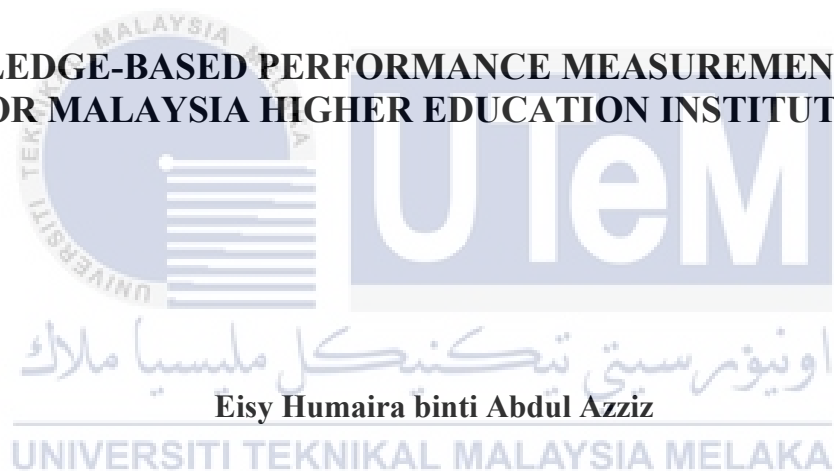




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FOR MALAYSIA HIGHER EDUCATION INSTITUTION**



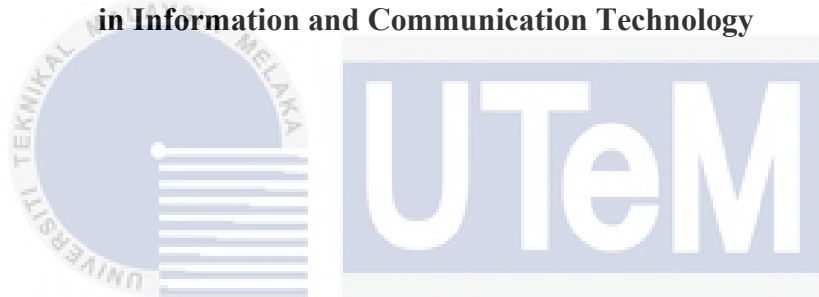
**Master of Science in Information and Communication Technology**

**2021**

**KNOWLEDGE-BASED PERFORMANCE MEASUREMENT MODEL FOR  
MALAYSIA HIGHER EDUCATION INSTITUTION**

**EISY HUMAIRA BINTI ABDUL AZZIZ**

**A thesis submitted  
in fulfillment of the requirements for the degree of Master of Science  
in Information and Communication Technology**



**Faculty of Information and Communication Technology**

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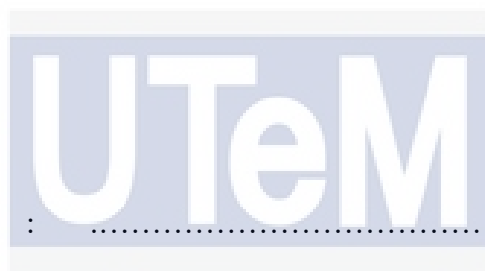
**2021**

## DECLARATION

I declare that this thesis entitled “Knowledge-Based Performance Measurement Model for Malaysia Higher Education Institution” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.



Signature



Name : .....  
Date : .....

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## APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in term of scope and quality for the award of Master of Science in Information and Communication Technology.

Signature	:	.....
Supervisor Name	:	.....
Date	:	.....



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## DEDICATION

I would like to dedicate my work to my beloved family especially to my parents Mr. Abdul Azziz Kadir and Mrs. Noraini Mustafa for their non-stop supporting and teaching me since I was born. Also, to my siblings (Fariz, Fariza, Zuin and Zatun) for always encourage and help me. This work is a guileless and humble reply to their kindness. May Allah bless all of them.



