalui bantuan '*System Dynamics Model*' telah dicipta untuk menunjukkan aliran pendaftaran serta mengkaji kesan perubahan senario ke masa hadapan. Data mengenai pendaftaran pelajar ke dalam kursus di bawah FTMK antara 2015 hingga 2022 diperoleh dan dimasukkan ke dalam model. Model ini pada mulanya dapat meniru aliran pendaftaran pelajar melalui kursus. Selepas berjaya melakukannya, beberapa senario digunakan sebagai analisis keupayaan model. Didapati bahawa model itu dapat mencipta nilai simulasi yang mempunyai kadar ralat kurang daripada 25% yang sangat baik. Satu senario asas telah dibuat untuk digunakan sebagai perbandingan dengan senario lain iaitu kemasukan seramai pelajar 120 mulai 2023 dan seterusnya, meningkat 10% daripada senario pertama dan meningkat 20% daripada senario pertama. Didapati model tersebut mampu mencipta ramalan pertambahan graduan bermula 2025 dan menjadi hampir statik pada masa hadapan bermula tahun 2028. Ini berkemungkinan besar disebabkan oleh keupayaan pihak pengurusan menguruskan kemasukan pelajar dengan lebih baik kerana manusia berkembang untuk mencapai sesuatu kemahiran melalui pengalaman. Oleh itu, model tersebut mampu menghasilkan ramalan yang agak berguna.

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LIST OF ABBREVIATIONS

FYP	**-**	**Final Year Project**
SDM	**-**	**System Dynamics Modelling**
CRISP-DM	**-**	**Cross Industry Standard Process for Data Mining**
RMSPE	**-**	**Root Mean Squared Percentage Error**

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CHAPTER 1: INTRODUCTION

1.1 Introduction

In the rapidly evolving world of technology, the demand for Information and Communication Technology (ICT) expertise has reached unprecedented heights. In the recent years, there have been an increase in demand of ICT experts due to the emergence of the Fourth Industrial Revolution (IR4.0). According to the International Trade Administration (2022), the ICT field contributed to 22.6% of Malaysia's GDP which by assumption will bring an exponential growth of needs of ICT experts to manage and develop in projects in all industries. The demand for ICT experts will most definitely increase in the next 10 years. Given this knowledge, how prepared are we in supplying experts to fulfill this rising demand? Education plays a vital role in shaping societies and preparing individuals for the challenges of an ever-changing world. As educational institutions strive to meet the demands of an expanding population, accurately forecasting student intake becomes essential for effective planning and resource allocation.

In this final year project (FYP), we delve into the field of student enrolment projection analysis and explore the potential of System Dynamics Modelling (SDM) as a powerful tool to unravel the dynamics of educational demands and provide accurate predictions. Student enrolment projection analysis involves examining historical enrollment data, trends, and other relevant indicators to estimate future student enrollment patterns. Traditional methods have been used to forecast student intake; however, they often overlook the dynamic nature of educational systems, which are characterized by feedback loops, time delays, and nonlinear relationships. By integrating SDM into the analysis, we can capture these complexities and gain a deeper understanding of how different factors interact and influence student enrollment.

System Dynamics Modelling offers a holistic approach to studying complex systems, allowing researchers to simulate and predict the behavior of educational systems over time. By representing the interdependencies between variables, SDM enables us to project student intake with a higher degree of accuracy. Through

simulation and scenario analysis, SDM empowers educational administrators and policymakers to anticipate future enrollment trends, optimize resource allocation, and devise effective strategies to accommodate changing educational demands.

While SDM has proven successful in various fields, its application and potential in student enrolment projection analysis in Malaysia remains relatively unexplored. This FYP report aims to bridge that gap by investigating the use of SDM as a forecasting tool in educational planning and management. By leveraging its ability to capture the dynamic complexities of educational systems, we seek to enhance the accuracy and reliability of student enrolment projections.

Through a comprehensive review of relevant literature, analysis of historical enrollment data, and the development of a customized System Dynamics model tailored to the specific educational context, this FYP report will provide valuable insights into the application of SDM for student enrolment projection analysis. We will explore the challenges associated with integrating SDM, highlight best practices, and evaluate the potential benefits and limitations of this approach. Additionally, by comparing the outcomes of SDM-based projections with traditional methodologies, we aim to demonstrate the added value and robustness of this modeling technique.

The findings of this research will have significant implications for educational administrators, policymakers, and researchers involved in educational planning and management. By harnessing the power of System Dynamics Modelling, institutions can make more informed decisions, allocate resources efficiently, and proactively address the ever-evolving demands of the ICT sector. Ultimately, this research contributes to the growing body of knowledge on student enrolment projection analysis, advancing our understanding of the dynamic nature of educational systems and paving the way for sustainable growth in the education sector.