## ABSTRACT

Performance Measurement (PM) is a valuable tool to measure organizational performance. The key factor in measuring the performance is to assess the current position of an organization and to assist managers in creating a better strategy. Some education organizations use ranking instrument system (RIS) in measuring performance for Higher Education Institutions (HEI) such as MyRA and QS Ranking. Hence, almost all HEIs strive to achieve the target performance. More emphasis is put on HEIs' PM plans to ensure that the institutions can perform well in RIS. However, the current Performance Measurement Model (PMM) does not emphasize in measuring individual capabilities in enhancing the overall performance of Higher Education Institutions. Staff may perform works that exceed their limit because the goal is not measured according to their strength. Besides, the current Knowledge-Based Performance Measurement features are not suitable to map with the existing ranking instrument system in which staff performance is one of the main factors. Many aspects are to be considered before measuring the performance because a lot of performance indicators exist in RIS. Therefore, a PM model that can overcome all these problems should be developed. This research develops an enhanced knowledge-based performance measurement model (KBPMM) that caters to the HEIs' needs. The primary aim of this model is to assist institution's top management in managing and monitoring the performance achievement of HEIs based on staff's contribution, hence, contributing to the overall HEI's performance. The proposed model considered some crucial aspects in calculating the performance of individual staff and utilized the Artificial Intelligence (AI) techniques, namely the knowledge-based (KB) and Expert System (ES) to build the model. Besides, non-AI techniques such as Full-time Equivalent (FTE) and Competitor Analysis were also used in the model development to enhance the model's capability. By using ES, the model recommends the possible solutions to enhance the performance. The proposed enhanced KBPMM is validated via expert validation process. Based on the result, the experts conclude that KBPMM could be one of the alternatives for the institution to measure and monitor the performance. KBPMM can also be used to assist the administrators in measuring the institution's performance better than the current existing system. Furthermore, combining AI and non -AI techniques in the model development shows that the use of a variety of approaches/techniques in conducting the process can improve the output. This research will give advantages to the HEI's in Malaysia, especially UTeM, in managing and controlling its institutional performance. In addition, with an in-depth understanding of the flow and process of the model, this model can also be applied in other sectors such as health care.