1.2 Problem Statement

Education still remains to be a very important field that needs careful attention to detail. To ensure quality in education offered at universities, management needs to be fully taken into account. In order to fully understand and define the requirements of this project, problem statement identification needs to be done.

Table 1.1: Summary of Problem Statement

PS	Problem Statement
PS_1	Using artificial intelligence forecasting algorithms requires analysis on choosing between various algorithms which might not be able to be used with every situation and the traditional way of forecasting student enrolment projection might cause a large margin of error that can cause the management to be unprepared as well as does not take into account various factors.

1.3 Project Question

Table 1.2: Summary of Project Question

PS	PQ	Project Question
PS_1	PQ_1	What alternative can be used where choosing algorithms is not needed?
PS_1	PQ_2	How to show the proposed solution is effective?

1.4 Project Objective

Table 1.3: Summary of Project Objectives

PS	PQ	PO	Project Question
PS_1	PQ_1	PO_1	To propose a student enrolment projection model using system dynamics modelling.
		PO_2	To predict the graduated students produced through the proposed model.
	PQ_2	PO_3	To visualize the student enrolment projection analysis through a dashboard.

1.5 Project Scope

1. Software:
    a. Vensim ® PLE
        i. Version : 9.3.5, Build: TK-221029.00184
        ii. Operating System : 64-bit
    b. RStudio
        i. Version:

        2023.03.0+386 "Cherry Blossom" Release (3c53477afb13ab959aeb5b34df1f10c237b256c3, 2023-03-09) for Windows

        ii. Operating System:

        Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) RStudio/2023.03.0+386 Chrome/108.0.5359.179 Electron/22.0.3 Safari/537.36

2. Programming language:
    a. R : Version 4.2.3
3. Device specifications:
    a. Processor : 12th Gen Intel® Core™ i7-12700H 2.70 GHz
    b. RAM : 16.0 GB
    c. System type : 64-bit operating system, x64-based processor
    d. Manufacturer : Acer
4. Windows specifications:
    a. Edition : Windows 11 Home Single Language
    b. Version : 22H2
    c. OS build : 22621.1848

1.6 Project Contribution

Table 1.4: Summary of Project Contribution

PS	PQ	PO	PC	Project Contribution
PS_1	PQ_1	PO_1	PC_1	Proposed technique to solve the student enrolment projection prediction
		PO_2		
	PQ_2	PO_3	PC_2	Proposed student enrolment projection analysis dashboard

1.7 Report Organization

Chapter 1: Introduction

This chapter discusses about introducing the project proposed. In order to prove the need for the proposed project, an analysis on the project problem, objectives, scope, and contribution needs to be taken into account. Proper focus on the various factors and problems involved in the project can help the identification of the requirements of the project. The scope is stated to inform future researchers wishing to use the proposed solution on the required specifications to carry out similar studies as well as address on version differences that might pose to be a problem in the future.

Chapter 2: Literature Review

This chapter focuses on analyzing, summarizing and conducting research on existing knowledge and research related to the topic of study. Reviews on scholarly articles, books and other relevant resources are done in order to identify key theories and concepts regarding knowledge within the field of study. Findings and methodologies from previous studies are addressed to identify problems from other proposed solutions and find trends that can be applied to the proposed solution. This can also help the process of distinguishing limitations along with the validity and reliability of research findings.

Chapter 3: Project Methodology

This chapter focuses on defining the methodology and approach used for the project. A detailed description on each stage of the selected methodology is stated, emphasizing its relevance to the project. This chapter also highlights the category of analysis and method of collecting data. The validity, and integrity of the data is also addressed in this chapter. Overall, the chapter provides a comprehensive outline of the methodology and project plan.

Chapter 4: Design

This chapter discusses about the items and details that needs to be taken into consideration during design, the methodology and techniques used. This chapter also discusses on the data collected such as features and variables in the proposed model. Some experimental designs, procedure, validation procedures, and limitations of the design are also addressed in this section. In addition, every iteration of model design proposed is also addressed along with the problems faced in the model. By addressing these aspects, the chapter provides a comprehensive understanding of the project's design and methodology, ensuring transparency and allowing readers to assess the validity of the findings.

Chapter 5: Implementation

This chapter concentrates on an overview of the proposed system dynamics model. An in-depth discussion of the equations proposed in the stock, values decided for each variable, the flow of data, and other factors is also done in this section. Additionally, the method of evaluating model performance is also discussed in this chapter. This chapter also focuses on on detailing the practical execution of the model. This chapter covers the software and tools used for implementation, the translation of the mathematical model into code or algorithms, data integration processes, model execution steps, performance evaluation techniques, scalability and efficiency considerations, validation and testing procedures, as well as the presentation and interpretation of the results. Additionally, the chapter acknowledges limitations and suggests areas for future improvement. By addressing these aspects, the chapter provides a clear understanding of how the proposed mathematical model will be implemented and executed in practice, ensuring the reliability and practicality of the solution.

Chapter 6: Testing and Analysis