## **MODEL PENGUKURAN PRESTASI BERASASKAN PENGETAHUAN UNTUK INSTITUSI PENDIDIKAN TINGGI MALAYSIA**

### **ABSTRAK**

*Pengukuran Prestasi (PM) adalah alat yang penting untuk mengukur prestasi organisasi. Faktor utama dalam mengukur prestasi adalah menilai kedudukan organisasi semasa dan membantu pengurus dalam membuat strategi yang lebih baik. Beberapa organisasi pendidikan menggunakan instrumen sistem pemeringkatan (RIS) dalam mengukur prestasi untuk Institusi Pengajian Tinggi (IPT) seperti MyRA dan Pemeringkatan QS. Oleh itu, hampir semua IPT berusaha untuk mencapai prestasi sasaran. Kini, lebih banyak penekanan diberikan pada rancangan pengukuran prestasi di IPT untuk memastikan institusi dapat menunjukkan prestasi yang baik dalam RIS. Walau bagaimanapun, Model Pengukuran Prestasi (PMM) semasa tidak menekankan pengukuran keupayaan individu dalam meningkatkan prestasi keseluruhan Institusi Pengajian Tinggi. Staf mungkin perlu melakukan kerja yang melebihi had skop kerja kerana matlamat tidak disetarakan dengan kekuatan semasa staf. Selain itu, ciri Pengukuran Prestasi Berasaskan Pengetahuan semasa juga tidak sesuai dipetakan dengan RIS yang ada kerana prestasi staf merupakan salah satu faktor utama. Banyak aspek yang harus dipertimbangkan sebelum mengukur prestasi kerana terdapat banyak petunjuk prestasi yang digunakan di dalam RIS. Oleh itu, model pengukuran prestasi yang dapat mengatasi semua masalah ini perlu dibangunkan. Penyelidikan ini bertujuan untuk membangunkan model pengukuran prestasi berasaskan pengetahuan (KBPMM) yang lebih mantap dalam memenuhi keperluan IPT. Matlamat utama model ini adalah untuk membantu pengurusan tertinggi institusi dalam mengurus dan mengawal pencapaian prestasi IPT berdasarkan sumbangan staf, yang juga akan menyumbang kepada prestasi keseluruhan IPT. Model yang dicadangkan juga mengambil kira beberapa aspek penting dalam mengira prestasi staf dan menggunakan teknik Kepintaran Buatan (AI), iaitu Sistem Berasaskan Pengetahuan (KBS) dan Sistem Pakar (ES) untuk membina model tersebut. Selain itu, teknik bukan AI seperti Penyetaraan Sepenuh Masa (FTE) dan Analisis Pesaing juga digunakan dalam pembangunan model untuk meningkatkan prestasi model. Dengan menggunakan ES, model tersebut mengesyorkan jalan penyelesaian yang dapat digunakan untuk meningkatkan prestasi. KBPMM yang dicadangkan diuji melalui proses pengesahan pakar. Berdasarkan hasilnya, para pakar bersetuju bahawa KBPMM dapat menjadi salah satu alternatif bagi institusi untuk mengukur dan mengawal prestasi. KBPMM juga digunakan dan membantu pentadbir dalam mengukur prestasi institusi lebih baik daripada sistem yang sedia ada. Tambahan pula, penggabungan teknik AI dan bukan-AI dalam membangunkan model menunjukkan bahawa penggunaan pelbagai pendekatan/teknik dalam menjalankan proses dapat membantu menghasilkan hasil yang terbaik. Penyelidikan ini akan memberi kelebihan kepada IPT di Malaysia, terutamanya UTeM dalam mengurus dan mengawal prestasi institusi. Di samping itu, dengan pemahaman mendalam mengenai aliran dan proses model, model ini juga dapat diaplikasikan di sektor lain seperti penjagaan kesihatan.*

## ACKNOWLEDGEMENTS

First and foremost, I would like to take this opportunity to express my sincere acknowledgement to my supervisor Ts. Dr. Zeratul Izzah binti Mohd Yusoh from the Faculty of Information and Communication Technology Universiti Teknikal Malaysia Melaka (UTeM) for her essential supervision, support and encouragement towards the completion of this thesis.

I would also like to express my greatest gratitude to Associate Professor Dr. Azah Kamilah binti Muda, co-supervisor of this research for her advice and suggestions during this research progress. Special thanks to UTeM short term grant funding for the financial support throughout this project.

Particularly, I would also like to express my deepest gratitude to my Computational Intelligence and Technology Laboratory (CIT Lab) lab-mates especially Atikah and Amirul for their helps during in all the lab and analysis works.

Special thanks to my beloved mother, father, siblings and families for their moral support in completing this degree. Lastly, thank you to everyone who had been associated to the crucial parts of realization of this project.

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## LIST OF ABBREVIATIONS

AI	- Artificial Intelligence
BSC	- Balanced Score Card
CRIM	- Centre of Research and Innovation Management
ES	- Expert System
FL	- Fuzzy Logic
FTE	- Full-Time Equivalent
FVP	- Functional Virtual Population
FCM	- Fuzzy C-Means
FIS	- Fuzzy Inference System
GA	- Genetic Algorithm
HEI	- Higher Education Institutions
KB	- Knowledge-Based
KBES	- Knowledge-Based Expert System
KBPM	- Knowledge-Based Performance Measurement Model
KBPM	- Knowledge-Based Performance Measurement System
KBR	- Knowledge-Based Rules
MyRA	- Malaysian Research Assessment Instrument
MPV	- Maximal P-Value
MTD	- Mega Trend Diffusion
MoHE	- Ministry Of Higher Education
PM	- Performance Measurement
PMM	- Performance Measurement Model
PMS	- Performance Measurement System
QS	- Quacquarelli Symonds
RIS	- Ranking Instrument System
RAD	- Rapid Application Development

RES	- Rule-Based Expert System
SMART	- Strategic Measurement and Reporting Technique
D-SETARA	- The Discipline-Based Rating System
THE	- Times Higher Education World University Rankings
UTeM	- Universiti Teknikal Malaysia Melaka



## LIST OF PUBLICATIONS

1. Abdul Azziz, E.H., Mohd Yusoh, Z.I., and Muda, A.K., 2020. Performance Measurement Model for Malaysia Higher Education Institutions using Knowledge-based System Approach. *International Journal of Engineering Trends and Technology*, pp.22–29.
2. Abdul Azziz, E.H., Mohd Yusoh, Z.I., and Muda, A.K., 2018. Performance Measurement Model: In University Performance Achievement. *JP Journal of Heat and Mass Transfer*, pp.1–5.



## CHAPTER 1

### INTRODUCTION

#### 1.1 Introduction

Strategic planning is a process in which top management analyses and identifies the organisation's objective and goal to achieve its planned vision for continuous achievement. It is also known as a set of processes undertaken to develop a range of strategies to achieve the organisational direction (Tapinos et al., 2005). Strategic planning is getting popular in the middle of the 1960s, utilized by business leaders in improving their business (Mintzberg, 1994). Hence, leaders need to develop strategies that will help their organizations achieving goals as well as objectives that are deemed suitable for their organization's mission (Kiptoo and Mugambi Mwirigi, 2014).

However, strategic plans cannot be obtained by only applying them alone; some elements are to be embedded. Dyson (2000) stated that many elements are required to develop effective strategic plans, and performance measurement is one of them. Performance measurement is a process by which an organization monitors important aspects of its programs, systems, and processes (U. S. Department of Health and Human Services, 2011). To set up the performance measurement, performance management ought to be created first. Performance management is essential to control all the processes in performance measurement, starting from creating the goal and objective of measuring the performance. According to Propper (2003), the performance management process may differ depending on the level at which it is implemented and the type of the sector. Performance Measurement details are discussed in Chapter 2. At the same time, potential benefits awareness of

performance measurement triggers the needs for a better understanding of strategic planning impact (Tapinos et al., 2005).

Over the last few years, Performance Measurement (PM) becomes a valuable tool in measuring the company performance. The main reason for measuring performance is to assess the current position of the organisation and help managers create a better strategy (Ivanov and Avasilcăi, 2014a). Therefore, applying performance measurement to some extent will give an impact on strategic planning development. Initially, PM is only used in the business sector, yet, after getting attention from other industries, PM is also being applied in healthcare (Grigoroudis et al., 2012; Mannion and Braithwaite, 2012), public sector (Speklé and Verbeeten, 2014), construction (Nassar, Nadim Abourizk, Simaan Asce, 2014) and also in education (Kallio and Kallio, 2014).

Some educational related organizations provide a system namely a ranking instrument system (RIS) in measuring university's performance with several well-known systems in Malaysia include Quacquarelli Symonds (QS) World University Rankings, Times Higher Education World University Rankings (THE), The Discipline-Based Rating System (D-SETARA) and Malaysian Research Assessment Instrument (MyRA). This ranking instrument system is gearing universities to achieve the performance target. Administrators of universities begin to place more emphasis on their performance measurement plan to ensure that they can perform well in the ranking system.

All these Higher Education Institutions (HEI) ranking instrument systems (RIS) produce a yearly result. Before getting their final results, the participated institutions are required to submit pertinent information (according to the specific indicators) prior to being evaluated. The results are significant to determine their level of excellence. Instead of waiting for the outcome of that ranking system, it is more beneficial for universities to predict the results earlier than the actual ones. Hence, they can gauge their performance and enable

changes to improve their institution's performance. One of the ways to improve the performance is through the staff contribution. The increase of staff satisfaction will affect the productivity improvement, products' quality, or services and innovations promotion (Gabčanová, 2011). Therefore, the new Performance Measurement Model (PMM) is to guide the administrators to measure their performance at par with these HEI's performance ranking systems based on their staff's contribution. This research also aimed to investigate the suitable approaches in measuring the HEI performance based on several indicators. Moreover, the outcome of this research is to provide a recommendation/suggestion for managing and controlling the current result of the HEI performance by comparing the current achievement with the expected achievement calculated by the system.

## **1.2 Research Problem**

Nowadays, performance measurement becomes essential for many sectors in order to monitor their performance. In the education sector, there are a few ranking instrument systems (RIS) like QS World ranking system used to measure and rank the institution's performance based on several aspects. This competitiveness makes many Higher Education Institution's (HEI) administrators try to improve their performance in all aspects and also strive to perform well in the RIS (Abdul Azziz et al., 2020). Performance measurement models like the Balanced Score Card and Dashboard are often used in measuring performance. Balanced Score Card and Dashboard are the most popular models in controlling and gauging the targeted goals of an organization (Gawankar et al., 2015). However, the current used Performance Measurement Model does not emphasize on measuring individual capabilities in enhancing the overall performance of Higher Education Institutions.

There are few key elements that are always considered in the performance measurement models, such as financial perspectives, customer perspectives, internal environment, and employee satisfaction (Rafiq et al., 2020). One of the major concerns in the organization is to measure their staff's individual work performance (Patro, 2013). Staff's contributions and commitments are one of the key aspects in improving the organization's performance (Patro, 2013). Good relationship with the staff is important in planning a good performance strategy (Ugboro et al., 2019). However, some of the HEI's strategic plan are not focusing on the strength of the number of active staff, where all staff are included without considering non-active staff who may not be able to contribute to their institutions. This issue might lead to failure in reaching the actual target, hence, jeopardizing the final results. When the goal is not equivalent to the strength, many staff are expected to execute works that exceed their limit. In order to assist HEI's administrator in measuring performance especially for individual staff performance, suitable approaches that able to measure the performance based on staff's contribution need to be identified.

In today's technology era, one of the solutions in assessing the performance of an institution is by applying artificial intelligence (AI) in measuring the performance. According to Chassignol et al. (2018), AI can assist in enhancing the decision-making process in more effective and fast ways. It can assist in achieving the organization's goals and objectives as it can monitor and provide assistance in strategy planning and its implementation (Chassignol et al., 2018). The use of AI in managing employees is becoming increasingly popular as it helps the decision-making process to become efficient and effective and it is able to capture and process data in real-time (Hughes et al., 2019). In this research, a Knowledge-based System (KBS) seems suitable to be used as an AI technique that can assist in the decision-making process. KBS has successfully been applied to measure

computer performance (Dahouk and Abu-Naser, 2018) and measuring the performance in manufacturing industry (Ngai and Cheng, 2007).

However, there is still no specific Knowledge-based (KB) model that able to measure the individual performance of the staff. Although there are a hybrid Knowledge-based Performance Measurement System that has been proposed by Khurshid Khan and Wibisono (2008) and Human Capital Data Analytics Model (HCDA) by Nicolaescu et al. (2020) , it is difficult to directly apply it in measuring HEI performance as it is not suitable to map with the existing RIS in which staff performance is one of the main factors. The method used in the current Knowledge-Based model is not deemed fit to measure the institution's performance based on the staff contribution. According to Zhang et al. (2017), combining the model with another model/technique can help in enhancing the performance and overcome the weakness of the model. Thus, it is necessary to develop an enhanced Performance Measurement Model by adding or combining the KB with some other non-AI techniques or approaches.

As the development of the enhanced Knowledge-Based Performance Measurement Model (KBPMM) is new in measuring the performance of individual performance, the techniques used are not assured able to measure the institutional performance based on the current staff contribution. So, the validity of the model cannot be assured either the techniques used are suitable to measure the performance or not. A good validation procedure is important to ensure the quality of the product (Jyoti et al., 2020). Thus, the proposed model needs to be validated by experienced experts in order to ensure that it is able to assist the HEI administrator in measuring the performance.

Until this study is done, there is no comprehensive study related to the development of a model that can measure the performance based on staff contribution. For these reasons, it is reasonable that a study was conducted to find a suitable technique that can be used to